

# ABSTRACT VOLUME

*World Water Week in Stockholm*  
*August 17–23, 2008*

*Progress and Prospects on Water:  
For a Clean and Healthy World  
with Special Focus on Sanitation*

The background of the lower half of the cover is a light blue gradient. Overlaid on this are several thick, wavy, horizontal bands of varying shades of blue, ranging from a pale sky blue to a deep, vibrant cerulean. These bands create a sense of movement and depth, resembling water waves or a stylized landscape.

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*World Water Week in Stockholm*  
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\*Workshop 7 was a special half-day workshop with no abstract.

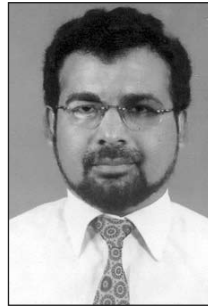
## Presenters Photographs



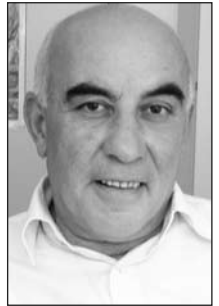
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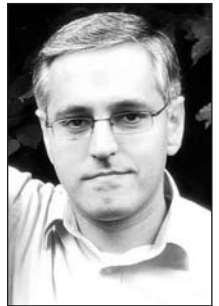
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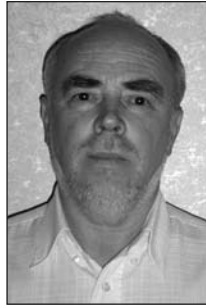
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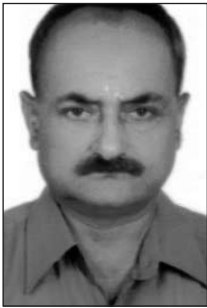
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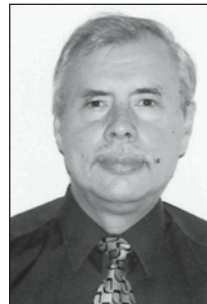
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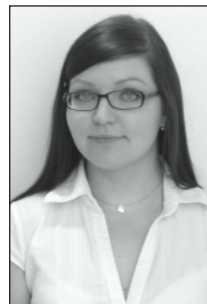
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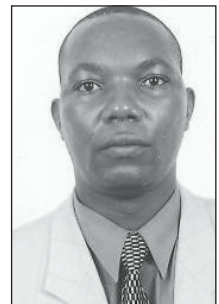
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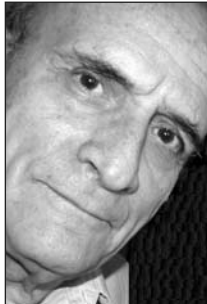
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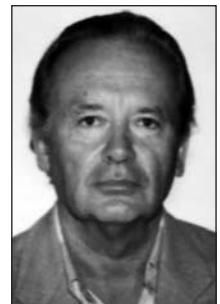
Dr. M. Suresh  
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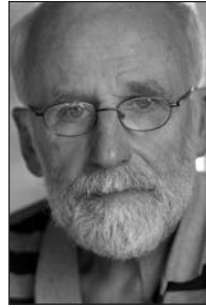
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# Efficient Reclaimed Water Use – Benefits for Farmer in the Jordan Valley

Author: **Mr. Sameer Abdel-Jabbar** et al.  
German Technical Cooperation (GTZ), Jordan

Keywords: Reclaimed Water, Irrigated Agriculture, Nutrient Management, Cost Reduction, Jordan Valley

The Jordan Valley (JV) is the fruit and vegetable basket of Jordan, where 80 % of the countries irrigated agriculture takes place. The exceptional climatic conditions allow the cultivation during winter season providing farmers with a good profit margin for their produce. Currently about 46 000 hectares are under irrigation using a wide range of water sources. Main crops are citrus, banana and vegetables.

While the northern area of Jordan Valley is still irrigated with water of the Yarmouk river, the middle and southern part mainly receives diluted reclaimed water from the highlands. Reclaimed water supplied to the Jordan Valley is mainly the effluent from the wastewater treatment plant at As Samra situated about 70 km upstream of Wadi Zarqa and 30 km northeast of Amman. On its course to the JV the reclaimed water is temporarily stored in the King Talal Reservoir where it is diluted by surface run-off water from adjacent catchment areas. According to Jordan Valley Authority (JVA), around 3000 farmers irrigate 11300 hectares with diluted reclaimed water. About 80 % of the area irrigated is under drip-irrigation in combination with plastic mulch, which is a good barrier against potential microbiological risks.

Reclaimed water delivered to the Jordan Valley contains substantial amounts of macro nutrients available to the cultivated crops. The nutrient values vary widely throughout the year with an average total nitrogen concentration of 18.6 mg/l most of it in the form of ammonium and to a lesser extent as nitrate. The average phosphorous concentration is 4.0 mg/l, and the average potassium concentration 28 mg/l . However, previous surveys revealed that farmers in the Jordan Valley spend around 10.7 US\$ million per season on buying commercial fertilizers.

The reclaimed water project (RWP) which has been jointly implemented by the Jordan Valley Authority and the German Technical Cooperation (GTZ) developed agronomic guidelines for the safe use of reclaimed water in the Jordan Valley.

Based on the intensive monitoring of nutrient contents of soils, reclaimed water and of the prevalent farming practices on more than 20 farms, one conclusion drawn was that reclaimed water provides plants with 20 – 40 % of their total macro nutrient requirements. The guidelines suggest a significant reduction of fertilizer application based on the actual nutrient content of the reclaimed water used for irrigation and the nutrient content of the soil. Furthermore, the use of single fertilizers instead of compound fertilizers is promoted allowing a more precise fertigation.

The guidelines were tested and implemented on-farm in cooperation with innovative farmers on 15 demonstration sites between 2004 and 2006. The project field staff advised farmers on efficient fertigation patterns and closely monitored fertigation and the resulting yields.

The results derived from two cropping seasons showed that the reduction of commercial fertilizers according to the guidelines did not affect the yields. Particularly P and K fertilizers could be reduced



by up to 60 % for some crops. Hence, farmers can save up to 60 % of the fertilization cost which is equivalent to xx JD/ha or US\$ 770 per hectare.

Assuming that one third of the target farmers (3 000) adopt the guidelines on farm level, the estimated cost savings are about 2.1 US\$ million per year. These savings are direct benefits for farmers through an increased income.

The project “translated” the academic guidelines into fertigation sheets in arabic language to be used directly by farmers. They are currently disseminated in an intensive training campaign for farmers targeting at least 1 000 out of 3 000 farmers in the project area. In future, these sheets will be updated according to changing nutrient values in the irrigation water and in the soil.

The increasing water scarcity in Jordan and significant population growth will urge the government to tap more reclaimed water sources for irrigated agriculture in the Jordan Valley. The experiences of the reclaimed water project in the middle and southern Jordan Valley will provide valuable experience to other areas in Jordan and the Middle East.

# Municipal Solid Waste as Agricultural Resource: Lessons from Colombo Municipality Area

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Keywords: solid waste, composting, Colombo, source separation, nutrient deficiency

Collection, deposition and management of Municipal Solid Wastes (MSW) are a mounting problem in Sri Lanka as in many other developing countries. The total collection of MSW by local government authorities in Sri Lanka is around 2,900 tonnes/day, in which around 25% of solid wastes are collected from Colombo municipality limits, the country's most urbanization area. The city of Colombo has a population of over one million with 650,000 resident population and 450,000 floating population living in an area of 37 km<sup>2</sup>. The collection and disposal of waste generated within the Colombo municipal limit is one of the challenging day to day task of Colombo Municipal Council (CMC).

The average density of waste collected in the Colombo Municipal limit is around 600 kg/m<sup>3</sup> and the gross weight of the collected waste is 700,000 kg/day. The bulk of the waste is organic materials from vegetable markets and households. The composition of the MSW is spatially and temporally varies depending on the type of activities and the communities. According to the test carried out in CMC, the organic component in the MSW was 81 percent in 1991 and has reduced to 65-70 percent in 2006. The change in composition indicates the change of MSW with the change in life style. The addition of plastic and other non organic materials to waste stream increases with the increase of income level.

The CMC collects and dump the wastes in open lands and low-lying marshy areas within the city on daily basis. This has been the general practice of CMC over the years in solid waste management. However, increasing garbage quantity, scarcity of lands for garbage disposal, environmental pollution, increasing protests and actions of civic society on dumping of garbage in open space has created a serious problem for CMC pushing them to find alternative means to manage the solid waste generated in the city limit. Composting of solid wastes was identified as one of the feasible solutions to minimize this growing problem in an environment friendly manner. The composting or recycling of wastes was seen garbage as resource but not waste. The composting project was implemented by CMC as government private partnership.

CMC signed a memorandum of understanding with a private sector firm called "Burns Environmental Technologies (Pvt) Limited for compost the wastes generated in CMC area for a period of 25 years beginning form 2002. CMC collects the household and commercial wastes through its collection networks which has about 2,000 labourers and vehicles on daily basis. All the collected wastes are transported and disposed in a specific location with in the city limit. 'Burns' collects the waste from this point to its composing factory and removes all contaminants from bio degradable waste to produce agricultural compost. CMC has to pay a tipping fee of Rs 500/mt of solid waste to "Burns".

The objective of this paper is to discuss the major lessons of composting of MSW in CMC area and the quality of the final product and marketing potential of the compost manufactured using MSW as an organic fertilizer.

The findings of the project show that composting of MSW is one of the most feasible solutions to minimize the growing garbage problem in the cities. Lack of awareness and education among the urban dwellers on sustainable waste management and no proper separation of wastes at source are key problems experienced in composting. It has been found that, MSW is suitable for composting after sorting, shredding and screening. Only about 50% of the solid wastes collected would be acceptable for composting after sorting, shredding and screening. The temperature and moisture content should be monitored throughout the composting process in order to obtain the proper bio-chemical qualities of the compost.

Quality analysis of compost reveals that most of the chemical, physical and micro biological properties are in line with the Sri Lanka standard (SLS) specifications. Nevertheless carbon-Nitrogen ratio is little lower than the specified requirement, which is mainly due to lower level of organic carbon in the compost. The main nutrient deficiencies are lesser amount of phosphorus and potassium compared to SLS requirement. Similar result for phosphorus was also found for compost produced by CMC waste by Weerasinghe and Ratnayake (1994). The findings also show that the availability of heavy metals are at lesser than SLS maximum limit. As CMC area has less number of industries, the addition of heavy metals to the waste stream is very less.

The compost manufactured has a good market demand as an organic fertilizer. However, the distorted fertilizer market by government fertilizer subsidy programme for inorganic fertilizer is a great challenge in marketing the organic fertilizer. Therefore, the composting projects implemented by local authorities strongly needs the incentives and other conducive policy environment from central government in order to sustain the project. Since, the urban solid waste management is primarily about behavioural change of the community rather than technical and financial, the responsible authorities should take initiatives to obtain more people participation through changing attitudes and behaviours. The experience of composting in CMC area clearly demonstrate the possibility of having solid waste management programme on a public-private partnership as a win-win model which is mutually beneficial and ultimately yields broader benefit to the society as a whole.

# Livelihood Impacts of Treated Wastewater Reuse in Agriculture in The Lower Jordan Valley (LJV): The Case of Wadi Al-Fara'a – Palestine

Author: **Ms. Suha Al-Madbouh/Abadi** et al.  
Bielefeld University, Germany

Keywords: Wastewater Reuse, Treated Wastewater, Agriculture, Livelihood Impacts, Lower Jordan Valley

## Introduction

The problem of increased pressure on the Palestinian water resources prioritized the reuse of treated wastewater in the Palestinian Water Policy adopted by the Palestinian Water Authority and Ministry of Agriculture (IWS et al, 2004). Irrigated lands in the Jordan Valley (JV) constitute more than half of the irrigated land in the whole of Palestine, and more than 50% of irrigation water in West Bank is consumed in the JV, where springs are main water sources for irrigation. The problem of water scarcity in West Bank and in the JV in particular can be alleviated by decreasing water consumption in agriculture, accompanied with finding alternative water resources such as treated wastewater (Sbeih M, 2005). Accordingly, agricultural reuse of treated wastewater is a major concern in the Lower JV. However, reasons behind failure of previous experiences in treated wastewater reuse (WWR) in agriculture have been mainly of sociocultural and technical origin. While lack of national strategy and guidelines of WWR makes it more rejectable, wastewater in Palestine has a high reuse potential due to its low industrial constituents (IWS et al, 2004).

Intensive water-related research started 50 years ago in Jordan Valley. However, a substantial gap regarding socioeconomic consequences of water-related issues on the livelihood of families still exists, and occupations linked to agriculture are mostly affected of water management decisions due to its major role in providing livelihood for families in the Jordan Valley (Wolff H., 2005). This gap exists since it was much easier to achieve common ground among the three riparian states regarding research and decisions on technical and natural aspects than in regard to evaluation of socioeconomic consequences (Wolff H., 2005). This ignorance becomes less important in countries of diversified economies such as Israel as it allows for a shift of employment and market from agriculture to industry and services. On the contrary, it becomes a major obstacle in Jordan and Palestine where non-agricultural sectors do not offer sufficient employment opportunities for the rural population (Wolff H., 2005).

Social acceptability, potential health risk on farmers and users' health, environmental and economic risks were considered as main livelihood constraints associated with the expansion of WWR in the LJV (SMART Project, 2006). While WWR in agriculture leads to tradeoffs in terms of generation of livelihoods for producers on one hand, it offsets the same by creating health and environmental risks at various levels on the other (Wi, 2006). Accordingly, the analysis of pros and cons of using treated wastewater in agriculture in terms of these parameters would help in assessing the tradeoffs of sustaining livelihoods of wastewater users.

## Objectives

In view of that, this study comes as part of wastewater reuse pilot project designed by SMART Project to support other technical oriented work-packages of the project. It aims mainly at i) identifying farmers' current practices of WWR in agriculture in the study area (Wadi Al-Fara'a), mainly their

needs and preferences, and comparing them with those of farmers who do not use wastewater ii) identifying a set of livelihood indicators (e.g. health risks, income opportunities, perceived economic risk) to assess livelihood impacts of treated wastewater reuse and comparing these impacts with the corresponding ones of using freshwater or untreated wastewater in agriculture, and iii) suggesting best practices for mitigation of negative impacts.

### **Methodology**

This study mainly adopts the qualitative research paradigm to achieve its objectives. Participatory Rapid Appraisal techniques are main tools to be used. These include i) Focus Group Discussions with the key informants, ii) In-depth, semi-structured interviews with the regional stakeholders who represent all community groups, and iii) Structured and unstructured observations of participants' social attitudes and health behaviors, their living and working environments and activities related to WWR.

Significance of the study: At the research level and contrary to the usual norm of technically and scientifically orientated wastewater-related research, data will be collected by the participation of the locals and stakeholders who will be involved throughout the research process as full partners rather than as contributors. In addition, the study will inquire about women's/mothers' opinion about WWR for irrigation.

At the community level, this research will introduce the stakeholders to the concepts of wastewater reuse and 'Eco-social' concepts and in clarifying their misperceptions.

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# Using Waste Water Safely and Profitably

Author: **Dr. Colin Chartres** (Invited Speaker)  
International Water Management Institute (IWMI)

The world currently faces food, water and energy crisis. All are interlinked, in that water underpins food production and water is also under competition for use in the energy sector including hydropower generation and biofuels production. However, until recently, we have continued to use water as if it is an infinite resource and we squander millions of litres through inefficient management practices in many sectors of the economy. Furthermore, once used in agriculture, industry and domestically, water is returned to the environment frequently contaminated with salts, pesticides, persistent organic compounds, sewage and heavy metals. Elsewhere, literally cubic kilometers of untreated effluent are dumped in the oceans, polluting fisheries and the environment alike. Storm water runoff is often similarly discharge straight into rivers, and lakes, or the ocean rather than being seen as a valuable resource. Whilst many developed countries have done much to clean up their act with respect to sewage treatment, there are many developing countries that have few, if any, operational sewage treatment plants. Where sewage is discharged into rivers, it is often reused almost immediately in its untreated form by poor farmers. Whilst the nutrients in the water can be regarded as useful fertilizer, other contaminants including fecal coliform bacteria, helminths, viruses and chemical and metal contaminants pose immediate health risks for those using the water for irrigation and for those who consume their produce.

This paper addresses some of the key issues associated with the utilization of waste water in agriculture in terms of viewing waste water as an important resource that can assist in fighting the water and food crises. It examines the major contaminants in waste water being used in agriculture and considers these from risks that they pose to human health and the environment.. It also considers the types of responses that are required from government to ensure that management, regulation and policy actions are introduced to ensure that risks are adequately minimized. The paper is focused around work in developing countries and will use examples from West Africa, India, Pakistan and Sri Lanka.

Wastewater use is already a common reality on some 20 million hectares, where inadequate local sanitation facilities mean that farmers often have no alternative to the use of heavily polluted irrigation water. In many cases farmers have to stand in the polluted water to extract it and the water is then irrigated directly onto the leaves of green vegetables and fodder crops. Furthermore, little may be done between the field and the point of sale to wash off biological contaminants. In other cases, heavy metals and persistent organic compounds may also be found in the irrigation water and these may accumulate in the soil and the edible leaves and tubers of food crops causing long term damage to consumers. Whilst immediate effects of contamination are usually most noticeable in terms of hospital admissions with diarrhea and parasites, long term exposure to other compounds may cause damage to internal organs and/or be carcinogenic. Where fruits and vegetables, or the meat of animals fed on polluted water is then exported to developed countries, the presence of contaminants in such products can do untold damage to future market opportunities for the country of origin.

To address these concerns, in 2006 WHO-FAO-UNEP released waste water use guidelines. IWMI was a major contributor to the development of these guidelines. The guidelines show that even in conditions where wastewater treatment is limited or negligible, risks for farmers and consumers can be significantly reduced. They aim at location specific measures for the locally best impact rather

than at meeting international thresholds. The guidelines are now being translated into fact sheets for farmers, policy makers and researchers that will be launched later this year. Still there are many challenges for research and development. These include:

1. lack of health risk assessments for consumers especially in developing countries where local adaptation levels can be very different from thresholds defined elsewhere
2. limited studies on alternative options for health risk reduction including on-farm water treatment, enhanced natural systems, and combined treatment and non-treatment (multiple barrier) options
3. lack of low-cost concepts for situations where pathogens and heavy metals pose a combined threat
4. slow progress in participatory wastewater governance where 'planning for reuse' is shifted from wastewater suppliers to wastewater users.

# Sustainable Water and Residuals Recycling – Lessons from North America

Author: **Mr. James Clark** (Invited Speaker)  
Black & Veatch Corporation, USA

Reuse of treated wastewater and recycling of treatment residuals can be safely accomplished, and should be included in any sustainable water resources management plan. Many jurisdictions in North America, particularly California in the United States, have invested much time and effort in developing recycling programs which are beneficial to the users and protective of public health. Regulations governing these practices have been enacted, and many successful programs implemented.

Appropriately treated wastewater can be safely used for a variety of activities including agricultural and landscape irrigation, industrial use, groundwater recharge, recreational impoundments, wildlife habitat, non-potable urban uses, and potable reuse. In California, over 620 million cubic metres (500,000 acre-feet) of treated wastewater is recycled annually, with a goal to double that by the year 2010. Considerations for public health protection, environmental concerns, aesthetics, public perception, political realities, economics, and technical feasibility must be evaluated, along with water quality requirements, treatment monitoring and reliability, operational issues, cross-connection controls, and use restrictions.

Treated residuals, often termed biosolids, have similar considerations and restrictions. One of the more popular reuse alternatives is agricultural land application. This requires a certain level of treatment for organic stabilization and pathogen removal, monitoring of potential pollutant constituents such as heavy metals and hazardous organic compounds, use of agronomic nutrient application rates, and control of application practices. Other residuals recycling practices include use as a biofuel, industrial uses such as cement production; and mixing with other materials to produce compost. The wet biosolids may also be dried to reduce the moisture for less expensive hauling to the end user. If stabilized in an anaerobic process, the biosolids can produce methane gas which may be used to produce electricity and steam for treatment plant operations.

This presentation will discuss the need for recycling and reuse of treated wastewater and solids residuals, the regulations which govern their use, and give examples of successful projects.



# Interactive, Target Audience Specific Ecosan Training Courses

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Keywords: ecological sanitation, training courses, education of local people, target audience, developing countries

## Interactive Ecosan Training Courses

The Millennium Development Goal to halve the number of people without access to improved sanitation cannot possibly be attained with conventional sanitation systems due to:

- the enormous costs for the pipe network,
- lack of water (for flushing),
- and serious environmental and social drawbacks.

Ecological sanitation (“ecosan”) is an established, cost effective, and environmentally as well as socially sound alternative that can help to solve the pressing problems in respect to inadequate sanitation. The objective of ecosan is to produce hygienically safe and useful resources from human wastes. This does not only enhance the environmental situation and reduce the pressure on scarce water resources, but also improves the living conditions of in a sustainable way; furthermore, it lowers risks for human health that springs from inadequate or lacking sanitation options.

Though ecosan is becoming more and more known worldwide and many projects have raised awareness and acceptance of innovative sanitation systems, there is still a significant lack of qualified personnel and people who actually implement projects at the grassroots level. The many successful projects in developing countries have created a market in the commercial, cooperative and public sector, as authorities increasingly recognize that the sanitation target cannot possibly be reached by conventional sewer based sanitation. This demand is to be met by qualified personnel who are able to put innovative ecological sanitation solutions into practice.

In order to successfully implement ecological sanitation solutions, a broad understanding is fundamental. The subject touches social, cultural as well as economic aspects; it requires knowledge of the local climate, the groundwater situation and soil conditions. Furthermore, expertise in ecosan treatment technologies and knowledge of options for reuse are essential in order to make the practice hygienic and safe, as well as a thorough comprehension of the underlying philosophy of sustainable water, energy and nutrient cycles.

Hence, this paper shows how in cooperation with the Innovative Ecological Sanitation Network India, the Ecosan Services Foundation, an India based NGO, and with the financial support of the German Agency for Technical Cooperation GTZ, seecon international developed an innovative and interactive set of ecosan training courses especially tailored to the needs of developing countries. These holistic courses have been tested and improved together with partners such as Maharashtra’s State Water and Sanitation Supply Department (MJP) and the Indian Water Works Association.

In order to meet the need of various stakeholders, who wish to learn not only different aspects of ecosan, but also have various levels of knowledge and interest, the paper explains how the course deals

with these requests. The course is offered in four varieties:

- Ecosan introductory e-learning course: E-meetings and classroom sessions with individual and partnered assignments take place over seven days. The course is aimed at a worldwide audience, in particular students in the field of water, environment, and sanitation. The learning target is the knowledge and understanding of ecosan concept. Successful participants are able to give the initiative to start an ecosan project.
- Ecosan introductory course: Face-to-face lectures and interactive exercises take place over three days. The course is aimed at a general audience; in particular decision makers who need to understand the various options in the field of sanitation. The learning target is the knowledge and understanding of ecosan concept. Successful participants are able to give the initiative to start an ecosan project.
- Ecosan Basic Course: Face-to-face lectures and interactive exercises take place over one week. The course is aimed at Strategic & administrative government staff, NGOs, and businesses. Successful participants have an in-depth, holistic understanding of ecosan and are able to plan and initiate own ecosan solutions, in particular within their respective agencies.
- Ecosan Expert Course: Face-to-face lectures, a two-day field trip to an existing ecosan project and interactive exercises take place over two weeks. Successful participants are able to design, plan and implement ecosan solutions on their own. This course is aimed in particular at practitioners, engineers and project managers.

With this range of courses, a broad audience can be reached, and the problem of a lack of local implementers can be countered. All the courses are taught by a team of international and local experts that have several years of experience in this field. Besides a basic structure, the courses are always adapted to the specific target audience.

The course received effusive responses from participants and respective organisations. In particular, the broad and holistic approach to sanitation and the innovative and interactive teaching methods were praised.

So far, four courses have been held in 2007 and two in 2008. They included four ecosan expert courses in India and Sri Lanka, one ecosan basic course in India, and one international e-learning course. More than 100 participants have been trained so far, and several projects have been implemented by successful course participants. Further courses for this year are scheduled. Participants have come from NGOs, government agencies, universities and private companies. This paper analyses the results and feedbacks from the current courses and presents these findings.

# Local ECOSAN Champions in West Africa

Author: **Mr. Linus Dagerskog**  
CREPA, Burkina Faso

Keywords: ecological sanitation, excreta reuse, west africa, local initiatives, pioneers

Some people are more open towards new concepts and dare to experiment. When it comes to introducing ecological sanitation, the successful pioneers in the community who lead by example are the ones that in the long run will spread the approach to the more hesitant parts of the population. We call them local ECOSAN champions.

CREPA has been doing research, training and project implementation in the field of ecological sanitation in francophone West Africa since 2002. During the dissemination phase 2006-2010 the aim is to touch more than 1 million people in the region with the concept of ECOSAN. This poster will display the personal stories of some local champions from different ECOSAN projects in the region. They have fully adopted the Ecosan-concept of collecting and sanitizing excreta to get access to safe fertilizer and grow more food. The local champions are vital in the process of spreading awareness of the benefits of ecological sanitation.

The poster will display five local champions, richly illustrated with photos. Here are three examples:

## **Mrs Maïga Fatoumata Sanogo, Fana, Mali**

Mrs Maïga is one of the pioneers of ecological sanitation in the municipality of Guengnéka in Mali. When CREPA-Mali initiated an ECOSAN project here in the beginning 2006 Mrs Maïga heard about the fertilising effect of urine, and she was curious enough to experiment even before she had her own urine diverting toilet. She has now used the urine of her family to grow onions, spinach, bananas, papayas and mangos in her homestead garden for almost two years. The plants receiving urine have a better vegetative development than the others and according to Mrs Maïga, the onions produced with urines even taste better!

“With the urine I am really relieved. In three days we fill up a 20 litre jerry can. We are 9 people in the family and everybody collects their urine. My ECOSAN garden gives me enough fruits and vegetables to eat and also some to sell so I can earn money.”

“People ask me what I do to make my fruit trees grow so well. Now I have trained 15 other women and also 6 old men. One of the old men used the urine to grow tomatoes and earned 100\$ when he sold his harvest. My only wish now is a larger piece of land so I could produce even more!”

## **Mr Ambroise Dipama, Saaba, Burkina Faso**

Ambroise is 50 years old and has been growing vegetables in a suburb of Ouagadougou since 1992. Four years ago he learnt how to use sanitized urine and faeces as fertilizer with the agronomist of CREPA Burkina.

“You easily see on the field where I have used sanitized urine – the leaves are larger and greener and the vegetables are bigger”

In Saaba not everyone who built a urine diverting dry toilet during the ECOSAN project (about 100 toilets) was interested to reuse the excreta. To have enough urine to fertilize his vegetables, Ambroise started to collect the urine of his neighbors. He used to spend 200-300 \$ per year on chemical fertilizers that he was able to save with the arrival of Ecosan in Saaba. With this saving and the earnings from his vegetables he could buy a moped. His neighbors have noted his increased income and are getting more and more reluctant to give away their urine for free – to Ambroise’s great frustration. He is now thinking about setting up urinals at the school or market to fill his needs.

**Dr Kodzo Dogba, Lomé, Togo**

Dr Dogba is professor at the Medical University of Lomé in Togo. He has been involved in supervising the risk and sanitary aspects in CREPA’s ECOSAN program during the research phase 2002-2005 and is now a member of the Regional Technical Committee that supervise CREPAs ECOSAN projects. He is also an ECOSAN ambassador in his home town, leading by example. In his garden, professor Dogba grows vegetables with the fertilizers he gains from the family’s UD dry-toilet.

Dr Dogba doesn’t need to buy certain vegetables like onion, tomato, paprika anymore. He can even sell the excess production in the local grocery shop. People are very impressed by the results and the exceptional quality of Dr Dogba’s vegetables. When it comes to taste and texture his vegetables are superior to the vegetables that have been grown with chemical fertilizer.

Respected people in society like Dr Dogba who are convinced of the virtues of ECOSAN will be the real agents of change. All CREPA agents involved in the ECOSAN projects should be able to lead by example. To begin, all that is needed is a simple urinal and a small plot of land or some fruit trees. A new concept like ECOSAN is very difficult to spread if we only “talk the talk” but don’t “walk the walk”!

# The Role of the Institutional Setting for Decentralized Wastewater Treatment and Reuse in Arid Climates – A Case Study of Jordan

Author: **Dr. Ines Dombrowsky\*** et al.  
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Keywords: wastewater treatment, wastewater reuse, decentralization, institutional setting, Jordan

In arid climates, treated wastewater can constitute an important resource complementing the water budget. Under certain conditions – such as remote locations without sewerage systems in place – decentralized solutions can be cheaper than centralized systems and provide additional benefits. Taking the case of Jordan, this paper analyzes the role of the institutional setting in enabling or constraining the potential of decentralized wastewater treatment and reuse under arid conditions.

In Jordan treated wastewater is considered as an important water resource. In realizing this reuse potential Jordan has so far mainly pursued centralized solutions, with an overall connection degree to sewerage systems of about 60%. Even if future plans for additional plants are taken into consideration, in principle a considerable potential for decentralized solutions exists in the country. In order to explore how the potential of decentralized wastewater treatment and reuse in Jordan can be realized the institutional framework conditions were analyzed based on document analyses and interviews with experts at various levels within the Jordanian administration.

The paper finds that the Jordanian institutional setting offers opportunities but also constraints towards the implementation of decentralized wastewater treatment and reuse options in Jordan, as such indicating the importance of the institutional setting. First, the administrative competences for the planning, ownership and operation of public wastewater systems are with the Water Authority of Jordan (WAJ), and not with the municipalities. The Jordanian government does, however, promote greater private sector participation and since 2001 WAJ may transfer the operation of wastewater treatment plants to other entities, including private operators or municipalities. Furthermore, private entities may implement their own plants at their own costs for which they need to get permission by WAJ. Second, funding for the capital costs of public wastewater project is also being funnelled through WAJ and the financial capacities of municipalities are very limited. Despite some reforms to strengthen municipalities in 2002, the total spending of municipalities is less than 6% of total government spending, a figure considered low in comparison to 20-30% in other developing countries. Third, the current tariff structure for freshwater, wastewater treatment and treated wastewater (in combination with the limited ability to pay by large segments of the population) tends to constrain the opportunities for full recovery of operation and maintenance costs by respective operators. This is in particularly the case in the Jordan valley where freshwater for irrigation is heavily subsidized. However, there appears to be a potential for decentralized solutions where households pay significant costs for tankers emptying septic tanks as a transition to decentralized system could allow for significant cost savings. Furthermore, ongoing reforms of the water tariff system are underway. Fourth, Jordanian standards for wastewater reuse are relatively strict, raising the question how monitoring for decentralized plants could be ensured.

This implies that under the current conditions there are two options to pursue decentralized wastewater treatment and reuse. The first is to implement decentralized systems in close collaboration with WAJ.

In doing so, there is in particular the opportunity to transfer the operation of the respective plants to municipalities, NGOs and potentially to the private sector. The second option is for the private sector to get the permission to design, implement and operate wastewater systems for clearly defined communities. This model might in particular be applicable for new affluent communities in the Greater Amman area. Beyond this, careful consideration should be given towards opportunities for further institutional change in the current process of decentralization and privatization, such as further tariffs reforms in the water sector and the strengthening of the financial capacities of municipalities.

# Sanitation System for the Slum Area in Indonesia: Recovering Nutrients from Human Excreta and Improving Sanitary Conditions

Author: Prof. Naoyuki Funamizu\* et al.  
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Keywords: Reuse of human excreta, Sanitation, Composting toilet, Low cost, Slum

## Introduction

The dry toilet is a toilet for bioconversion of human excrement into compost which can be used as organic fertilizer rich in N, P, and K. Although the several types of dry toilets, including urine separation toilet and composting toilets, have been developed, there are still rooms to be studied and discussed for implementing dry sanitation system to the developing countries. The sanitation system with dry toilet is completely different from that of water flush toilet and this raises the issues in the implementation of it which include

- culture relating to human excreta management
- initial and maintenance/operation cost
- social and institutional systems for supporting dry toilet system such as maintenance; collection and transportation system for compost and separated urine
- acceptance of compost and urine by farmers

Southeast Asian and South Asian countries have a slum area where sanitation system and resource recovery system should be improved. In the poster, field survey results in the slum area in Indonesia and long term operation experience of composting toilet are demonstrated and necessary conditions of sanitation system are discussed based on the field survey results. And the model of adequate sanitation system is proposed which includes not only toilet unit but also social systems for collecting and transporting compost and urine from an urine diverted composting toilet.

## Field Survey

The field survey area is Kiaracandong district known as a largest slum located near the center of Bandung city, Indonesia.. The study site was resident area W-02 of Sukapura village in the district. The population was 1,477 with 410 families. The area is only 0.03km<sup>2</sup>, and the population density is 19,000 persons/ km<sup>2</sup>. The field investigation from 2004 to 2007 showed that

1. Toilet squatting style toilets with water flush was used. Although 47% of toilet had septic tank, the maintenance of them was not adequate. The 53% of toilet discharged toilet waste directly to the river. Furthermore, sludge withdrawn from septic tank was dumped into river. People who does not have private toilet was using shared toilet and most of them stood along channel or ditch, and waste was directly discharged.
2. Water demand: Total amount of water used was 89 liter /capita/day, and 41% of them was used at toilets. People bought water with 20 liters plastic tanks, and the price was 250 rupiah/20liters or 5,000 rupiah/person/month (1 US\$ = 11,000 rupiah).

3. Income and expenses: Average income ranged from 100,000 to 199,000 rupiah /month/family. As to the expenses, cost for water, electricity and garbage collection occupied respectively 1-6 %, 4-7% and 0.1-0.7% of income. The construction cost of toilet used ranged from 1,100,000 to 4,100,000 rupiah excluding labor cost.

### **Study on People Perception for Using Dry Toilet: Introduction of Composting Toilet in a Religion School**

In Indonesia, they have a wet sanitation custom with flush toilet, clean water use for cleaning up the “body” after use. It is important to observe the habits of the people regarding their adaptability to alternative dry sanitation system. The composting toilet (CT) with special spray apparatus for cleaning up body was operated at the dormitory in the Pesantren Daarut Tauhiid, famous Moslem school in Indonesia three years, and we interviewed students after use. Their impression was:

- Only 9% said the CT was dirty, 91% said “It was clean to enough”
- By asking respondents for the comfort of CT in compare with normal existed toilet, 31% said CT better then the existed toilet, and only 16% said in contrary. About 50% of respondent said both model was accepted.
- After using the CT, 95% respondents agreed to use CT.

### **The model of Sanitation System for People in Slum Area**

Shift the society: The model of sanitation system for slum area was proposed. The model includes 1)urine diverted composting toilet for treating human excreta and garbage from kitchen and recovering nutrients; 2) collection and transportation system for compost and separated urine by local community; 3)utilization system of compost and urine at farm land.

Development of low cost composting toilet. The low cost urine diverted composting toilet was developed. To reduce the operation cost, urine was separated and manual mixing unit was installed. The locally available materials were used. The estimated cost was still expensive and approximately 800,000 rupiah, but this price is only 10% of the price of commercially available composting toilet in Japan. The performance of the new toilet was evaluated three month operation.

Compost and urine collection system. We examined the possibility to use current practiced solid waste collection system in the slum area. The case study showed that the additional cost of collecting compost and separated urine was approximately 10,000 rupiah /family. This amount of cost is compatible to the cost for septic tank maintenance (12,500-50,000 rupiah).

### **Conclusion**

The appropriate sanitation system model with composting toilet was proposed for the slum area in Indonesia based on social data through field investigation. Low cost composting toilet has been developed for improving sanitary condition and recovering resources. The work showed that the newly developed toilet and compost and urine collection scheme can solve sanitation problems in high populated areas. This system aims to recycle organic wastes(compost) by environmentally sound and low cost technology by reducing water usage and on-site treatment operated by local community.



# Waste as Resource and Wealth in Sustainable Aquaculture

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Keywords: Aquaculture, Aquifer, Phytoplankton, Recycling, Wastewater

## Introduction

Waste must be regarded as a resource for sustainable development and not as disposal matter.

Urban system emulates an ecological system when waste and resource are its essential parts. This leads to circular economy and ecological footprint area is reduced.

With economic growth, urbanisation and change of life style, resources including water are consumed in larger quantities and more waste is produced. With poor water management in many Asian megacities, 25 – 30 percent water is wasted and 80 percent of water consumed becomes wastewater which requires disposal through an expensive system of drainage. With unsustainable pattern of city development aquifer recharge is often difficult. Due to climate change, many cities in monsoon zones are under frequent floods where disposal of storm water is a problem.

Wetlands present in the periphery of many cities serve multiple functions including supporting biodiversity of aquatic and plant life, storing rainfall and releasing water into ecosystem. Sewage-fed wastewater is taken to wetland for natural recycling in aquaculture, producing fishes. Sludge and wastewater with natural composting produce vegetables in the surrounding areas and aquatic plants also contribute to the economy. These wetlands with waste water provide food, employment and improve environment by producing oxygen. With campaign of Ramsar Convention and environmentalists this indigenous system is preserved as wealth for sustainable development.

## Wastewater recycling

The World Health Organisation (WHO) suggested reuse of wastewater for aquaculture and agriculture and provided guidelines.

In Asia, Kolkata, Dhaka, Hanoi, and Shanghai many other cities are adopting wastewater recycling for aquaculture, taking wastewater as resource for farmers and fishermen. In many small scale operations, constructed wetlands are being used where there is no natural wetland.

In many cities in China, municipal wastewater is drained into waterbodies which work as fish ponds. In Hanoi, Vietnam, untreated domestic waste water including sewage effluent (70%) and industrial wastewater (30%) is discharged directly into a common sewerage and drainage system of 125km of sewers, 15 lakes, 25 canals and 4 main drainage rivers. The waste water which is considered a valuable resource is being used for fish farming, irrigation of vegetables and paddy fields producing 3000 tones of fish and 20000 tons of vegetables each year.

There are similar examples from cities in India, Bangladesh, Cambodia, Thailand and other countries with Kolkata in India having the largest recycling district.

## **Kolkata Case Study**

The Kolkata municipal system generates about 750 million litres of waste water daily. Local fishermen are using this for many years in about 150 ponds in eastern Kolkata, wetland system.

The pond units each of lagoon type (between 7 – 10 ha in size) facilitates natural aeration through wind action and allows sufficient sunlight to reach the bottom of a shallow depth of about 1.5m. This promotes growth of phytoplankton algae and photosynthetic oxygen. This oxygen is then taken into (usually) two sluice boxes as inlet and outlet points for periodical sewage feed exchange from the city's nearest drainage outflow channels and canals. Aquatic plants like water hyacinth and duckweed water are used to purify by exposure to sunlight and aeration (oxygenation) enhanced by sun and wind. This aquaculture is generally associated with urban agriculture. The city's garbage (solid waste) is dumped nearby and after manual separation of metals, papers the garbage is naturally composted. Sludge and waste water of ponds are used for irrigation for the production of vegetables.

In Southwest Kolkata, a fishermen's cooperative has taken lease of 15 ponds with 50 ha area where 25 million litres of sewage-fed waste water is treated. Fish is produced and the area is a nature park with microflora, birds and deer. In other municipal areas in metropolitan Kolkata community based wetlands ecosystem has been introduced, in participatory process involving fishermen and farmers.

## **Livelihood Options**

There are many aquatic plants which grow quickly in waste water ponds. Besides water chestnut, exotic flowers medicinal herb etc, many of these are traditionally utilised to make commercial products including indigenous building materials and ornamental handicraft.

## **Conclusion**

Wastewater recycling should be part of integrated water resource management plan. It produces wealth and at the same time it enhances environment and ecology which is essential in sustainable development.

# Composting: Vermicomposting Away of Reducing Urban Waste

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Keywords: Vermicomposting, Urban agriculture, Solid waste, sanitation, Incomegeneration

## Introduction

Composting is the process of turning waste into organic fertilizer. It is the most economical and sustainable option for organic waste management as it is easy to operate and can be conducted in contained space provided it is managed properly to produce a good quality produce. Composting is a natural process of organic waste treatment. It is also an accelerated decomposition of organic matter at high temperature in the presence of microorganisms mainly bacteria, fungi and actinomycetes.

Vermicomposting is an ecofriendly natural fertilizer prepared from biodegradable organic wastes and is free from chemical inputs. It involves the processing of organic wastes using earthworms. Earthworms ingest and transform organic residues into high quality humic material of earthworms to compost solid waste, it an effective way in that the compost generated. Vermicomposting is advantageous because it does not have any adverse effect on soil, plant and environment, improves soil aeration, structure and texture thereby reducing soil compaction, and improves water retention capacity of soil because of its high organic matter content. Furthermore it promotes better root growth and nutrient absorption and improves nutrient status of soil-both macro-nutrients and micro-nutrients.

Most of the urban centers in Kenya are unable to dispose off waste generated from domestic use, markets and hotels. Kisii town is no different scenes that are common in the town include animals such as cows, goat, sheep, pigs and poultry are a common scene and are seen around the dumpsite furthermore some people derive their livelihood from collecting peripherals like bottles and polythene paper. This has created a health hazard with prevalence to high levels of toxic gasses being emitted. Most of the people in the urban centers are practicing urban farming which is the practice of agriculture in urban and peri urban areas or small plots within compounds.

Urban farming is practiced for income-earning or food-producing activities. It increases the amount of food available to people living in cities, and allows fresh vegetables and fruits to be made available to urban consumers.

Preliminary study on urban agriculture in Kisii town shows that farmers are using any available land to grow vegetables .furthermore their incomes do not allow for purchase of fertilizers and thus Vermicomposting provides an alternative to the expensive, non environmental friendly fertilizers. This paper reports on a project done in Kisii town involving youth and women groups who used vermicomposting to reduce the amount of solid waste generated from the town. Vermicomposting has been introduced to farmer groups who practice urban farming in Kisii town with the aim of reducing solid wastes generated in the town, provide income to the farmers and beautify the town.

## Approach taken

The project is part of a larger project sponsored by International Development Research Council

(IDRC) known as integrated approach to research on water, sanitation and solid waste management in small urban centers in Lake Victoria Region of Kenya. The project's objective among others was to identify farmers practicing urban agriculture in the town. Questionnaires were used to get information on the number of farmers, what they grow, challenges and benefits that they accrue from the farming. The farmers formed groups with emphasis put on women and youths. These farmer groups were first trained on how to make the compost using a demonstration plot where the facilitators and trainers made the compost as they trained the farmers.

The solid waste was collected from the towns market and surrounding estates dumpsites, on site composting was encouraged so as to reduce the cost of transport. Special earthworms were obtained from the University of Nairobi's Soil Science department and provided to the groups. The compost takes two to three months to mature. The farmer groups were also helped to put together nurseries that would have trees and flowers. Each of the group made their own compost and used it on their farms and nurseries. The trees and the flowers were sold to customers and with the cooperation with the town council the farmer groups also sold trees and flowers and planted in the town for beautification purposes.

### **Conclusion**

The compost was sold to the farmers who had plots which they were growing vegetables to provide the essential nutrients. This generated income to the youth and the women, providing money for food, clothes and other basic necessities that they require. The youth were provided with an occupation which reduced their dependency on their family, promoted a sense of responsibility and reduced chances of lawlessness in the town. Furthermore this project significantly improved the lives of the town dwellers that depend largely on agriculture for sustainability.

# Promoting Resource Oriented Sanitation Technologies for Environmental Sanitation and Food Security

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Community Initiatives for Intergrated Development, Uganda

Keywords: Waste, Resource, Technologies, Sanitation, Agriculture

The provision of sanitation is a key development intervention without which ill health dominates lives. But the sanitation challenge is still looming among 60% of the population of the developing world, amounting to 2.4 billion people. Within the international commitments, legislations and regulations; national governments, civil society organizations and other stakeholders are struggling to make better hygiene and sanitation a reality. In the midst of these efforts, there is needed to take responsibility for the environment because inadequate sanitation practices impact negatively on it.

Community Initiatives for integrated Development (CIFID) is a network of 12 community based farmer groups in Buikwe county, Mukono district. CIFID works in congested peri-urban and rural communities where the lack of basic sanitation has led to poor waste management with open defecation, drain clogging, animal manure and waste littering. This has created a health hazard as it has favored the growth of disease vectors and contamination of water sources in a community where majorities are crop and animal farmers. Against this, CIFID promotes technologies that safeguard the environment and maximize the potential of waste products to be re-used at local level. The ecological sanitation practices promoted improve environmental sanitation by improving the management of animal and human excreta, drainages and solid wastes.

Through the Integrated Sanitation Improvement project CIFID is promoting bio gas production for rural farmer groups to increase incomes, improve home air quality, as a source of fuel for cooking as well as improving environmental sanitation. Using a household centered strategy, waste is treated biologically using anaerobic digestion. Organic materials and water are put together and ensure that there are no stones, sticks, and unnecessary materials then mixed with water in adequate proportions of Dung and Water ratio of 1:2. The mixture is fed into the digester through the inlet opening. The digestion process then takes place through fermentation of the material to form bio gas and slurry.

2 types of biogas digesters are promoted; the fixed dome bio-gas digester and the tabular Bio digester. The tabular digester is promoted more because it is cheap, easily repaired, maintained and materials are locally available. The fixed dome digester is constructed under the ground and the gas produced is stored in the upper part of the digester. The dome also has a compensation chamber into which slurry is displaced when gas production increases.

12 demonstration models have been set up for the groups and farmers have been trained on how to handle the process appropriately. Management of the digester includes protection of especially the tubular digester from direct sunshine, feeding done on regular basis with at least 19 kilograms of manure and 40 liters of water, monitoring gas pressure, monitoring the temperature, availing enough water and urine as well as emptying the digesters after at least one and a half years. The bio-gas produced is stored in a separate gas holder and is used as a source of energy for cooking and lighting

while slurry as a secondary product is stored in well covered outlets from where it is removed for use as fertilizer for group vegetable gardens and for mushroom growing.

CIFID promotes household Ecological sanitation latrines to enhance re-use of human waste as manure for their gardens and to improve sanitation in the community. Local communities have been supported to exploit local materials to adopt safe, environmentally -friendly household technologies and accept excreta as a valuable resource that can be used after composting sanitization.

The paper will show how the identified approaches maximize safe reuse, minimize environmental hazards, educate the community about environmental management benefits and ensure the balancing of local needs with wider environmental concerns by reaching out to the unserved rural communities.

# Promotion of Ecological Friendly Toilets in the Village

Author: **Mr. James Kilonzo**  
World Agroforest Centre (ICRAF), Kenya

Keywords: Ecological, Sanitation, Low cost, Waste management, Arbaloo

Nthaani village is a typical rural setting in Tulimani Division, Makueni District in Kenya where the Kavilo Women Group of 25 members is found. The area lies in the Arid and Semi Arid Lands (ASAL) and receives unreliable rainfall pattern averaging 500-1000mm per annum. The village is situated at the foot of Mbooni hills and members practice subsistence farming for their livelihood. Through the assistance of Regional Land Management Unit (RELMA), members have started building rain water harvesting tanks. The source of this water comes from the springs at the hills. The women of this group were trained as resource people in the community. Consequently, their services have been requested by several other people in the neighboring communities. They have been able to train other women in Kenya. Through exchange visits, they have been able to share their skills with other women in other provinces in Kenya and Tanzania.

The soils are not fertile and there is need for farmers to use fertilizers for their crops of which many of the members cannot afford. The other alternative is to keep livestock whose manure can be used to add nutrients to the soils, but not all members are able to keep livestock. Fruits especially the mangoes do reasonably well in these kind of soils.

Due to deep rooted cultural beliefs, the use of human waste as manure to fertilize crops is a new concept in this village although the members acknowledge the use of human urine as an antiseptic for curing wounds and the treatment of measles. The sanitary method used here is the “drop and store” or commonly known as the pit latrines. The pit latrines have a problem of smells and flies which later infect food and cause abdominal illnesses like cholera and dysentery. Pit latrines are also known to contaminate the ground water especially in this area where the members cannot afford to dig beyond 60ft. according to Ministry of Health, Public Health department, a pit is to be dug beyond 100ft to avoid contamination.

The project had an opportunity of introducing the “ecologically friendly toilets” or the “Arbaloo” in the village where the recycling of the human excreta or waste is done. The Arbaloo is a low cost toilet which is portable and can be moved from pit to pit. When the pit is two thirds full, that is, approximately after 3 ½ months, a new pit is dug and the toilet is carried high and moved to a new site to repeat the same activity. The filled up old pit is then topped up with garden soil, some water is added and then a tree is planted. In most cases a fruit tree is preferred as returns are realized sooner. To avoid ground water pollution, the Arbaloo is only dug to a maximum of 1 meter/3ft depth. The poster presentation will show the step by step construction and maintenance of the low cost eco-friendly toilets and their advantages in the recycling of nutrients. This will also include concrete slab construction showing the different types, making of the pit in either square or rectangular slab and giving the appropriate measurements of the concrete seat. For maintenance of the Arbaloo, a handful of wood ash will need to be added to the pit each time after use in order to enhance decomposition. To promote hygiene, a 5 litre jerry can of clean water is placed outside the door so that the user may conveniently wash their hands.

Being a typical project in the area, the poster presentation will portray the challenges and advantages of the case study at the Nthaani village. Different views from the villages will be presented so that other cultures may understand the advantages of human wastes as a resource in areas where soils are heavily depleted and crop harvesting is unreliable. Attitudes of people in Africa will change and will embrace the concept of “waste” turned into a resource which will be used to promote the socio-economic and environmental status of the village. The poster will show how this can be replicated in other communities in developing countries in general and Africa in particular.



# An Assessment of the Public Health Hazard Potential of Waste Stabilisation Pond Effluents Reuse for Crop Production in Arusha Municipality, Tanzania

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Keywords: Resource, Public health risk, Irrigation, WSP effluents, Re-use

The use of urban partially treated or untreated wastewater for crop production is receiving greater attention in most parts of the world due to the increasing scarcity and high prices of fresh water resources especially in semi-arid and arid regions. Wastewater reuse is one possible way in which food production can be improved especially in developing countries where food is often scarce. Due to the nature of sewage, fears have been expressed on the possible health hazards associated with effluent use. Health considerations are centred on the pathogenic organisms that are normally present in effluent; build up of toxic materials within the soil, and subsequently within the plant and animal tissue, which might eventually reach the human food chain.

In Arusha Municipality, there are waste stabilisation ponds (WSP) which are used for treatment of domestic wastewater. A number of people re-use effluents from WSP for irrigation. Irrigation using WSP effluents has received great attention and is mainly practiced in Lemara ward which is located downstream of the WSP. Crops which are grown using waste water as resources are maize (66.5%), Beans (54%), Vegetables (50.5%), Banana (39.7%) and others like fruits, potatoes, etc (19.7%). Generally people do not like to eat vegetables grown using waste water however these vegetables are sold in markets in Arusha where customers who do not know the source of the vegetables buy and use them. The situation of acceptability is different for crops such as maize and banana. For these crops people have no problem using them even when they know that they are grown using waste water. However the potential public health risks associated with waste stabilisation ponds effluents re-use in Arusha Municipality is of major concern. Health concerns are centered on pathogens and other health related pollutants that normally occur in the effluent.

This study is being conducted in Arusha Municipality, Tanzania as part of a big Resources Oriented Sanitation Concepts (ROSA) Project during the period from October 2006 to October 2009. Arusha Municipality is located in northern part of Tanzania in the foot of Mount Kilimanjaro and is one of the five districts of Arusha Region, with other districts being, Arumeru, Monduli, Ngorongoro and Karatu. It is situated between Latitudes 3.00 and 3.40 South and longitudes 36.00 and 36.40 east. It lies at an elevation ranging between 1160 and 1450 meters above sea level.

The study aimed at assessing the potential health impacts of WSP effluents reuse for irrigating crops. Some 95 farmers are using wastewater for irrigation of vegetable crops on plots of about 500m<sup>2</sup> each. Samples are collected from the effluent, the fields and vegetables and analyzed for selected water quality parameters of health significance. Results are compared to national and international guidelines for effluent use in irrigation. Farmers' knowledge on potential risks and practices are investigated through interviews.

Preliminary results show that 65% of the respondents are aware of related health risks of re-using WSP effluents for irrigation. Respondents reported no major disease outbreaks. Mean values of pH

are 8.1 and 7.3 for effluent and field soil and are within the FAO range of 6.5-8.5 for irrigation. Average temperature was 22.6 °C while electrical conductivity ranged from 784 to 957  $\mu\text{S}/\text{cm}$  and was less than the guideline value of 2000  $\mu\text{S}/\text{cm}$ . Total coliforms in the effluent were found to be 7291 cfu/100ml while faecal coliforms were 5836 cfu/100ml compared to the WHO limit of 1000 cfu/100ml for irrigation.

It can therefore be concluded that there is some health risks related to reuse of the effluent from WSP (resource) in the field, while for consumption of the vegetables there appears to be no risk.

It is recommended that appropriate wastewater treatment mechanisms such as another maturation pond be put in place to reduce the coliform levels. Farmers must minimize direct contact with the effluent. The long-term impact of the irrigation on the soil and the seasonal impact on results need further studies.

# Treated Wastewater as a Resource of Technical Water Supply

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Keywords: wastewater, treatment, toxicology, safety, utilization

## Presentation/topic

Utilization of wastewater as a main resource of technical water supply ensures the preservation of water ecosystems and independence of the industry development trends from the presence of natural sources of water supply.

Possibilities of the repeated use of treated wastewater can be expediently established by considering an example of the category of wastewater featuring the most complex chemical composition. From this viewpoint the wastewater of textile mills is highly representative since it contains up to about 300 different chemical reagents and is characterized by the COD and BOD values reaching several thousand mgO/L. The most typical pollutants include dyes and surfactants that pass into the wastewater in the amount up to 90%.

## Innovative nature of the paper

To the present day the quality criteria of polished municipal effluents have been developed for closed systems of technical water supply. The innovative nature of this study is determined by the following aspects: 1) utilization of a new ecologically and economically acceptable process technology combining the biological treatment of industrial wastewater on a carbon fabric with immobilized bacteria-destroyers and the adsorption advanced treatment on activated carbon; 2) hygienic substantiation of the repeated use of treated wastewater in technological processes with open water surface as harmless for man. Data obtained on the epidemic and toxicological safety of treated wastewater while using them in open systems of recirculating water supply can be extended to different categories of industrial wastewater.

## Practical application

The purpose of the present study was to establish the feasibility of safe repeated use of the treated wastewater by considering a case study of the worsted-cloth manufacture facility where the wastewater treatment procedure proposed by the authors was applied in industrial processes with open water surface. The wastewater at worsted-cloth manufacture facilities was produced in the processes of boiling, washing, carbonization, bleaching, dyeing, and wet finishing. As a result of these operations fragments of polypeptide chains, amino acids, dissolved products of keratin hydrolysis, surface-active substances, melanin oxidation products, dyes, stabilizing agents of peroxide baths, etc find their way into the wastewater.

The wastewater treatment was conducted in a rectangular bioreactor operating in the ideal displacement mode and having the design proposed by the authors. This bioreactor was equipped with submersible elements having activated carbon cloth. The wastewater passed the anaerobic and aerobic zones

along the motion of flow. Biodestruction of pollutants was achieved by using a culture of specially selected strains of microorganisms-destroyers. Biologically treated wastewater was subjected to the final treatment on a filter with activated carbon.

The efficiency of the method of biological treatment and adsorption advanced treatment of wastewater was estimated by controlling the indices of color, turbidity, COD, BOD, total organic carbon, the content of surface-active substances, oils, and resin-forming compounds.

Epidemic safety was estimated by the value of coli index, while the toxicological assessment of treated wastewater was performed on the basis of results of the skin-resorptive, general toxic, gonadotoxic, and mutagenic effects. The skin-resorptive effect was detected during the multiple application of the wastewater on the skin of tails of rats.

A six-month-long persistent sanitary-toxicological experiment was conducted on white male rats for estimating the general toxic effect of the treated wastewater. The gonadotoxic effect was estimated by changes of the functional indicators: mobility and osmotic resistance of spermatozooids, the number of stationary and pathologic forms. The mutagenic effect of the treated wastewater was investigated by using the method of dominant lethal mutations.

It was established that after the biosorptive treatment and final treatment on activated carbon the quality of wastewater was characterized by the following indicators: COD – 7.6–11.8 mgO/dm<sup>3</sup>, BOD<sub>5</sub> – 1.1–2.4 mgO/dm<sup>3</sup>, total organic carbon – from traces to 1.2 mg/dm<sup>3</sup>, SAS – 0.1–0.2 mg/dm<sup>3</sup>.

The treated wastewater did not produce a toxic effect on organisms of animals. However, after the polishing treatment on activated carbon the treated wastewaters were bacterially contaminated: coli index, generally, varied in the interval 230 – 2000, i.e., such wastewater required further disinfection.

## Conclusion/recommendations

The conducted investigations showed that:

1. The proposed technology of biological treatment on a carbon cloth with immobilized bacteria-destroyers together with the subsequent adsorption treatment on activated carbon makes it possible to obtain the treated water suitable for repeated use in technological processes of worsted-cloth manufacture.
2. The content of pollutants in the treated wastewater of an enterprise is reduced to harmless levels, when such water does not produce any toxic effect on organisms of animals. This allows us to recommend application of the developed wastewater treatment technology for repeated use of water in production processes with open water surface, even if wastewater have a complex composition.
3. Utilization of the wastewater after its polishing treatment on activated carbon in systems of technical water supply necessitates the prior obligatory disinfection of such water.

# Re-Sourcing Water in Africa and the Middle East

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Keywords: Wastewater, Reuse, Planning, Scale, Basin

Population growth, urbanization and growing economies are driving urban areas in many parts of the world to search out new water sources, which in turn is swelling the volumes of wastewater being generated. Conditions, issues and challenges are different for each region, country and even city. In the wealthier parts of the Middle East further investments are being made in already well developed infrastructure, whereby the wastewater is well treated and then distributed for direct reuse, with an increasing emphasis on using this “new” resource to satisfy some of the demands for new supplies. At the other extreme are cities in the poorer parts of Sub-Saharan Africa, where it is a struggle to secure even basic hygiene and sanitation services for much of the population, and planning for wastewater reuse is a low priority. In such cases only a small portion of the population is connected to piped sewer systems, and where they do exist there is either no treatment plant, or it is not functioning. Here the focus has been on less capital intensive approaches to improving the management and reuse of the rising tide of wastewater, including mitigating the effect of unplanned reuse.

In many basins in the Middle East and North Africa the inter-linkages between the freshwater source, drinking water, wastewater, and reuse are increasingly evident, and number of countries have incorporated and implemented the need for effective management of wastewater in their policies. In many cases, reclaimed water, that is effectively treated wastewater, is already the only practically affordable source for further development of agriculture, industry and non-potable municipal uses (Lazarova et al., 2001).

The characteristics of the wastewater management and water reuse systems are unique for each country, shaped by the prevailing economic conditions, from the highly treated wastewater used to irrigate urban landscapes in some of the Gulf States, a combination of treatment and regulation in Tunisia and Jordan, or varying systems of enforcement where farmers are irrigating with untreated wastewater.

Many sub-Saharan African countries are characterized by inadequate development and management of water supplies, poor hygiene and sanitation and food insecurity. Efforts to introduce conventional wastewater management systems in many of the urban areas have generally failed, in part because there are simply not the capital resources to extend coverage to the extent required, but also because of other conceptual, planning, implementation, institutional, and management deficiencies.

To meet the needs of the burgeoning population, this gap in sanitation and hygiene services has been filled by community systems based on combinations of latrines, septic tanks, cess pits, and open sewers. Such approaches are much less capital intensive, significantly less dependant on higher level institutions to maintain, and generally use less water, which is particularly relevant as the per capita volume of water supply is also typically low. However, while the volume of wastewater generated may be relatively low, these untreated and dispersed discharges often contaminate surface and ground water sources, especially when applied at scale.

This wastewater and in some cases contaminated freshwater sources are in many cases used in an unplanned fashion to support vegetable and fruit production for the urban markets, and more often than not provide livelihood options for the poor. Such practices present serious health risks for those working in the fields and the consumers. Being officially illegal, this unplanned reuse has been in practice ignored unless there was an immediate health threat or public outcry, usually to the detriment of those dependent on the practice for their living. Most recently, however, there have been efforts to better manage or mitigate these practices (eg. Ghana) while preserving or enhancing the livelihoods supported by the resource.

Recognizing the important of the immediate sanitation and hygiene needs; the fiscal, institutional and infrastructure constraints; and the past experience with conventional wastewater systems, it is essential that consideration be given to the likely system requirements in the medium to long term to effectively manage the resource (Bahri, 2007). It is imperative that solutions are developed in harmony with the local conditions, accounting for among other things the needs, traditions and capacity. Particular attention needs to be paid to the rate at which these urban areas are expanding, with the likes of Addis Ababa expected to double in size within the next 15 years, and the likely effect of using the existing community based approaches for sanitation services. Also, immediate consideration should be given to ensuring that industrial wastewater is not mixed with the domestic wastewater, no matter how dispersed it is.

### **Conclusions**

Increasingly wastewater management has to be considered in the context of the overall water resources management, especially in basins where it is becoming a significant portion of the overall resource. Furthermore, while it may be a low priority in the short term, the eventual development and management of the resource has to be considered in present efforts to meet the water supply, sanitation and hygiene needs of the urban population.

Conventional wastewater management systems have been less than successful in much of sub-Saharan Africa and have been supplanted by community based sanitation systems. However, on a large scale, these present their own problems. In some cases some form of piped sewer systems may be the answer, with treatment being deferred until the necessary capacity is in place. In other cases, the most appropriate approach may be to consider the water supply, use, wastewater system, and reuse at a local level, while considering the broader effects of scaling up.

# Integrated Water, Energy and Sanitation Solution for Stand-alone Settlements

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Keywords: Water, Energy, Sanitation, Integrated, Waste

Lake Victoria basin has one of the world's poorest and densest populations living in the backdrop of the second largest freshwater lake on the earth. The large rural and rapidly growing peri-urban population lacks sustainable solutions to safe and adequate water supply, energy and sanitation with access to safe water and sanitation assessed at below 60% by 2006. The populace depends heavily on biomass resource to supply energy with the dense population overstressing the land resource leading to massive degradation of the environment through deforestation, erosion and soil nutrient depletion. The cumulative effects are heralded by the high eutrophication and sedimentation of the surface water resources providing habitat to the invasive water hyacinth and pollution of the water systems leading to the proliferation of water borne and water related diseases that continues to compromise the health of the people of this region. Poor access to water, sanitation and energy supplies limits the participation of women in core socio-economic activities and interferes with the learning of the girl child as they allocate their precious time and energy to collect water and firewood for household use. This has compounded the poverty situation in the region with 63% of the populace living on less than one dollar per day while 70% are regarded as chronically hungry. This is due to their dependence on an over-mined and thereby unproductive soil system for an unrewarding agricultural production system.

To meet the UN millennium development goals on poverty eradication and battle the overall environmental degradation by 2015 in this region, an Integrated Water, Energy and Sanitation Solution (IWESS) is being muted as an entry package. This system aims to improve access to water and sanitation, provide biogas and biomass for energy and housing and the requisite manure for nourishing the depleted soils as a step to improving agricultural production. The system is being developed through a piloting initiative in two unplanned peri-urban settlements and one stand-alone scheme in the rural area of Lake Victoria. The goal is to develop a more sustainable way of utilising the natural resources through a concept that turns waste into a resource and thereby take advantage of what are currently considered as problem sources and converting them into useful inputs. The system proposes a paradigm shift from the conventional waste water systems that works on the principle of Mix First Separate then Dispose (MFSD) to one that aims to Keep Separate Treat and Use (KSTU) the waste in a closed loop system.

Tests from the Pilot and replication sites developed show that grey and black water, kitchen and solid human waste can be used as separate inputs into an integrated waste management technological chain system that incorporates a constructed wetland-biogas-sand filter system to purify water and biodegrade solid waste in a manner that provides water for non potable uses, biomass and biogas for energy and timber supply and manure for soil nutrient enrichment.

Initial results indicate possibility of continual supply of energy at 30 litres of biogas per day, 100 litres per day of non potable water with NTU values of less than 5, increased supply of biomass from

the wetland bamboo timber lots and up to 20 kg of manure from simple 200 m<sup>3</sup> units meant for homesteads and communal stand alone settlements. Further studies are going on to improve on the designs with replications and up scaling sites targeted for peri-urban settlements and institutions that currently do not have access to centralised energy, water and sanitation systems.

This holistic approach that ensures that waste is kept separate in the state in which it is generated, treated as it is and then used appropriately provides a viable solution to increasing rural and peri-urban access to safe water and sanitation and energy for domestic and agricultural use. The system when applied at macro scales will stem the increasing trends of environmental degradation while providing a lifeline to the disenfranchised rural communities who do not have access to safe and adequate water, sanitation and energy supplies.

The poster is a graphical design of the system, pictorial illustration of the pilot scenes and tabulated statistical display of the expected impact of the system in improving access to water, energy, and sanitation for stand-alone settlements.



# Fertilizer Value of Human Urine in Pumpkin (*Cucurbita Maxima*) Cultivation and Quality of the Products

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Keywords: Fertilizer, Nitrogen, Pumpkin, Sanitation, Urine

## Background

Water borne diseases are major problems in many countries; unhygienic sanitation is main cause of water source contamination, use of eco sanitation such as urine separation and use as fertilizer can be a good solution. In human excreta urine contains most of nitrogen, phosphorus and potassium; its fertilizer value can be NPK 18:2:5 (3). In general, pure human urine contains only few enteric microbes (1). Nutrient contents in urine could be good fertilizer for plants as in cabbage (4).

Main objective of this study was to evaluate the fertilizer value of human urine in pumpkin cultivation and evaluate the microbial and chemical quality of the products. Pumpkin was selected for this work because of its worldwide distribution and high N needed.

## Methods

Pumpkins (*Cucurbita maxima*) were planted in Kuopio and fertilized with urine and industrial fertilizer as 113 kgN/ha and control group was non-fertilized.

Used urine was collected from many eco-toilets a part of them located in south-western Finland and a part in Tampere district. Urines were analyzed for microbial and nutrient quality. Growth and number of flowers of pumpkins were monitored every 7th day. Commercial biomass and yield size were measured from each pumpkin. Harvesting had to be done early due to frost nights in early September.

Edible portion of the pumpkin yield was analyzed for microbial, nitrate, nitrite, chloride, soluble sugar and the taste assessment as in cucumber (1).

## Results

All plants grew well. Nutrient contents of NPK in used urine were 0.93-0.06-0.36 (low concentrated urine) and 8.17-0.65-2.1 (high concentrated urine), and few microbes were detected.

The growth of mineral fertilized was higher than urine fertilized and none fertilized from the beginning and urine fertilized was higher since 51st day of cultivation. Commercial biomass of mineral fertilized pumpkin was significantly ( $P < 0.05$ ) higher than none fertilized and urine fertilized pumpkins, but commercial biomass of urine fertilized pumpkin was slightly higher than non-fertilized and the size of pumpkin fruits were bigger, so that their use in kitchen was easier – similar as those fertilized with mineral fertilizer.

Few enterococci were detected in all fertilized pumpkins. The hygienic quality of all pumpkins were good and in the taste assessment subjects were not able ( $P > 0.05$ ) to differentiate the pumpkins from urine or mineral fertilized.

## Discussion

The study shows that the chemical and microbial quality of the urine fertilized pumpkin is as good as from mineral fertilized pumpkin. Industrial fertilized pumpkin plants showed N deficiency after a certain time and they stopped the growth, but urine fertilized had continuous growth as in cabbage (4). This is somehow supported by the claim of slow nutrients release in organic fertilizer than from mineral fertilizer (5). Industrial fertilizer can remain insoluble in soil if irrigation is not sufficient or in dry season but can be effective even in dry season.

Microbial quality of urine fertilized pumpkins was similar between all treatments. Compared to contamination by pure urine, yields in field can be also contaminated by other factors like birds, insects, wind etc.

Nitrate, nitrite and soluble sugar concentrations were comparatively lower in all treatments. Nitrate and nitrite concentrations were significantly ( $P < 0.05$ ) higher in none fertilized than urine fertilized pumpkins because of very small yield in non fertilized pumpkins group. The chloride contents was significantly ( $F = 15.492$ ,  $P = 0.001$ ) higher in urine fertilized pumpkins than mineral fertilized and none fertilized pumpkins as it was in cabbage (4). The taste of the urine fertilized pumpkin was similar with industrial fertilized, and all pumpkin was evaluated as good tastier as in cucumber (2).

## Conclusion

Urine separation and use as fertilizer is beneficial for environmental, economical and public health aspects. People can get fertilizer free of cost, it increase agricultural products and reduce nitrate and microbial contamination in water sources. This study demonstrates the benefits of eco toilet which can encourage for practicing the use of toilet and reduce open defecation. N-mineralization in the urine fertilized soil seems synchronized with the N-uptake by crops this may reduce the risk of N leaching to the water sources. Still further studies are needed in this field to make it safe and effective.

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# Scaling Up Sustainable Wastewater Use in Urban Agriculture: The Case of Sub-Saharan Africa

Author: **Dr. Susanne Scheierling**  
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Keywords: waste water, agriculture, water reuse, water scarcity, health

In part as a result of massive rural-urban migration, cities in Sub-Saharan Africa have been growing at unprecedented rates. This trend has been accompanied by dramatic shifts towards urban (and periurban) agriculture. Data on the extent of urban agriculture in Sub-Saharan African countries is sparse. Surveys in different cities indicate that the percentage of urban households engaged in farming ranges from 25 to 80%, satisfying from 25 to 100% of the vegetable and protein demand.

Especially in the semiarid and arid regions of Sub-Saharan Africa, wastewater, either untreated, partly treated or diluted with water from other sources, is the main irrigation source for urban agriculture. The production of municipal and industrial wastewater is growing rapidly due to urbanization, improved living conditions, and economic development. The composition of wastewater is also changing from being predominantly organic to including more toxic components as industry is expanding. With increasing scarcity of freshwater resources in many arid and semiarid regions and the intense competition for water in urban areas, wastewater is widely used as a low-cost alternative to other water sources. This is associated with a number of potential benefits. Urban agriculture relying on the use of wastewater provides increasing income and employment opportunities for vulnerable groups, and reduces hunger and malnutrition. It constitutes a reliable source of water supply and increases crop yields and returns from farming. It also conserves nutrients and reduces the need for artificial fertilizers. Furthermore, it is a low-cost method for the sanitary disposal of municipal wastewater.

Yet the use of wastewater for irrigation is also associated with serious environmental and public health risks that are receiving increasing attention. The environmental impacts include pollution of surface and groundwaters with high levels of nutrients, high total dissolved solids, and other constituents such as heavy metals, but also with pathogenic bacteria and viruses. The public health impacts can be direct and indirect. Contact with untreated wastewater through flood or furrow irrigation can lead to increased helminth and protozoal infections. Indirect impacts arise especially when vegetable and salad crops, grown with untreated wastewater, are consumed raw. This can be linked to cholera and typhoid as well as to faecal bacterial diseases, bacterial diarrhea and dysentery.

Due to the global and national public goods involved—including the environmental and health aspects and the poverty reduction potential—, public policy needs to play an important role in reducing the risks in the rapidly rising use of low-quality water in urban agriculture. The Water Anchor in the World Bank is currently carrying out a study with the aim of providing an overview of the use of wastewater and other low-quality water in urban agriculture in Sub-Saharan Africa, and its future potential for expanding food security and poverty reduction. Options are being examined for reducing the related environmental and public health risks, including both technical measures and policy and institutional support mechanisms. Based on this analysis, the study will suggest possibilities for increased involvement of the World Bank and development partners, and priorities for investments.

The paper will present results of this study, including (i) a review of the emerging patterns of water use in irrigated urban agriculture in Sub-Saharan Africa; (ii) a summary of the main impacts of these trends, focusing on the changing role of wastewater from a waste material to an important water source that must be better managed if negative effects on water and soils are to be avoided and public health and food safety risk minimized; (iii) a description of the technological tools as well as the main policy and institutional instruments applied in developed and middle-income countries as well as in the countries of Sub-Saharan Africa, including those promoted in projects supported by the Bank Group, other organizations, and international initiatives; and (iii) an outline of key operational concerns and issues, and recommendations for public policy entry points and possible support.

# Waste as a Resource – The Reuse of Domestic Wastewater for Crop Production

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Keywords: Waste water, ecosan, recycling, crop, rooftop

A domestic household in an urban Indian city of Bangalore usually has a 150 square metre plot. It also has a 100 square metre roof area. It is peopled by 4 individuals. Water consumption is 540 litres per day and waste water generated is 450 litres per day. Toilets use 160 litres per day.

## Supply

The city waters come from 100 km and 500 metres below the city. Embodied energy is high in pumping the water. It takes 80 mega watts of energy to supply the water to the city and an additional 80 mega watts to pump it into overhead tanks.

## Rainwater harvesting

The city receives on an average 970 mm of rain spread over 60 rainy days. On the entire 1250 square kilometres of city area incident rainfall translates to 3000 million litres per day equivalent. All this rainwater has traditionally been treated as a waste. Harvesting rainwater can help generate a substantial amount of the water requirement. A 100 square metre roof area receives 97,000 litres of water. This can be stored or recharged. Calculations suggest a storage of 6000 litres is good to harvest 70,000 litres. The rest of the water is put in through a recharge well. A mathematical model has been developed to optimize rainwater harvesting for households in Bangalore. Recharge well structures have been designed to harvest the rest of the rain and storm water for aquifer build up. Building bye laws now incorporate the findings and make it mandatory for all new building. Rainwater a waste has been converted to a resource.

## Ecosan

Ecosan toilets have been designed with bamboo as the superstructure material and are put in the first floor. Pans made out of fibre reinforced plastic have been developed and manufactured locally to make it available for all in the city. The ecosan system uses about 320 ml of water only for anal washing and hand washing purpose. A small water dispenser called the Tippy Tap dispenses small doses of water in the toilet. A yearly demand for toilets is of the order of 120 litres for the toilet which is met through rainwater from the toilet roof itself. The toilet generates 2926 litres of urine which is used to irrigate paddy and bananas. The faeces is composted on site and reused for paddy cultivation. Both urine and faeces which were earlier classified as a waste by the city have been converted to a resource and used for local urban cultivation on rooftops.

## Greywater

From the washing machine and bath around 75 litres of water daily and 27375 litres of water is generated annually. All this grey water is captured in a small tank pumped to the roof and is treated through a simple reed system using typha plants in 6 numbers of 90 litre drums. The treated water is used for paddy irrigation. Paddy is cultivated on the terrace on 45 square metre roof area and it is estimated that around 40 kilograms can be grown in a year on the terrace without any additional source of water except treated grey water and rainwater.

### **Kitchen water**

At 60 litres per day around 21,900 litres of kitchen water is generated. This is treated through an oil and grease trap and a planted sand filter and reused for garden purpose.

### **Composting**

Kitchen waste and the faeces collected in eco-san is composted on site for reuse in plants.

### **Dissemination strategy**

A combination of the website [www.rainwaterclub.org](http://www.rainwaterclub.org), a blog and you tube films have been used to widely disseminate findings and models developed. A weekly article in a national newspaper called Water Wise helps influence decision makers and educate and inform people in the city of the options available for sustainable water management.

Through a combination of rainwater harvesting, ecosan, grey water recycling and aquifer recharge systematic models for houses are being developed for the city to emulate. Already the rainwater harvesting system is part of the building bye laws of the city. It is possible that the entire gamut of technologies will be become part of the city policy for incentivization to enable it to sustainably manage water for the future.

# Waste as a Resource to Maintain the Human & Ecosystem Health – A Case from Sri Lanka

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Keywords: Water Pollution, Recycling, Biogas, Socio-economic benefits, Replication

Solid and liquid waste disposal is of major concern for the Marsh and the Lagoon areas in Negombo, a highly populated coastal town in Sri Lanka. Solid household wastes are dumped at roadside location, and are used or filling up plots of land. The smaller streams carry waste into the marsh and the lagoon. Organic pollutants originate from concentration of people as well as from the many small piggeries that can be found in many lagoon areas.

Besides the importance from the ecological points of view, there is a clear threat to human health. The marsh is an unhealthy environment as it is with many mosquitoes and the concentration of solid waste and pools of wastewater aggravate the possibility of disease. Particularly the poor have to cope with this, since their houses cannot be isolated from insects, and they often depend on ground water for at least a part of their water requirement.

Many people breed and fatten pigs as coastal areas are predominantly Roman Catholic and pork is a delicacy. The manure usually flows untreated and unused into the marsh and into the lagoon. The fish auction center at Pitipana, Negombo, the amounts of fish waste thrown into the lagoon is substantial. Until recently, shark heads constituted the major part of the fish waste dumped in to the lagoon.

Eutrophication is a serious problem in Negombo Lagoon. The cumulative effect of organic waste, which increases the irate level, contributes to the immense growth of filamentous green algae. Thick growths of algae also undermine fishery productivity and obstruct lagoon fishing activity.

## Objectives

This paper presents the lessons learnt from the waste – related initiatives that were executed under Integrated Resource Management Program in Wetlands (IRMP; 2002/2006) which sought to address the above described issues together with the communities. Five projects were implemented under the title of waste processing to achieve the objectives below.

- Mitigation the negative environmental effects on habitation and economic activity in the marsh and vicinity of the lagoon.
- Socio- economic benefits to the resource users
- Reduce the problems of filamentous algae bloom (eutrophication) in the lagoon.
- Establishing a model for successful replication

## Projects

### 1. House hold – based awareness, recycling, composting and home gardening

Waste management projects executed through NGO's have shown a great potential. Well-managed home garden gave a sufficient amount of vegetables for daily consumption while the excess was even sold and a good income for housewives. Composting reduces the organic waste dumping in to the lagoon.

Recycling of polythene, glass & paper was collected separately was important to keep the lagoon from becoming clogged with waste.

## **2. A biogas plant with pig manure**

The installation of a biogas unit at a piggery demonstrates the feasibility of generating gas from the manure of pigs. In collaboration with the National Engineering Research & Development centre (NERD) a biogas system was installed. It was linked to an existing CBO, which was to take care of the partial repayment by the client. The selected client agreed to pay half of the investment. The residues going in to the marsh are now quite harmless and odour is reduced. Despite the success the project cost (600 \$) is an impediment to replication.

## **3. A fish silage machine for converting fish waste to low cost animal feed**

A fish silage machine was seen as a solution to the large quantities of fish waste being dumped into the lagoon. The project was embedded at the Pitipana South Fishery Corporative society one member was volunteered to operate the machine. Technical expertise is obtained from the Industrial Technological Institute (ITI) for designing the machine and Veterinary Research Institute(VRI). VRI analyzed fish meal & this silage contains 42% protein.

## **4. Plastics waste recycling for the production of LP gas cylinder seals**

IRM program facilitated a contact between Shell Gas Limited & a NGO for the supply of LP gas cylinder seals made with recycled polythene collected in the Negombo Lagoon area. Shell Gas paid a fair price for two years. At a certain point a new manager preferred to use virgin plastic for better looking seals & terminated the contract with the NGO.

## **5. Community initiative on solid waste and water pollution management**

Communities in the form of Environmental Protection Committees(EPCs) adopted solid waste initiatives in a general strategy to improve the local environmental condition. They introduces compost bins, holiday clean campaigns, install garbage bins at strategic locations with town councils and took a high level initiative and ownership.

### **Outcome**

The below direct & indirect outcomes were obtained derived from the objectives.

- Reduction of solid and liquid waste and pig manure
- Increased awareness among population on waste management and nutrition , health, education and counseling sub- projects
- Trained people especially women become willing to recycle waste, even if the monetary benefits are too marginal to justify the effort
- Decrease the problems of eutrophication in the lagoon to a certain
- Helped functioning of CBOs Financial awareness and management skills were enhanced
- Created better link of CBO with local authorities.

### **Conclusion**

IRM Program aimed at protection of the ecosystem with the involvement of communities. The ultimate yardstick was a positive effect, directly & indirectly, on the functioning of the ecosystem. The involvement of communities is not sustainable if their economic constraints are not addressed. Therefore the consequences for the households in terms of income and time investment have been taken seriously to ensure the sustainability. Bio gas plant and fish silage machine introduced through this project can be replicated for any area, deals with similar problems, to convert the waste in to money.



# The PeePooBag – A Self-Sanitising Single Use Biodegradable Toilet

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Keywords: Sanitation, single-use toilet, nutrient reuse, human excreta, disease prevention

Over two billion people lacks improved sanitation which result in polluted water sources and disabled possibilities for reuse of excreted nutrients. Unsafe water, sanitation and hygiene together with deficient nutritional status and are major contributors to the global burden of disease (GBD) and contributed 19% of the 2001 GBD measured in Disability -Adjusted Life Years (DALY) (Lopez et al., 2006). In cities, even the mega cities, up to half of the food is produced locally within the city boundaries and one of the major factors limiting the production is lack of nutrients. By safe collection, disposal and reuse of the human excreta it would in many regions be possible to decrease the risk for transmission of diseases and to increase the house-hold food security. Nevertheless, the main part of the people estimated to lack improved sanitation is poor people in societies with weak infrastructure. Implementing and maintaining sustainable sanitation systems, and even toilet facilities, in those contexts may be impossible due to poverty, land tenure issues or high population densities.

The objective of this study is to develop a sanitation option for that socio-economic segment of society – a single use, self-sanitising biodegradable toilet including the system for collection and reuse based on the filed patent SE#07005116-9.

The concept is a self-sanitising, single-use, biodegradable toilet (PeePooBag) for collection of faeces and urine at defecation. The single use aspect gives the PeePooBag flexibility regarding privacy, the lack of which greatly influences peoples daily life with especially women being a vulnerable group. The PeePooBag will be cheap and light. Cheap enough to be managed as a commercial product (which however, does not exclude a non-commercial handling where that is regarded necessary) and light to be easy to handle for the user and to transport. The toilet, formed as a bag, is made by biodegradable plastic and is easy to seal, e.g. with a simple knot. It can be used in both standing and sitting. After sealing, the PeePooBag is odourless for over 24 h, allowing initial storage by the user. As its appearance resembles a plastic bag, it takes advantage of the widespread habit, in the absence of sanitations systems, to defecate in plastic bags. Important though, the PeePooBag adds the property of sanitising the material by use of urea integrated in the bag. Urea will degrade to ammonia upon contact with faeces and urine. Ionised ammonia,  $\text{NH}_4^+$ , is tolerated by most organisms and acts as a plant nutrient, whereas  $\text{NH}_3$  has a toxic effect even at low concentrations. The uncharged  $\text{NH}_3$  molecule freely passes through cellular barriers by passive diffusion and is responsible for the sanitation efficiency (Vinnerås et al. 2003). The faeces and urine in the PeePooBag are hygienised within a time-span of 2-4 weeks depending on the surrounding temperature. The PeePooBag will remain intact until the content is sanitised and no pathogens are available. This means that the PeePooBag can be thrown away anywhere. On the other hand, the used PeePooBag holds an economical value as fertiliser since the fertiliser value is enhanced by the addition of urea. This makes business systems possible to evolve and to be economically self sustaining. Therefore, a ordered system for collection and reuse of the used PeePooBag will be included in the concept. The full paper will present the whole toilet concept from the development and use to the collection, treatment and reuse as fertiliser.

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# Dry Toilet Compost and Separated Urine as Fertilisers for Cabbage and Potato – A Case Study from Finland

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Keywords: dry toilet, urine, compost, fertiliser, agriculture

## Introduction

Human excreta use as a fertiliser in food production is no longer a natural and sustainable process as it has been during the long history of agriculture. There has been a remarkable change from self-sustaining local agriculture to the highly industrialised production of food. Properly managed reuse of human excreta, however, would enable sustainable food production without increasing nutrient imbalances and run-off in agricultural soils. Currently the use of these fertilisers in large scale food production in Finland is not possible, since the current legislation does not acknowledge human excreta as eligible fertilisers. This paper discusses the chemical, microbiological and quality issues regarding of foodstuffs grown with organic fertiliser products – source separated urine and dry toilet compost.

## Experimental setup

An experiment was conducted during growing season 2007 where dry toilet compost, separated urine and combination of these fertiliser products were used as fertilisers for cabbage (*Brassica oleracea* var. Napoli) and potato (*Solanum tuberosum* var. Nicola). For comparison artificial fertiliser and no-fertiliser treatments were used. Compost and urine was collected from separating dry toilets from private households. Compost was about two-years old and urine was stored for several months before use. Amount of each fertiliser product used in this experiment was in accordance with Finnish legislation concerning environmental protection in agriculture – 80 kg N/ha for potato and 175 kg N/ha for cabbage. Microbiological quality was determined using *Salmonella* sp., faecal coliform bacteria, enterococci and clostridia as bacterial indicators and coliphages ATCC 13706 and ATCC 15597 as virus indicators. In addition heavy metal concentrations of the fertiliser products, soil and vegetables were determined. In addition the yield and the taste of the potatoes and cabbages were studied.

## Results

The fertiliser treatments did not result in significant differences of potato yield. Cabbage instead grew the best where urine and combined urine and compost were used as fertilisers. This shows that cabbage, which requires a lot of nitrogen to grow clearly benefits from the soluble nitrogen in urine. The use of dry toilet compost and source separated urine does not seem pose any significant microbiological risk for the cabbage and potato. From urine and compost no *Salmonella* was found. The amounts of faecal coliform bacteria, enterococci, clostridia and coliphages ATCC 13706 and ATCC 15597 in both fertiliser products, urine and compost, were very low. From potatoes and cabbage only enterococci were found from compost fertilised (408 cfu/g) potato and in combined urine and compost fertilised potato (88 cfu/g). These can also be of natural origin, not necessarily from the fertiliser products. Otherwise no other pathogen indicators were detected in the vegetables.

The taste panel did not find any significant differences in the taste of the potato and cabbage. This indicates that the taste of organically fertilised foodstuffs is equally good to products fertilised with artificial fertilisers. The results also showed that the use of the fertiliser products did not affect the

heavy metal concentrations neither in the soil nor in potato and cabbage. All heavy metal concentrations studied were way below the limit values, both in vegetables and soil.

### **Conclusions and future research needs**

Our findings in this study indicate that human excreta a) when source separated and b) correctly managed, stored and used, is a safe and sustainable fertiliser in food production. The use of the fertiliser products does not pose any significant pathogen risk, at least for Salmonella, faecal coliform bacteria, clostridia and enterococci and certain virus indicators, neither for the user of the fertiliser nor to the consumer of the crops. Crop plants that require a lot of nitrogen for their growth, clearly benefit from the use of urine. Urine is rich in nitrogen and it is already in soluble form. The results also indicate that the use of pure human excreta compost and urine does not increase the soil heavy metal content. One must bear in mind, however, that this can be confirmed only in long-term follow-up studies. Based on this and also other studies all over the world, there are strong indications that the use of human excreta as fertiliser should be reconsidered, also in Finland.

# Biofuel Production from Solid Waste in Rural Communities of P.R. China in Comparison to European Countries

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Keywords: biofuels, methane, solid waste fermentation, rural community, life cycle assessment

The decline and shortage of fossil fuel resources, the energy crisis, and the lack of healthy drinking water to millions of people, the water crisis, are two undeniable points of concern all over the world. Biofuels are considered by many as the obvious solution to the energy crisis. In areas where the shortage of healthy drinking water is caused by pollution, waste water and solid waste management as seen as key to overcome the water crisis. The proposed paper will show how solutions for both, the energy crisis and the water crisis, can be combined for a winning approach to ensure human well-being in rural communities of developing countries as envisioned by UN Millenium Development Goal # 7 (“Ensure environmental sustainability”: Reduce by half the proportion of people without sustainable access to safe drinking water.).

Research teams that inquire about the optimization of biofuel production have been focussing at different aspects of the problem from the economic, biological, chemical or environmental perspective. At present, the foremost concern in replacing petroleum by biofuels is the reduction of greenhouse gas emissions (Hill et al., 2006). The relation of various interacting factors for the optimization of efficient biofuel production need a systematic analysis to minimize the impact on the environment, that means to avoid further deteriorating of living conditions in developing countries.

The accelerating economical development in the P.R. China aggravates the energy and water crisis continuously. Recently, both issues are given high priority in policy making. After the first “gold-rush” for bio-ethanol production, the government of P.R. China has realized that it is essential to regulate the establishment of bio-ethanol plants. The majority of bio-ethanol produced in P.R. China stems from corn, thus threatening the security of food supply for large parts of the population. Therefore, P.R. China has decided to adapt the input sources for biofuel production from corn to starch and sweet potato but also, as applicable, the output product from ethanol based on corn to methane based on the fermentation of rural and urban solid waste (MOF, 2006).

Our paper will explore how the type of input material and production routine affect the production of biofuels such as bioethanol or methane. In a second step, we evaluate the efficiency of biofuel production for households of a small community based on life cycle assessment methodology. We are interested in the energy yield and how the carbon dioxide budget relates to various types of biofuels production—with a focus on waste fermentation.

We will present a detailed life cycle assessment calculation for a rural community (Dafengying, Shenxian region in Hebei Province, P.R. China). The community of Dafengying has 33.000 inhabitants. The community belongs to Shenzhou city area, which is located 250 km South of Beijing. The main crops in the area are corn and wheat. Farmers in Dafengying are traditionally recycling solid waste from agricultural activity for the production of methane, which is used for heating purposes.

The results of the status quo analysis and the life cycle assessment will allow us to make suggestions for the optimization of the ratio between different types of input sources for biofuel production and

waste recycling. The results are expected to support sustainable development of rural communities. Moreover, we will compare the results with the situation of biofuel production in European countries (setting the focus on Germany). This should allow us to point out factors of solid waste management, which influence the water resources situation. We will discuss the results in context of the various environmental policies enacted. The assessment of energy budget of rural communities should to enable decision makers to support policies for increased solid waste fermentation.

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## Workshop 2: Water Afteruse – Protecting Health and Ecosystems

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# A Voice for Waterways: An Integrated Approach to Managing Catchments and Waterways in Australia's Fastest-Growing Region

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Keywords: partnership, sediment, nutrients, ecosystem health, waterways

The South East Queensland (SEQ) Healthy Waterways Partnership (the Partnership) framework illustrates a unique integrated approach to water quality management whereby scientific research, community participation, and policy/strategy development are done in parallel with each other. It focuses on water quality and the ecosystem health of our freshwater, estuarine and marine systems through the implementation of actions by individual partners and the collective oversight of a regional work program that assists partners to prioritise their investments and address emerging issues.

The Partnership represents a whole-of-government, whole-of-community approach to understanding, planning for, and managing the use of our waterways. The Partnership has led to significant cost savings by providing a clear focus on initiatives towards achieving the healthy waterways: healthy catchments vision which is: By 2026, our waterways and catchments will be healthy ecosystems supporting the livelihoods and lifestyles of people in South East Queensland, and will be managed through collaboration between community, government and industry.

South East Queensland has one of the fastest growing populations in Australia, with just over 2 million people, increasing by 2.9% per annum. These increases in population are expected to result in 75 km<sup>2</sup> of bushland, agricultural land and other rural land being converted annually to housing and other urban purposes. Initial scenario runs using the Partnership's decision support tools have enabled us to understand the potential impacts in 20 years' time from the predicted population growth.

While this population growth will drive significant changes in SEQ, the issues relating to water are focused around adequacy of good supply and the significant demands urban growth will place on water allocation, water quality and waterways quality. Water supply, water quality, waste water treatment, urban use and reuse and healthy waterways are inextricably linked, and the strategic planning for these needs to be tightly linked. The sustainability of our rural sector and industrial growth, as well as achieving good ecosystem health in our waterways are all essential for urban growth. Hence planning for water needs to be done in a whole-of-systems context, embracing the SEQ region overall and embodying natural resource management in the broadest sense and not just water resources in isolation.

Inherent in the SEQ Healthy Waterways Partnership model is demonstrable proof that we can take a regional approach and have singular success. Guided by sound scientific and planning advice we have been able to improve the standard of wastewater discharged to our waterways. About 80% of the nitrogen and 60% of the phosphorus now is removed from the wastewater with consequent improvements in water quality for Moreton Bay and other waterways. From a healthy waterways perspective, the next major challenge is to effectively address the pollutant loads coming from non-point (diffuse) sources, if environmental targets are to be met. The Partnership estimates that within three years, diffuse pollution sources will contribute three quarters of the total nitrogen load, one third of the phosphorus load and up to 90% of the sediments coming from our catchments into our waterways.



Clearly this remains a priority, but it is equally as clear that this issue now needs to be addressed in concert with a wider set of issues relating to sustainable water futures for urban and rural growth. As such, the South East Queensland Healthy Waterways Strategy (SEQ HWS), developed through extensive consultation amongst partners, includes a set of ~ 500 actions to be implemented over the next 20 years to maintain and improve the health of SEQ's waterways , and achieve the Healthy Waterways Vision.

One of the hallmarks of the Partnership has been the development of a comprehensive and defensible aquatic ecosystem health monitoring program (EHMP) to provide an objective assessment of the health of waterways throughout South East Queensland. The EHMP releases an Annual Report Card, which provides a timely reminder to local and State Governments and the broader community as to how well we are tracking in terms of protecting the health of our waterways.

The Partnership's 'public face brand', the Healthy Waterways Campaign, provides an essential portal to communicating the understanding of environmental issues to the stakeholders. Healthy Waterways as a brand currently enjoys around 50% "brand" recognition in the South East Queensland regional community. The Healthy Waterways tagline 'because we are all in the same boat' reinforces the need for everyone to take responsibility for their local environment.

There is already a strong focus within SEQ to deliver through a "whole of water cycle" philosophy that gives a strong weighting to water quality planning and management. Key regional planning initiatives have been established in anticipation of the rapid population growth expected within SEQ over the next 20 years. What is not clear is how each of these initiatives will knit together to ensure a strong framework for the management of water as a potentially limiting resource, in ensuring security of supply for all sectors and the environmental outcomes we are also seeking for our catchments and our waterways. The opportunity and the challenge that faces us now is how to best evolve the Partnership model, with its attributes of strong regional integration, critical technical skills, track record and a strong "brand" presence to help deliver on our future needs for water and waterways health.

# SMART – An Integrated Water Resource Management Project for the Lower Jordan Valley

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Keywords: Lower Jordan Valley, Water Resources, Water Reuse, Water Demand, DSS model

In their Resolution 58/217 of 20. December 2000 the United Nations decided within the context of the so-called “Millenium Goals” on the implementation of the International Decade “Water for Life, 2005 – 2015”. The objectives of the Water Decade comprise inter alia to halve the number of humans without a safe access to water. Presently, ca. 1.2 Billion humans are without safe drinking water supply, i.e. a reduction by half implies that the safe access will have to be supplied to 280,000 people daily for the next 10 years (population increase included).

Within this context the BMBF (German Federal Ministry for Science and Research) issued the re-search program “Integrated Water Resources Management (IWRM)” to fund international projects for the sustainable development of water resources.

One of the funded projects is (SMART) project “Sustainable Management of Available water Resources with innovative Technologies in the catchments areas of the Lower Jordan Rift Valley.”

The main objectives of this project are:

- A More research on the geological and hydrogeological situation of the aquifers in the Jordan Rift Valley
- B Water quality investigations and control
- C Developing a new strategy for waste- and irrigation water reuse
- D Adopting of modern methods to use rain- and storm water
- E Socio-economical aspects and water management in the Valley
- F DSS for water management in the Lower Jordan Valley

German universities and research centres are working together with partners from the neighbouring countries of the Jordan Valley. First results of this project will be presented.

## Project strategy

In order to achieve the stated objectives, which cover a wide spectrum of disciplines and issues that need to be integrated, SMART has been structured following the DPSIR (Drivers – Pressures – States – Impacts – Responses) conceptual framework which has been adapted to the specific objectives of SMART, e.g., by adding Stresses and Policies:

This conceptual approach will be implemented to the project area, the JRV, which covers a wide variety of climatic conditions (from semi-temperate in the mountains to arid in the Jordan valley), socio-economic textures, environmental and ecologic characteristics and other specific problems.

## Work plan

The work plan of the project consists of 11 working packages.

They are as follows:

- WP 1: Project management and coordination
- WP 2: Data and Information Management
- WP 3: Geology Hydrogeology and Geochemistry
- WP 4: Water budgets
- WP 5: Technologies – Managing Waste Water for Reuse
- WP 6: Tools for scenarios
- WP7: Tools for socio-economic assessment
- WP8: Precision irrigation and artificial recharge
- WP 9: Definition and assessment of IWRM scenarios
- WP 10: Impact of IWRM Scenarios
- WP 11: Dissemination, training and technology transfer

### **The Catchments area (Wadis) of the model region**

In frame of the IWRM-Project concept in Jordan Valley detailed studies in 8 different catchments areas (wadis, s. Tab. 2) are going on since 4 months. The different catchments areas are classified due to different criteria's (hydrogeological situation, Type of problem, Water use, socio-economic structure, potential solutions options, applied technology). The criteria for the different catchments areas allow us to develop a general concept for the region and may be to apply the results on similar semi-to arid regions. A decision support system will be developed for catchments areas. This system will help by applicable recommendations between supply and demand in dependence with other factors.

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# Geochemical and Isotopic Investigation of Seawater

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Keywords: pollution, nitrates, seawater intrusion, Coastal aquifer, Tunisia

As many other semi-arid regions, the Cap Bon peninsula (N.E. Tunisia) shows a parallel increase in overexploitation and mineralization of groundwater resources and the groundwater quality is deteriorating. Along the coast, the seawater intrusion resulting from the groundwater overexploitation is identified but is not the only cause of the qualitative degradation: the irrigation development that induces the soil leaching and the fertilizers transfer to groundwater over the whole aquifer extent is another major reason of the mineralization increase.

Because of the regional situation along the seashore, the seawater intrusion in the unconfined Plio-Quaternary aquifer is an obvious explanation for the rising salinity but other processes may also be intervening. Surveys including level measurements, hydrochemical and isotopic samplings were performed in 2001, 2002 and 2003 and results were compared with previous information.

The study area is 45 km long and 17 km wide at the most, with a mean annual rainfall of about 500 mm and potential evapotranspiration of about 1100 mm. The landscape is a coastal plain slightly sloping (3%) towards the sea. The Plio-Quaternary aquifer extends over 475 km<sup>2</sup> and its thickness varies between 30 and 150 m. Groundwater flows from NW, at the foot of a mountain range, to SE in the coastal plain. Two deeper aquifers exist but they are separated from the Plio-Quaternary aquifer by an impervious clayey layer.

Piezometric and salinity maps of the Plio-Quaternary aquifer were established. The continuous increase in pumping has created several depressions in the water table, up to 12 m below msl and induced a deterioration of the water quality. The temporal changes in water-table level and salinity are often similar which suggests a strong link between them.

Several geochemical approaches were performed to identify the importance of the marine intrusion in the increase in mineralization. The chloride is strongly correlated to the sodium for the majority of the samples. Even for points far from the sea, the Na<sup>+</sup>/Cl<sup>-</sup> molar ratio does not significantly differ from the Mediterranean ratio (0.86). This indicator is then of a limited interest for distinguishing the origins of the mineralization.

The contents of Ca<sup>2+</sup> and Mg<sup>2+</sup> are very variable. In most cases, Ca<sup>2+</sup> is higher than Mg<sup>2+</sup> but for 4 samples (11635, 11637, 11281, 11828) where the Ca<sup>2+</sup>/Mg<sup>2+</sup> ratio lower than 1 indicates a mixing with the seawater (marine ratio 0.2). These points are close to the sea in the region where the mineralization is the highest.

The Br<sup>-</sup>/Cl<sup>-</sup> ratio is often used for identifying a possible seawater intrusion because of its relatively constant value (1,5.10<sup>-3</sup>) in the present sea water. In the Plio-Quaternary aquifer, the Br<sup>-</sup>/Cl<sup>-</sup> ratio is

in general lower than the marine ratio. The few points close to the dilution line of seawater may trace a mixing with the seawater.

The graph  $18\text{O}$  vs.  $2\text{H}$  shows three groups. The first one ( $18\text{O}$  between  $-4.3$  and  $-5.5$  ‰) is between the global meteoric water line (GMWL) and the local meteoric line of Tunis-Carthage (LMWL). This reveals the important contribution of the present rain to the groundwater recharge. These points are situated all over the plain and especially close to the temporary rivers. The second group, along the mixing line with the seawater, corresponds to wells in the piezometric depression (P19, 11281, 11635, 8684, P3, 5729, 6077, 5610), but two exceptions (3002, 5994). The seawater contamination is then clearly identified. The third group with isotopic values lower than the mean present rainfall ( $18\text{O}$  between  $-4.82$  and  $-6.05$  ‰) is made of wells in Miocene and Oligocene aquifers with a probable mixing between present and old waters.

In the old measurements, typical of the natural state, the upstream part of the Plio-quaternary aquifer was more mineralized than downstream. This implies that the rainfall infiltration in aquifer outcrops is significantly complemented by the infiltration from temporary rivers floods when they reach the plain. Recent observations confirm the importance of the present recharge: after rainy years, as 2003 and 2004, the decrease in mineralization is clear.

In this region, the  $18\text{O}/2\text{H}$  study is the most efficient geochemical tool for characterizing the seawater intrusion. As the most depressed areas are not systematically the most mineralized or contaminated by the seawater, other processes modifying the Plio-quaternary chemistry are to be searched for. An upward leakage from the Miocene aquifer is very weak or even nil: its mineralization is lower (less than  $1 \text{ g.l}^{-1}$  for 90 % of the samples), even in the depressed area. The return of irrigation water to the Plio-quaternary water-table affects the whole region, whatever the thickness of the unsaturated zone (1 to 31 m), as shown by the  $\text{NO}_3^-$  content (median value of  $90 \text{ mg.l}^{-1}$  in 2001) This a fundamental driver of the geochemistry changes for the coming decades.

All around the Mediterranean sea, the human modifications of the natural water cycle are now superimposed over the large natural hydrological variability, following asynchronous dynamics. Even in apparently simple cases as this present study, a cautious and critical approach is necessary. Only the comparison of different methods at different spatial and temporal scales can lead to the pertinent identification of main processes at work.

# Environmental and Public Health Hazards of Nitrate Accumulation in the Soil-Groundwater-Food Chain in Central Bekaa Valley, Lebanon

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Keywords: Intensive agriculture, nitrate accumulation, leaching, groundwater quality, dietary intake

Increased pressure is put on water resources by growing population and other social and industrial needs. Agriculture is a major source of nitrates in the soil-groundwater systems. Loss of nutrients from agricultural lands by means of leaching and surface runoff is suspected as one of the important non-point contamination sources. The research aimed at assessing the environmental and health risks of nitrate build up in the soil-groundwater-food chain. The study was carried out in Terbol area in the central Bekaa valley of Lebanon, which is located between Lebanon and the Anti-Lebanon mountain chains. The plain is filled by Quaternary sediments. Fluvisols are the dominant soil type in the central plain found in association with Regosols, Cambisols, Vertisols and Luvisols. Annual precipitation ranges between 500 and 700 mm. The depth of the perched groundwater table varies between 1m and 10 m near the Litani River and up to 25 m in other locations. Wells used for irrigation have a depth varying between 75 and 90 m.

The field assessment survey undertaken by our team showed poor agricultural practices prevailing in the region consisting of excess fertilizer input, absence of rotation and mismanaged irrigation are the main factors affecting the high residual N left in the soil after harvest. Agriculture in the Bekaa valley mainly focuses on field crops, vegetables and in some areas on fruit trees. In vegetable cultivation, high inputs (over 750 kg N ha<sup>-1</sup>) of inorganic fertilizer per vegetation period lead to large amounts of residual nitrogen (> 450 kg N ha<sup>-1</sup>). The high soil-groundwater vulnerability to contamination is due to vegetable monoculture as observed in Terbol area and to the fact that land is left bare for the winter season. This poor land management coupled with the rainfall pattern is responsible for nitrate fast leaching reaching the shallow water table. Nitrate concentrations of more than 300 mg L<sup>-1</sup> have been measured in the local ground water as a result of leaching. This water is largely used for irrigation and farmers do not control N input from fertilizers, soil mineralization and irrigation water. As a result, the quality of groundwater is deteriorating by a steady increase of NO<sub>3</sub>, NH<sub>4</sub> and salinity value. Monitoring of the impact of landuse and cropping pattern during the years 2001-2003 and 2007-2008 showed high nitrate discharge to groundwater from vegetable monoculture (275 kg N ha<sup>-1</sup>), 175 kg N ha<sup>-1</sup> from fruit trees and close to the tolerant level discharge from simple potato-wheat rotation (45 kg N ha<sup>-1</sup>).

Our studies using modern irrigation techniques and controlled N input showed the possibility of reaching higher nitrogen and water use efficiency. Reducing environmental risks of nitrate buildup in the soil-groundwater systems can secure accepted quality irrigation water and reduce public health hazards related to nitrate dietary intake. We are now assessing the Lebanese average diet and currying analyzes of fruits, vegetables and other consumed fresh products to quantify the average daily nitrate consumption. A demonstration plot is being organized on the Farmer's field where neighboring farmers and local consumers will be invited on a regular basis to show the good agricultural practices. Starting from next spring, we are planning to satisfy the plant needs for N from the soil reserves and

irrigation water. Therefore, in order to stop the polluting agricultural practices and prevent further contamination of the soil-groundwater system, we will expose the feasibility of this approach and the possibility of money saving through following environmentally sound practices. This will allow controlling the nitrogen balance in the soil-plant system and reducing the cost of fertilizers input and energy saving for water pumping from deep wells without affecting the quantity and quality of fresh vegetables. Demonstration and information dissemination will raise public awareness on the risks of nitrate buildup in the soil and explain the negative environmental consequences and public health hazards related to the deterioration of groundwater quality.

# Valuing Water Afteruse – Why? How? What? Lessons from Engineers Without Borders’ Rural Community Development Projects

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Engineers Without Borders’ (EWB) water afteruse projects have been jointly implemented with local community stakeholders across the general categories of: direct human usage, nutrient capture, and energy capture. The approaches and technologies are robust, low cost and deliver benefits that are recognized by rural community residents. Interestingly, and consistent with development experience, the benefits recognized by rural households that incentivize project implementation are related to household-level needs for clean water, sufficient food and energy and family health rather than community-wide, basin-wide recognition of water afteruse benefits. These Engineers Without Borders rural project experiences provide insight into Why community recognition of water afteruse benefits within highly constrained, rural living conditions require effective stakeholder communications.

To assure sustainability of water afteruse programs in rural communities, stakeholder outreach must complete the critical link between recognition of household-level benefits and the relationship to community-level, basin-wide benefits. EWB projects provide insight into How this critical community outreach link can be developed.

Given the ongoing pronounced human migratory patterns across most of the developing world from rural to larger, more dense peri-urban and urban communities, it will be important to adapt the message from effective rural stakeholder outreach programs on water afteruse to the very different constraints and incentives faced by peri-urban and urban households who have made this migration. What are some of the ways to leverage lessons learned from Engineers Without Borders water afteruse technologies, knowledge, community engagement, and capacity building in small, rural communities to facilitate this improved awareness in new urban households?



# Mobilizing Wastewater to Protect a Sustainable Water Cycle in Different Indus Zones

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Keywords: drainage effluent, hydronomic zones, flood plain rivers, water cycle, regenerative

The freshwater stress, rivers pollution, increasing industrial and urban waste, groundwater deterioration and new areas requiring effective drainage are growing challenges faced by the country. For decades, development of water resources in the basin has benefited from the natural resilience provided by the drainage and flood-plain characteristics of the rivers. The system at the basin scale is no more regenerative, while new commitments for drinking, sanitation, agriculture and hydropower developments have been made. The water quality and wastewater management problems are increasing. A sustained water cycle needs to minimize effluent quantity, control quality and maintain regenerative potential of surface and ground water bodies. A protective approach towards alluvial surface-groundwater conjunctive system is the key to address over-exploitation of resources in the vulnerable regions and mobilize all available water. The paper highlights how fresh, used and saline water management can address the zones having different hydrological potential. Each zone needs a well sort out combination of technical, regulatory and monitoring measures. Three situations need to be managed.

1. Pollution of lakes, rivers and canals due to untreated urban and industrial discharges. Accumulated municipal and industrial waste disposed into rivers of Pakistan was 56 m<sup>3</sup>/sec in 2000, about half dumped into Ravi river (Saeed 2002). The biochemical oxygen demand load for this wastewater is 104 to 240 mg/l. The least and most polluted rivers, Jhelum and Ravi require a BOD load of 45 and 885 tones/day respectively. The total dissolved salts monitored in 2003 (PCRWR) were about 600 mg/l in Sutlej river, 4600 mg/l in Hamal and 5300 mg/l in Mancher lake. All three are important for the local water access. The Ravi and Sutlej rivers have no committed fresh flows for their waterways in Pakistan.
2. The groundwater quality deteriorates by over extraction and saline water mixing in the fresh aquifer. Water productivity, natural drainage and recharge potential declines in these areas. Relatively higher drainable effluent generates and accumulates in the saline aquifer zone.
3. The development of infrastructure contributes to changed natural hydrology of watersheds, flood and irrigation plains. It also sets new urban supply and drainage management tasks.

The above-mentioned conditions in different regions create at least three large zones (equivalent to hydronomic zones – Molden 2001), having smaller diverse segments. The most threatened freshwater areas are bounded by unreliable or drying rivers. The surface diversions are supplemented by groundwater mining. The net water balance of these areas is negative (Habib 2004, 2006). An unaccounted shift of water from irrigation to other sectors is occurring. The industrial and domestic effluent is exponentially increasing because of high population density and commercial activities. Large sections of Ravi River (passing by the Punjab capital Lahore) and low-lying areas have been converted into sewage ponds. The environmental laws exist but not always implemented. Similar situations are emerging close to other big cities (Faisalabad, Multan). Limited experiments of wastewater treatment (Faisalabad) indicate high potential of urban drainage segregation, treatment and reuse. Partially

treated water is purchased by the farmers at higher rates. These zones need a combination of wastewater recycling, flood river diversion, and improved recharge from the rain and drainage effluent. A comprehensive water balance shows that about 1.5 bcm water going into drainage and flood runoff can be motivated to enhance existing water availability.

The second type of areas has a good potential for sustainable fresh and wastewater management. Though like elsewhere urban and industrial areas face safe drinking supply, water quality and drainage management problems. The surface water availability is relatively high, regulated waterways are intact and drainage from primary uses is recaptured in flood plains and aquifers. Agriculture has been extending in the northern, western and middle regions of the basin. The emerging problems are depleting aquifer sections, increased secondary salinity, bad quality spots close to industrial and urban centers and shrinking fresh water bodies. The drainage-recharge character not fully truncated but consistently reducing due to pumpage schemes and infrastructure development. The segregation of toxic industrial effluent (about 5% of the total), treatment at the source and bringing used water back into the cycle in urban and pre-urban areas is possible. The rainwater harvesting and artificial recharge can effectively support drainage load, aquifer quality and leaching in specific areas.

The third region, water logged and saline zone of the basin, has been considered fully stagnant and bound to increase drainable effluent as more fresh water has to push in to satisfy increasing food, domestic and environmental needs. The allocations and reliable supply is critical as the domestic and livelihood needs must come from the surface resources, rivers and lakes. The big city falling in the zone, Karachi, face the biggest problems pose by its industrial waste. However, the good news is that segregated treatment indicates good potential. Increased cropping intensities and shallow wells close to rivers have added recycled component, which can be enhanced through wastewater and saline agriculture. High water use efficiencies and joint management of surface drains and rivers are essential in the zone.

The country has initiated domestic supply and sanitation as a priority Million Development Goal. A new phase of water and urban infrastructure development has planned. Serious efforts are required, however specific management packages can be defined to sustain regenerative water cycle in three main zones of the basin.

# Water Quality Monitoring on a Basin – Wide Scale as Essential Part of Water Quality Management within Transboundary River Basins: Case Study of Ukraine

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Keywords: Pollution, Monitoring, Development, Water, Management

## Presentation of topic and analysis of issue

Ukraine is one of the poorest countries of Europe concerning the potential water resources (1.6 cub km of water in a year per an inhabitant). 76% of total average annual river runoff come to Ukraine from the neighboring countries (Russia, Belorus, the Danube river basin countries), and only 24% of river runoff are formed within the territory of Ukraine. Thus, Ukraine is an important area for international co-operation in water management and protection on a basin-wide scale.

The large volume of sewage water came into the surface waters of Ukraine. About 3,025,400 t of pollutants (oil products, sulphates, chlorides, organic matter, pesticides, heavy metals and so on) arrive into the surface waters together with a sewage waters. That is why water quantity and quality become a limiting factor of usage of surface water resources and of sustainable development of the country. The national policy of sustainable development concerns a wide spectrum of water management, including water quality management.

The Danube River Protection Convention (DRPC) which has been entered into force on 22 October 1998 is the good basis for development of water quality management and water protection within transboundary river basins. One of the major strategic goals of the Convention is to maintain and to improve the status of water resources as to quality and quantity, and to prevent, reduce and control water pollution, including accidental pollution. In order to implement these goals, the Danube river basin countries have established the International Commission for the Protection of the Danube River (ICPDR). The Danube countries also agreed that the ICPDR should serve as a common platform for the implementation of the EU Water Framework Directive (EU WFD) on a basin – wide scale.

## Discussion of Results/Findings

There are the following directions in the area of development of water quality management:

1. Creation of the transnational water quality monitoring network. The main objective of this network is to provide a structured and well-balanced overall view of the pollution status, as well as of the long-term development of water quality and pollution loads for the major rivers in the river basin. The transnational monitoring network is based on the national surface water monitoring networks of the Danube river basin countries.

In order to meet to the criteria for selection of transnational monitoring network, points of the water quality observation should be located:

1. upstream and/or downstream of an international border;
2. downstream of the largest point sources of pollution;
3. connecting to control of water use for drinking water supply.

Each monitoring station can have up to three sampling points located on the left side or right side, or in the middle of a river. The pollution load is calculated for the following determinants: BOD 5, inorganic nitrogen, ortho-phosphate-phosphorus, dissolved phosphorus, total phosphorus, suspended solids and chlorides.

2. Prevention and control of accident pollution. The accident emergency and warning system is elaborated in order to provide a warning message downstream the Danube in case of an accident in the Danube river basin. In the Danube river basin countries, the so-called Principal International Alert Centres (PIACs) have been established. The Ukrainian PIACs has been created in the Izmail town which is located in the estuary of the Danube river. The principal goal of these centres is to provide an exchange of pollution warning messages among the Danube countries. The warning system has proved its efficiency many times for a prevention of consequences of accident pollution which have been observed on the Danube, Prut and Tisza rivers.

3. The Danube river basin countries have agreed to use the ICPDR for implementation of the EU WFD in order to achieve good surface water status of water bodies. It means that the non- EU Danube river basin countries, including Ukraine, should also take the commitments to enforce the EU WFD in these countries.

The implementation of the EU WFD in Ukraine demands the solution of the legislative, organizational, scientific and technical problems. In contrast to the EU WFD, the Ukrainian water legislation focuses on very strict limit values for emission but it does not include water quality standards for the period of water bodies use. It is necessary to upgrade the programs of monitoring which were accepted several decades ago, with strictly defined objectives and approaches. It is very important to improve the technical equipment of water quality observation and analytical control. The interdepartment programs should be created and implemented in order to improve the technical layout and equipment of monitoring.

### **Conclusions and recommendations**

Creation and development of effective water quality monitoring system within transboundary river basin on a basin-wide scale is the essential component of elaboration and implementation of the river basin management strategies for pollution abatement, river protection and restoration. This system allows to obtain data about different types of pollutants that is very important for water users and ecosystems' health. The present state of the water quality monitoring system in Ukraine cannot satisfy the objectives of water quality management. Development of water quality monitoring system in Ukrainian river basins on the basis of EU WFD can be an instrument for improvement of water quality management. Taking in account that the State Hydrometeorological Service (SHMS) operates the most extensive water quality monitoring network in Ukraine, the measures of improvement of water quality monitoring system of the SHMS are carried out now on a basis of the recommendations of the EU WFD.

# Education for Improving Community Based Watershed Management

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Keywords: river basin, education, community, public, social factor

It is well known that educational campaign assists significantly in creation and implementation of community-based river watershed management in order to empower stakeholders to take action at the local level and to make improvements of water policy, management and sanitation [ 1-2 ].

Two Ukrainian NGOs : Sustainable Development and Ecological Research Centre and Women for the Democracy Development in cooperation with Ministry of Municipal Housing and development of Ukraine aimed to introduce basic community development concept and model to community leaders and professionals at the local levels in Ukraine. Specifically actions were concentrated on the Dniester river which is a second largest river in Ukraine.

Dniester river basin and ecosystems has being intensively modified and damaged by human activities, in particular at the second part of the last century. Three water reservoirs and a number of hydro-electric stations were built in a river. Inadequate hydrological assessment during the construction of water reservoirs led to the appearance of “destroyed ” zones within the river basin. The quality of Dniester river is classified as polluted and dirty one: phenols, ammonium and nitrite nitrogen, pesticides residues metabolism, heavy metals and petroleum products are among the primary pollutants. Pollutants discharge by industrial and municipal enterprises along with discharge from agricultural practices in small holder farmers substantially exceed the standards admissible levels. Erosion of the agricultural land is facilitating by inadequate agricultural practices and uncontrolled forest cutting in the highlands at the upper Dniester. That leads to the deterioration of water quality and significant loss of freshwater biodiversity [3].

That is why the significant problems arise to create Dniester river watershed management plan which has to be community-based. It is an approach to Dniester river watershed protection that enables individuals, groups, and institutions with a stake in management outcomes to participate in identifying and addressing local issues that affect or are affected by watershed functions. Proponents of community-based watershed management maintain that involving of local stakeholders will result in a more locally relevant solutions that take into account each community’s unique social, economic, and environmental conditions and values. Stakeholder participation is also thought to create a sense of local ownership of identified problems and solutions, thus ensuring long-term support for resulting management plans.

Educational program was created for the stakeholder and accomplished for local governmental officials, public and community leaders and educators from two regions located within Dniester river basin. Having this practical examination of the education program factors which produced differences in the development and utilization of social capital and local capacities for watershed management have been investigated. The success of education program was examined qualitatively by means of indicators and sociological survey results.

It was established that success of the program correlated with a number of social factors: the extent of stakeholder involvement, the availability of social capital in the watershed, and the presence of real or perceived water resource concern. Both short term program success and the longer term prognosis for continued watershed management activities looks to depend mainly upon the amount of social capital in the watershed. Two major changes in resource management programs and organizations could lead to increased focus on and support for local watershed management initiatives.

Summarizing it can be concluded that Educational Program assisted in developing leadership skills and preparation of community members, NGO members and professionals to be catalysts for water quality protection and development of Watershed Management Plan for Dniester River.

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# Eco-Hydrology of the Pangani River, Tanzania: A Case Study of Downstream of Nyumba Ya Mungu Reservoir

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Keywords: Eco-hydrology, Flow Duration Curve, Hydraulic rating methodology, Pangani River, PHABSIM

Eco-hydrology defines new approaches to freshwater protection, restoration and management, thus one increases opportunities for ecosystems maintenance. Eco-hydrological studies are highly emphasized worldwide at the moment especially where hydraulic structures such as dams are concerned, mainly focusing on benefiting both the humans and existing ecosystem for the present and future generations. Eco-hydrological studies on river systems have two main purposes: first, they are used to develop an understanding of the relationship between the various parts of a river ecosystem (channel, wetlands and floodplains, banks, groundwater, estuary; and their plants and animals (the biota)) and flow; and secondly, they are used to advise management on how flows can be manipulated for offstream purposes whilst holding changes to the river within acceptable limits. The study at Pangani River basin was aimed at assessing the sufficiency and the amount of flow reaching the downstream area of the Pangani River at the Kirua swamps for maintenance of ecosystem. Fish species were considered as the indicators for ecosystem health.

The Pangani River is one of the most important rivers in Tanzania. Pangani River Basin covers an area of about 43,650 with 5% of this in Kenya and 95% in Tanzania. It is located in the north eastern part of Tanzania between Latitudes 02 55'S to 05 40'S and Longitude 36 20'E to 39 02 'E. Most of the water in the basin is used for irrigation or hydropower production. There are three hydropower facilities that supplies up to 91.5 MW or 17% of country's electricity one of which is called Nyumba ya Mungu (NyM). NyM is one of the most important man made regulating reservoir in the river, which started operation in 1968 incorporating a power plant with a capacity of producing 8 MW and ever since the flow downstream has been controlled. Downstream of the NyM dam there is Kirua swamps which as swamps their importance to aquatic ecosystem and environment is known. The swamp at present covers an area of approximately 36500 ha which is said to have decreased from 90000 ha in the past.

In addressing the issue of Eco-hydrology the environmental flow assessment (EFA) methodologies are important. So far there is no recommended specific EFA method but a number of them such as hydrological, hydraulic, habitat simulation and holistic methodologies. Hydrological and hydraulic methodologies were applied in carrying out this study, whereby hydrologically by making use of flow duration curves (FDC) and hydrographs, and hydraulically by using a hydraulic model.

FDC and hydrographs capture the trend of flow variations with time and were developed by using the collected historical daily flow data and used for assessing the flow variation before and after Nyumba ya Mungu (NYM) dam construction. The results showed that there is no seasonality and that for most part of the year the flow is within 20 – 40 m<sup>3</sup>/s. It implies that the flow variations from season to season, year to year are useful in maintaining the biodiversity and resilience of the system thus making it more able to cope with human disturbance. From the comparison it was found out

that there is 42.7% decrease in Q5, 2.1% decrease in Q95, 38.9% increase in Q75, 23.4% increase in Q50 and decrease of percentage exceedence of 50 m<sup>3</sup>/s by 61.5%.

Physical habitat simulation model (PHABSIM) which is part of a broad conceptual and analytical framework for addressing stream flow management issues was used for hydraulic simulation incorporating geometric and flow data collected in the field. The model helped to relate the hydraulic parameters at present to ecology as it is known that flow variations whether high, medium or low impact on hydraulic parameters very significantly. From the simulations by making use of the resulting relationship between wetted perimeter and discharge, minimum flow for habitat protection is about 15 m<sup>3</sup>/s and for flood formation flows should be greater than 50 m<sup>3</sup>/s.

Thus the proposed reservoir outflow for sustainable water resources management at the NYM should be greater than 50 m<sup>3</sup>/s for higher flows and minimum flow of about 15 m<sup>3</sup>/s and also should be linked to current climate within the catchment so that releases mimic wet and dry years.



# Options for Facilitating Multi-Level Stakeholder Participation in Transboundary Water Management: Experiences from the Volta Water Governance Project

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Keywords: River banks restoration, livelihoods support, multi-stakeholder forums, Code of Conduct, Volta Basin Authority

Transboundary water governance has traditionally been an affair of State institutions carried out through diplomatic means, usually by high-level government officials. This approach has changed in recent times, with greater emphasis on closing the gap between decision-makers and local stakeholders and devolving authority to the local level, as well as building trust in the communities and among partners.

From mid-2004, the World Conservation Union (IUCN) initiated the 3-year “Project for Improving Water Governance in the Volta Basin” (commonly referred to by its French acronym – PAGEV) aimed at strengthening the bilateral cooperation between Burkina Faso and Ghana on shared water resources and to demonstrate how water governance can be improved through the implementation of pilot activities. Burkina Faso and Ghana were selected as pilot states because they are the two among the six riparian countries which share the largest proportion of Volta Basin’s area (nearly 85%). The project which received donor support from the Swedish International Development Cooperation Agency (Sida) and The Netherlands Directorate General for International Development Cooperation (DGIS) is developed and implemented by IUCN Regional Office for West Africa (IUCN-BRAO) in partnership with the West African Water Partnership of the Global Water Partnership (GWP-WA), Ghana’s Water Resources Commission (WRC) and Burkina Faso’s Directorate General for Water Resources (DGRE).

The PAGEV strategies have focused on combining the long-term benefits of water resources management with immediate impacts on meeting the livelihood needs of the communities. Stakeholders at the village, district, national and trans-national levels and local NGOs were mobilized to work on field based activities to improve the governance of selected sub-basin in the White Volta Basin.

After three years of implementation of PAGEV Phase 1 some of the important results that have been realized include:

The compilation of knowledge and decision-support information to support planning, decision making and monitoring of interventions in the basin through a water audit of the basin, the production of maps and the collection of socio-economic data on the riparian communities in the pilot zone.

The establishment of river bank protection committees in communities on both sides of the Ghana-Burkina border. These committees have undertaken re-vegetation of nearly 16 km of river banks to reduce soil erosion and protect water quality. Fruit trees and fuel-wood trees have also been introduced to combine environmental management and provision of new livelihood options.

The establishment of a set of multi-stakeholder forums for water resources management. The forums operate at local, national and transboundary levels, and are also designed to “mix” the different levels, with the aim of increasing involvement by local communities in transboundary water management.

The formulation of a Code of Conduct on the shared management of the Volta River system between Burkina Faso and Ghana. The process involved stakeholder consultation, national workshops and joint validation workshops.

Supporting communities to dig wells and rehabilitate an irrigation dam in Ghana. These initiatives have created benefits (e.g. dry season vegetable farming, rice cultivation, water supply) for the communities while at the same time working with them to build awareness and capacity in sustainable water management and conservation of natural resources.

Some impacts that have been realized at the completion of Phase I of PAGEV in September 2007 include the following:-

Before PAGEV, institutional arrangements for coordinating the management of the water resources the Volta River basin were weak and did not exist at transboundary level. Presently, transboundary coordination of management of the Volta River Basin has evolved rapidly. Now, all six riparian states in the Volta basin have signed protocols to form the Volta Basin Authority (VBA) – bringing together Burkina, Ghana, Mali, Benin, Togo and Cote d’Ivoire.

The innovative co-ordination arrangement on transboundary water management initiated through the formulation of a Code of Conduct and establishment of a local transboundary committee has helped close the water policy and legislative gaps between Burkina Faso and Ghana. The language barriers which may hinder cooperation have been broken, and communities of different nationalities are working together on integrated water resources management in a transboundary basin.

PAGEV implementation has helped to mobilize partnership with ministries, and decentralized local government agencies, NGOs and civil society. The joint activities have reinforced the cooperation and exchange of information between institutions in both countries, thus creating an enabling environment for transboundary water resources management.

Through education and sensitization of the local communities on the potential benefits to be derived from creating buffer zones on the banks of the Volta River and introduction of “economic” trees, PAGEV has brought the communities to give up part of the lands along the river banks they used to farm on for the conservation of the river banks.

The PAGEV approach to protection of the river banks together with linking poverty alleviation to water and soil conservation have strongly influenced the operations of agricultural programmes in the pilot zone. The creation of buffer zones is being replicated by the Regional Directorates of Agriculture from the regions straddling the border between Burkina Faso and Ghana as part of support to communities to improve small-scale irrigation for food security.

# Water Management of the Afteruse Territory of the Northern Buzachi Oil Deposit on the North-East Low Coast of the Caspian Sea

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Keywords: Oil Gas Deposit, Liquid Drilling Waste, Sewage Treatment Facilities, Subsoil Waters, Oil Hydrocarbons

The oil gas deposit Northern Buzachi is located in the northwestern part of peninsula Buzachi within the limits of lowland near Caspian Sea Region. It settles down as a narrow strip in the latitude direction along the Caspian Sea coast and has an area of 126 km<sup>2</sup>. Radius of a sanitary – protective zone is 1000 m. The territory of Northern Buzachi deposit is at a distance of 20 km from the Caspian Sea, and therefore its objects are not included in the Nature Protective Zone of the Caspian Sea, determined in the size of 2 km.

Climate is sharply continental. Area relief represents plain with marks from -19 up to -28 m abs. Numerous salt marshes, representing drain less depressions, are basically impassable for motor transport.

In 2006 on the deposit 159 oil wells were operated. It was extracted 1, 2 million tons of oil and 46,692 million m<sup>3</sup> of passing gas.

Industrial activities of Buzachi Operating Ltd. are allied to water consuming branches of industry characterized by big water consumption and formation of large volume of sewage.

The enterprise has no own water intakes. In order to maintain its technological, industrial and household needs it uses the Volga water from water passage “Astrakhan – Mangyshlak”. The length of the main water passage that consists of two lines is 1041 km.

Brine water is extracted along with the oil from underground petroliferous horizons and released during oil preparation. In order to meet technical needs of the deposit 675, 9 thousand m<sup>3</sup> of brine water were used in 2006.

During industrial, economic and household activities in the deposit the following kinds of sewage are formed: economic – household, industrial drains and the waters polluted with oil products.

Sewage from centralized system of camp-type water drain is delivered for purification to sewage treatment facilities with the help of pump stations and pressure head collectors. The sewage treatment facilities include biological treatment facility with a processing capacity of 125 m<sup>3</sup>/day.

While assessing performance of the treatment facilities it is possible to draw a conclusion that efficiency of household sewage treatment is high enough, since concentrations of the basic indicators of household pollution after treatment are reduced almost by 2 times. For example, the efficiency of treatment of weighed substances is 50-92 %, oil products – 78-96 %.

There is no special landfill for burial of liquid and solid drilling waste in the deposit territory. There are 2 Platforms for temporary storage and processing of drilling wastes and grounds polluted with oil. Drilling waste is mixed up with the pit ground and is used for construction of drilling platforms and partially roads. As ground is received at the Platform for mixing, it is immediately processed. Drilling slime and grounds polluted with oil are processed in a similar way. After the ground processing the sampling for chemical analysis of construction material is regularly made.

Liquid fractions of drilling solution, as well as sewage from equipment washing, are placed on the existing Platform for temporary storage and processing of drilling waste. They are settled and directed to evaporation pools. Dried up slime is mixed up with the transported pit ground and is used for construction of drilling platforms and roads.

Treated sewage is used from April till October for dust suppression, sprinkling of green plantings, and also for industrial needs like smoothing down grounds and roads construction.

Monitoring observations show that concentration of oil products in the underground waters was about 0,12 mg/dm<sup>3</sup>. It is necessary to note, that increase in contents of oil hydrocarbon and synthetic surface active substances, which had been observed till the end of 2002, has stopped and the obvious tendency of its decrease has appeared. Excessive contents of chlorides, sulfates, lead and cadmium are observed, which relate to conditions of intensive evaporation and is typical for subsoil waters of the captioned area. This causes intensive ground salinization of aeration zone resulting in the formation of salt crust on the soil surface.

The deposit territory exhibits a drainless depression, where subsoil waters are discharged only through intensive evaporation within the limits of salt marshes. Here this process is represented by saline soils. Subsoil waters in the Northern Buzachi deposit have no direct connection with the Caspian Sea waters. The transfer of oil products and others pollutants towards the sea with a flow of subsoil waters is excluded. The flow of subsoil waters is directed towards the deposit. Its territory serves as a local drain basis and salt marshes represent the centers of subsoil waters discharge through evaporation.

For constant control of possible reciprocal influence between the Northern Buzachi deposit territory and the Caspian Sea it is necessary to organize quarterly observations of level and hydrochemical composition of subsoil waters, including content of oil hydrocarbons.

The method of temporary storage and processing of liquid and solid drilling wastes and their recycling at construction of drilling platforms or roads, deserves approval and widespread dissemination.

# Integral Management of Industrial Effluents from Montevideo.

## Public Management of Industrial Effluents from Montevideo

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Keywords: Industrial Effluents, Wastewater Program, Contamination, Reduction in the pollutants, Monitoring

Montevideo, the lowest of the 19 departments (political-administrative divisions) in the country, concentrated much of the industries, the majority of the service activities, and almost half of population. The principal water bodies of Montevideo are the streams: Pantanos, Miguelete and Montevideo's Bay, all of them are closely related with human activities.

The main contamination sources in these water bodies are basically: domestic sewage, industrial effluents and solid waste disposal.

The objectives are:

- Optimize technical resources (public and private) identifying weaknesses and strengths
- Reduce the contamination produced by the industries
- Work integrally, with the community participation

The objectives were mostly achieved, specially the reduction in the values of the pollutants. The economical crisis that affected the region (1999, 2002) caused a decrease in the active industries. However, the reduction in flow values is less than the reduction in the pollutants. Although since 2003 the number of industries that were controlled has increased, the tendencies indicate the achievement of the objectives.

### Initial Context

In Montevideo, the industrial emissions represent one of the principal sources of contamination of the water bodies. The population who lives in the water courses borders, the most impoverished, are exposed to the major risk.

### Establishment of priorities

During the industries control, an affair priority was given to the establishment of the Monitoring of Industrial Wastewater Program, that is complemented with the Water Bodies Program and Environmental and Sanitary Education Program initiated in 1997.

Previously it was implemented the municipal regulation: "Industrial Pollution Reduction Plan" (761/96 Resolution). This one prevented three stages with more and more strict limits. This demand was increasing gradually (contemplating the financial situation) allowing the adequacy of the industries that could not afford such investment in short time.

### Formulation of objectives and strategies

Some actions were implemented to recover the water bodies and improve the environmental quality: sanitation's infrastructure, nets and interceptors rehabilitation, carry out a Monitoring Program, eradicate not controlled discharges of waste and other contaminant contributions.

The main program objectives are:

- Assess impact of the flow wastewater on the water bodies, and its trends.
- Analyze and inform population about the rate of compliance with the Industrial Pollution Reduction Plan.
- Control the wastewater flow on sewage system, improving its maintenance.
- Financial resources: Financial resources of the IMM are intrinsic.
- Technical and Human Resources: The IMM has 13 civil servants (8 women, 5 men) and 6 internships that belong to the different universities.
- The Neighbours participation is voluntary: in denounces, industries watching, and environmental commissions in a local level. It is remarkable the incidence of women in all this tasks.
- The Industries have apt and technical personal able to do performance tasks and maintenance of the treatment plants.

### Process

At this moment it was significant the participation and compromise of the Industrial House, the Environmental National Direction (DINAMA) and other municipal units to concrete the Industrial Pollution Reduction Plan and Monitoring of Industrial Wastewater Program.

The UEI identified the industries responsible for 90% industrial pollution. They have been divided once again in accordance to its real or potential contamination contribution into categories:

- First priority: Industries that are responsible for more than 85% of the industrial pollution. They are monitored every three months.
- Second Priority: Industries that are monitored every six months.
- Third Priority: Industries that are responsible for less than 10%, (not included in the Program). They are monitored once a year, in order to watch changes that justify its entrance into the Program.

Discharges are typified by: sector of activity, body receptor and kind of discharge (water body, infiltration to soil). The results are published every six months in Montevideo's newspapers.

The main difficulties noticed were mostly economical. In spite of the fact that the economical problems are limiting the innovations, up to now, everything has been developed regularly.

### Results achieved

The biggest contribution of industrial pollution at the end of the year 2007 comes from 26 First Priority enterprises, whose percentages of the total are: 81% in Flow, 90% in Greases, 89% in DBO5, 86% in Sulfide, 95% in Chromium, 67% in Lead.

Since the Program started, it is notable the increase in the number of industries and in flow values. However, thanks to industrial improvements, quality and environmental management systems implementation, the control of activities, joined to the citizen monitoring, made possible to achieve the following reductions: 81% in Greases, 28% in DBO5, 57% in Sulfide, 81% in Chromium and 94% in Lead.

As for the water courses, there were important descents in the contributions to the Miguelete and Pantanoso Streams that imply a positive environmental impact. They also improved the sewage system maintenance, and of course, the local population quality of life.

Stakeholder's interest and increased participation is something to remark, and it can be observed through the number of denounces and the new environmental commissions formed during last years. Those increases have also improved industries and society relationship; the first ones changing into an open door policy, and the second ones improving the use of more and better information.

Monitoring Program has also contributed with the employment generation for environmental technicians to report, build and rebuild treatment plants among others.

# Urban Waste Water Management Practices of The City of Kanpur, India under Ganga Action Plan : A Blessing or Bane for the Peripheral Urban Areas

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Keywords: Waste Water Management, Ganga Action Plan, Central Effluent Treatment Pla, Threat for survival of the per, Role of Civil Society

The river Ganges, being the heart-line of the Indian subcontinent, caters to the needs of the vast rural as well as the sprawling urban population living on the side of the Ganges. While the urban population by the sides of the river is heavily dependent on drinking water supply, bathing and also for drainage discharge, the rural population is benefited in terms of availing the Ganges water for drinking, bathing, fishing and above all by using the water to irrigate the crop fields. Moreover, both the rural and urban population are dependent on the Ganges water to perform various social and religious ceremonies. It is embedded in the minds of millions of Indian people as “the Mother Ganges”. Many of the Hindus believe that a dip in the Ganges on a holy day will wash away their sins. Further, it is believed that performing various death rites on the embankment of the Ganges including immersion of the ashes of dead persons in the Ganges followed by holy deep, the dead man can go to the heavenly abode. Thus, the Hindus look forward for a dip in the Ganges to purify themselves. However, due to massive extension of irrigation network in the post independence period, the stream flow of water in the river has decreased significantly. And to add to it, rapid urbanization and industrialization in the cities located by the side of the river have increased the load on the stream flow in terms withdrawal of fresh water (for domestic, industrial and commercial uses) and disposal of waste water, as a result of which the pollution level of the river had gone up significantly. Particularly, the pollution of the river (i.e., BOD & COD parameters) had become extremely high in the segment between Kanpur and Allahabad in Uttar Pradesh, which had caused many problems in the water resource management in the urban areas.

With a view to find out a sustainable solution to urban water resource management in the cities located by the side of the Ganges, the Government of India had initiated the Ganga Action Plan (GAP) with Dutch collaboration in 1987. It was a bilateral cooperation between the Government of India (GOI) and Govt. of Netherlands (GON). By the initiative of the former Prime Minister Late Shri Rajiv Gandhi the Dutch Govt. supported the Ganga Action Plan and to start with it funded the Indo-Dutch Environmental and Sanitary Engineering Project in Kanpur and Mirzapur from 1987 to 1995 (GAP Phase I). Then it was followed by the Institutional and Community Development Project (ICDP), which was started in March 1995 to facilitate Ganga Action Plan Support Programme (GAPSP) that started in 1998. Under these schemes, a number of pollution abatement measures including Central Effluent Treatment Plants (CETPs) have been undertaken to improve the socio-economic conditions of the people in the cities and also in the nearby rural areas. In this paper, we have investigated the impact of the new technologies under GAP as implemented by the Kanpur Municipal Authority for the city of Kanpur, which is the largest industrial town in Northern India with a population beyond 3 million and with concentration of industrial units like leather, textile, woollen products and engineering goods, by undertaking a post evaluation study of those abatement measures and to assess the socio-economic environmental impact on the people. Attempt is made to examine the pitfalls of the



system and thereby to suggest remedial measures for improving the performances of those projects to attain sustainable development of the water resources of the Ganges. Further, we have examined the scope of peoples participation in the successful implementation of those sanitation projects. Our primary field survey results have established that though use of untreated, partially treated or diluted urban wastewater for agriculture was an established practice in Kanpur Municipal area since early part of 20th century, i.e., to use the waste water for agriculture in urban and peri-urban areas of the city and to earn revenue from the farmers, with advent of the imported technology of CETP under the Indo-Dutch Collaboration programme of Ganga Action Plan, the woes of the farmers have been exasperated and it has even posed a threat for survival of some of the surrounding villages that receive the waste water for farming. The drinking water sources are also being poisoned due to presence of harmful chemicals in the so-called treated water flowing through the sewage canal to the surrounding area. Our results have further indicates that the new technology is not being able to fulfill the MDG goals set up in terms of pushing back poverty, inequality hunger and illness. Hence, there is an urgent need for intervention of the civil society to resolve the ensuing problems in the peripheral areas of the city of Kanpur.

# Relative Role of Different Types of Pollution in The Dnieper Basin

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Keywords: Dnieper Basin, types of pollution, water quality, reservoir system, protecting water

This paper summarizes various information concerning relative role of different types of pollution in the Dnieper Basin. The Dnieper basin includes nearly 50 % of the total area of Ukraine and contributes with about 80 % of the total volume of Ukrainian water resources. The basin has been subject to man-made changes for a long time. The economic development within the basin has been undertaken without sufficient evaluation of the sustainable capacity of the natural environment and with a belief in successful performance of large hydraulic structures and schemes. As a result, a biased territorial distribution of industrial and municipal centers was created, with respect to the distribution of natural water resources.

Specific features of water use within the Dnieper basin are:

- a considerable decrease in both total and irretrievable water use during the last several years;
- a large share of irretrievable water use compared to total water use;
- a large share, more than 50 %, of total water use by industry and particularly by the electrical power sector;
- a major portion of irretrievable water use due to large scale irrigation schemes;
- an uneven regional distribution of water users; the largest users are located in the southern part of the basin in areas with accented water deficit;
- a considerable transfer of irretrievable water out of the basin boundaries by vast canal systems;
- a large loss of water due to inadequate piping systems.

The most accented fall in water use can be observed from the beginning of the nineties. For the last several years Ukraine has suffered from a deep economic crisis. During the period 1990 -1995 the total national product decreased by 42 % and total national income decreased by nearly 55 %. This crisis caused decrease of water demand especially for industrial and irrigation needs. During the period 1985-1996 these sector demands decreased with about 50 %. The smallest decrease has observed for municipal water supply, less than 10 %.

Long-term unsustainable economical developments in the Dnieper basin, disregarding the ecological requirements, have produced considerable negative impacts on the catchment area. Heavy anthropogenic pollutant loads on the Dnieper Basin ecosystem (point and non-point source pollution, intensive erosion, river flow regulation, and radiation) have resulted in degradation of the entire basin ecosystem.

A new methodology of surface waters evaluation was developed in response to the Law of Ukraine on Environmental Protection in order to harmonize Ukrainian requirements with the requirements of directives of the European Union, European and international standards in the water quality of the surface water.

General requirements and unified environmental criteria presented in this Methodology provide the basis for the clarification of the trends in the change of the quality of surface waters and estuaries

in Ukraine over time and space; the determination of the influence of anthropological factors on ecosystems of water bodies; evaluation of the changes of water resources; solutions for economic and social issues connected to provisions for environmental protection and; dissemination of information among the general public.

A recent evaluation, using the above mentioned method, reports that the Dnieper river reservoir water is classified as category IV or V according to the tropho-saprobiological indices. The Kanev and Dnieperdzherzhinsk reservoirs are in Category IV, based upon the copper content index, while the Kremenchuk, Zaporozhia and Kakhovka are in Category VI, based upon Cd and Cu content indices. Based on values of pH, NH<sub>4</sub>-N, non-organic P and COD, the water bodies could be categorized in Categories V or VI, and even sometimes VII. The latter is especially valid for the Dnieprodzerzhinsk, Zaporozhia, and Kakhovka reservoirs. By maximum values of toxicity indices, the water of the Dnieper reservoir was classified as Category VI or VII, in terms of Cd, Cu and Zn content. The water quality in the tributaries varied between Category II-V.

It is reported that about 50% of the wastewater in the Dnieper basin is produced by domestic sources. Furthermore, it is reported that the treatment facilities are operating unsatisfactorily or are overloaded, which results in large discharges of pollutants.

Data indicate that 17-27% of the wastewater is discharged without any treatment into the Dnieper river and its tributaries. In recent years, the oxygen regimes have been disturbed in all Dnieper reservoirs and in the Dnieper-Bug Liman. There are very large areas of oxygen deficiency in the Kievsky, Kanevsky and Kremenchugsky reservoirs. In the Dnieper-Bug Liman, the oxygen deficiency zones (anaerobic zones), during low flow periods, cover up to 2/3 of the total area of the water bodies.

The contribution of agriculture to the total nutrient load into the Dnieper Basin is extremely high and represents about 28% of the total nitrogen load and 7.4% of the total phosphorus load. In total, the yearly total nutrient load into the Dnieper Basin is 19100 tonnes of nitrogen, 630 tonnes of phosphorus and 118 tones of pesticides.

The environmental problems in the Dnieper River, in the reservoirs and in the estuary, are connected to primary and secondary effects of eutrophication. Inputs of nutrients (phosphorus and nitrogen) mainly from the agriculture sector and from municipal wastewater result in high concentrations of especially phosphorus, algal blooms and oxygen depletion in bottom waters when organic matter is decomposed (saprobisation).

The main measures will therefore concentrate on reducing the nutrient inputs from these sectors. The running of the hydropower plants, with reduced water flow in the spring and summer periods, increases the eutrophication problems. Besides reducing the inputs to the river system, a very important measure would be to increase the water flow during vulnerable spring and summer periods.

# Determining the Relative Role of Different Types of Pollution at Regional Scale by Using the AHP Based Participative Decision-Making Model

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Keywords: after use water, regional scale, participative decision-making, AHP, conflict resolution

Sustainable water management in Serbia receives serious consideration in recent times. A society is primarily concerned about availability of fresh and clean water. The fact that water will become an economic category rather than a social resource is perceived both by professionals in water sector and by politicians. An integrated approach to water management is becoming national practice as a result of increased perception of the policies and strategies for water resources sustainable planning and management stated in the EU Water Framework Directive (Integrated river basin management for Europe).

A self-funding of the water sector in Serbia is based on adherence to two principles: user pays and polluter pays. Funds required for the maintenance of current and building of new water infrastructures should be secured, however, because of incomplete or imprecise legislation, difficulties are encountered in collecting fees from users and/or polluters, legal processes against those who do not fulfill obligations last after long periods of time, inspection in-field is insufficient etc.

This article focuses on problems encountered in establishing model for continuous financing the operation, maintenance and long-term development of the regional hydro system Nadela in Vojvodina Province, Serbia. The system is named after the 83 km long central canal passing from north to south where confluence into the Danube river. This system is used as a case study example to assess possibilities to motivate key players to participate in vital (primarily financial) matters related to operation and long life development of the system. Main purposes of the system are themselves in conflict: a) drainage (land users within the basin); b) collecting used waters (one big milk factory and few smaller collectors); c) industrial water supply (big sugar factory and some small private firms); d) irrigation (12 irrigation systems located along the canal near villages or small cities); and e) other purposes (fishery and limited outdoor recreation activities). Along the first 30 km of the canal water is of desired quality ('blue and clean') and mostly used for irrigation. Along most downstream 15 km before canal's confluence, it is always possible during summer season to augment even ecological minimum flow of 0.5 m<sup>3</sup>/s. Such undesirable streamflow conditions produce heavy pollution in south section of the Nadela canal and in several instances provoked inhabitants along the canal, NGOs, ecologists and media to protest and require responsibility of Provincial Secretariat for Agriculture, Forestry and Water Management, and Public Water Management Company 'Vode Vojvodine'. The later one shares its responsibility with regional water company, contracted to operate the system of lockers along the canal, inspect quality of water, contracts water supplies with water users along the canal, and take care about budgeting, operation and maintenance of the technical system.

In recent studies, feasible scenarios of sustainable planning and development of water resources in Nadela system were assessed and recommendations are given to improve the situation, and firstly how to provide for regular financing of the system operation, maintenance and development. Start-

ing hypothesis in all past researches has been that, generally speaking, officials in the state/province public water enterprises 'involved' with this system, are aware of the lack of communication with the water users and polluters. This awareness goes to the point where decision has to be made which actions to undertake to improve situation and provide for better users participation in defining and implementing proper policies. This participation is now unsatisfactory. For example, interviews with water users showed that they consider the communication with public water enterprises and state and provincial government unsatisfactory, in a sense that their problems are often underestimated or superficially treated. On the other side, responsible officials are not reluctant to demands coming from the users, but they usually have to set unpopular priorities on use of very limited national budget and international loans and donations. Some water users in Nadela system argue that periodical dialogues between academics and NGOs with water users, with or without a support/sponsorship of responsible ministries, secretariats or other associations, do not help much to escape from the dead-trap-point. Drainage situation is better and local farmers pay regularly their fees according to land ownership.

Unacceptable sanitation, pollution and abuse of water in Nadela canal have negative implication on both citizens of the city of Pancevo (close by Serbian capital Belgrade) and various downstream users. Unsuccessful low flow augmentation in the canal during summer seasons provokes in many instances bad smell surrounding and endangering of the ecosystems which in turn lights-up societal and primarily ecological concern and complains.

In this paper a methodological steps are developed to over-ride major problems related to water pollution within the Nadela system. A motivating decision-making framework has been created based on the AHP methodology to examine and determine the relative role of different types of pollution generated in downstream part of the system. Participatory multilevel model is adapted to enable building the consensus that system is common good, and that it should be managed properly to become sustainable, but also to allocate proper (higher than now) importance to the after-use industrial users as key decision makers. Model recommends how to behave when there are more than one participant in the decision making process with different attitudes and approaches to the same problem, and provides a framework to conciliate such interests and resolve conflicts.

# Efficient Water Use Technology for Chemically Free Vegetable Production Managed by Farmer Group

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Keywords: chemically free vegetable, water use technology, farmer group, learning process, knowledge based

The Northeast Thailand has been consistently the target area of this research. The agricultural land is as large as 9,271,520 hectares in Northeast region, which accounts for 44 per cent of all in Thailand (21,014,620 hectare) and number of the farm household (5,642,890 hectares). The agriculture in this region is characterized by less favor or less developed due to the poor natural conditions such as sandy soil, erratic rainfall. The Northeast region especially around Khon Kaen province, is generally characterized by gently rolling topography with an elevation of approximately 200 meters. The research site, Don Han village located in 30 kilometers west from Khon Kaen city, is also in the same topography as mentioned above in terms of soil characteristic and rainfed area. The dominant of farming system around Khon Kaen province is the rice in paddy, vegetable and sugarcane. Water resources for agriculture activities are farm ponds and natural canal.

The purposes of the study were: 1) to study and develop the small watering system for chemically free vegetable production, 2) to study and develop the organic matter for productions of chemically free vegetable and 3) to increase farmer's knowledge based and to develop a farmer-to-farmer learning unit in the community.

The family size was approximately 4.3 members and labor force consisted of 2.5 persons per family. The main labors still were farther and mother while their children working in the big cities. The research result showed that their average age was 53.28 years old, while the oldest farmer was 67 years old. The data indicated the farmers are getting old thus they are finding out the appropriate technology to work on farms properly and conveniently, especially, consuming less manpower and less time for watering chemically free vegetable. The study found that 30 farmers were team up to cultivate the chemically free vegetable on two rai area as a demonstration plot and a learning unit. They also produced on their own farms that occupied 1.5 rai per household. Before joining the research, the group used water pump and one inches-diameter plastic tube. It took 3 hours and 5 farmers per day to water. It costed 1,500 baht per month of gasoline. This system costed 10,600 baht. The farmers used a spraying tank to apply liquid organic fertilizer and herbal repulsive extract. Then, farmers set up an electric water pump and a sprinkler system connected to the herbal repulsive and liquid organic fertilizer mixing tank. This system consumed less time and labor to water and apply liquid organic matter. The results indicated that one farmer was operate the watering system. It took 25 minutes per day and consumed 150 baht of electricity per month, while when they used the old system, they needed 3 hours per day and 1,500 baht per month, respectively. The watering system costed 34,000 baht. Liquid organic matter was applied by the watering system. Hence, farmers had applied the liquid organic fertilizer more frequently resulting to improve quality of soil properly. They, moreover, had enough water for watering year around, while farm pond water was available only 8 months when they

used the old water use technology on the same size of demonstration plot. The research also indicated farmers worked on farm year around by using water from ponds for vegetable cultivation instead of keeping water for cattles and buffaloes only. This resulted directly them increased incomes and food security, especially healthy food such as chemically free vegetables. The study also presented farmers innovated two formulas of herbal repulsive extract and three formulas of liquid organic fertilizer. Farmers gained knowledge based from learning process on chemically free vegetable and organic matter production, save and potential water use technology system, local marketing system and group management. The group also had one chemically free vegetable cultivation learning unit including a demonstration plot in the community. The study result showed that the efficient water use technology supported farmer saved various issues especially labor forces, time and energy, more importance, they had good opportunity to work with each other and exchange knowledge and experiences, not only group members but also farmers from outside the communities. It also can be seen that 1,950 farmers and interesting people from 13 groups both in Thailand and overseas visited.

# Excessive Danger of Organophosphorus Pesticides for Aquatic Ecosystem Health

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Keywords: Pesticides, Toxicity, *Daphnia magna*, Organophosphates, Threat

Among many xenobiotics entering aqueous media different organophosphorus and carbamates compounds on account of their high toxicity and selectivity action are of particular hazard. Being wide spread environmental contaminants, the anticholinesterase (antiChE) compounds are probably the most toxic man-made chemicals. Many compounds of this class are used as pesticides, drugs and chemical weapons. Currently, dozens of pesticides (organophosphates and carbamates) capable of polluting the aqueous media through the runoff from agricultural lands or as a result of chemical industry accidents are produced. The forthcoming destruction of chemical weapons, among which a major part is constituted by antiChE compounds (sarin, soman, Vx-gases) can also lead to the water pollution. Although the stability of these substances in water is not high (for example, when compared to organochlorine compounds), certain xenobiotics of this class are highly toxic for humans, animals and particularly for hydrobionts.

Among the great number of hydrobionts used in ecotoxicology *Daphnia magna* holds a most unique position and belongs to a class of paddle-handed crabs. Daphnids are extensively used as test organism in aquatic toxicology due to their small size, short life cycle, amenability to lab culture and high sensitivity to different xenobiotics. Analysis of the literature has shown that *Daphnia* is the most sensitive test-object in relation to antiChE compounds, among all known biological objects including experimental animals.

The present study was undertaken with the aim to investigate the toxicity for more than 30 antiChE pesticides in the experiments on *Daphnia magna* and albino mice. Experiments were performed with a 2-days old culture of *Daphnia magna*. The toxicity of xenobiotics was determined by the value of LC50, a concentration of the compounds causing death to 50% of hydrobionts during incubation with toxicants for 24 hours. In the first stage of the work, toxicity of some organophosphorus pesticides (malathion, dipterex, DFP, paraoxon, armine, DDVP, etc.), warfare agents – sarin, soman, Vx-gases and products of its destruction (ethyl, isobutyl, isopropyl, pinacolyl – methylphosphonic acid, hydrogen fluoride and S-diethyl-minomercaptane) was determined. Also, the toxicity of these compounds in experiments with albino mice following subcutaneous injection of poisons was determined (from the LD50 values). Besides, in experiments *in vitro* we investigated the antiChE activity of compounds using the mice brain and *Daphnia*s homogenates as source of enzyme – cholinesterase. The irreversible inactivation of the cholinesterases by organophosphates and carbamates was measured with the help of bimolecular rate constant ( $k_2$ ) of interaction of the enzymes with inhibitors at pH 7.5 and 250 C in the 20 mM of phosphate buffer, containing 100 mM of potassium chloride and 0.2 mM of 5', 5'-dithio-bis-(2-nitrobenzoic acid). We studied also the substrate specificity and kinetic behaviour of *Daphnia*s homogenate cholinesterase. The kinetics of ChE hydrolysis of different substrates was investigated at pH 7.5 and 250 C. For study of the mechanism of toxic action of antiChE compounds on *Daphnia magna* the effect of number muscarinic cholinoreceptors blockers – cholinolytics (atropine, glipine, pediphen) on the toxicity of an organophosphorus pesticide was determined. DDVP and its antagonists were added to the incubation mixture simultaneously.



The results of experiments demonstrate the absence of correlation between the toxicity of antiChE compounds on Daphnia and mice. For instance some organophosphorus pesticides with a very small toxicity on mice differ extraordinary toxicity for Daphnia, especially DDVP, dipterex and malathion. This inconsistency can be explained because Daphnia's cholinesterase differs from the mice enzyme by its very high sensitivity to organophosphates. It is very unexpectedly and non ordinary that the values of phosphorylation constant in experiments with Daphnia's ChE are equally for DDVP and soman. At the same time the toxicity of sarin, soman and Vx in experiments on Daphnia are lower than the toxicity of DDVP, dipterex, etc. It was found also that the toxicity of Vx-gases and of the products of its destruction –S-diethylaminomercaptane was the similar. On the other hand, the toxicity of products of destruction of sarin and soman in experiments on Daphnids and mice was very low. Thus the organophosphorus pesticides and aminomercaptane which are almost un toxic for animal and human at the same time are superecotoxicants for Daphnia and aquatic ecosystem health.

# Engaging the Public in Water Source Protection and Watershed Restoration

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Keywords: public education and outreach, source water protection, water quality, watershed protection

Protecting water sources for consumption and use is critical to the health of the community relying on the water source as well as the health of the watershed ecosystem. As a community develops around water sources, it is important that community members understand the role they play in ensuring a clean and safe water supply is preserved and protected.

The development and implementation of watershed protection plans is one strategy that may be applied to protect water sources and supplies. Furthermore, for watersheds that have been negatively impacted by urbanization or poor land use practices, the application of watershed protection plans may be used to restore watershed ecosystems and improve water quality.

A sustainable watershed protection plan includes a framework developed by the government that incorporates all potential impacts (e.g., land use practices, water run-off, pollution, agricultural practices and excessive water withdrawals) to the watershed and measures for mitigating impacts. Moreover, a sustainable plan includes the involvement of the local community surrounding the watershed and a definition of their role in protecting and preserving the watershed as well as their adaptation of the plan into their daily lives as they rely on the water source for consumption and use. Lastly, a sustainable plan includes a monitoring program that measures and trends water quality within the watershed to demonstrate the tangible benefits of a clean and safe water supply and allows for a community to celebrate the success of their preservation and conservation efforts.

This paper will discuss the development and implementation of a watershed protection plan for a developing community in the southeastern United States. The watershed protection plan was developed in conjunction with the local community and was focused on protecting an existing water supply as well as restoring damaged areas of the watershed for improved water quality and to further enhance the surrounding ecosystem. Components of the plan include mitigation techniques for managing pollution control from septic systems, managing storm water impacts, managing impacts from urbanization, agricultural practices and excessive water withdrawals from the source water. Furthermore, the plan includes information as to how a group of local citizens worked with the local government that managed the water source to improve the watershed protection plan and how they eventually became better stewards of the water supply. The last component of the plan includes a watershed monitoring program that defines analytical testing strategies used by the local government that manages the watershed and simple water monitoring techniques used by the local citizens so that they maybe further engaged in the quality of their water supply.

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# Green Technologies for Rural Infrastructure Construction through Women Training

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Keywords: Rural Sanitation, Women empowerment, Basin management, Rural capacitation, Green Technologies

Valle de Bravo Basin is located 150 km west from Mexico City. The artificial lake at its low part was created as an essential part of the (then: 1949) largest Hydroelectric System in Latin America. In the mid 80's, the system changed use: became a fresh water provider for Mexico City's Urban Area, and it is responsible for the water provision of 2 million people, exporting 6 metric meters per second.

For the last three decades, the area also became an important tourist destination, attracting new habitants in an important pace that exceeded National Growth Rate. Both Urban and Rural development lacked planning. As a result, Environmental degradation occurred, including water pollution, deforestation, soil erosion, land use change, among others. This degradation compromises the area capacity to provide Environmental Services for local populations and population abroad.

Created in 2000, the Valle de Bravo Basin Fund (VBBF) is a local NGO dedicated to the preservation of the area's 800 springs, 5 rivers and 25000 hectares of pine and pine-oak forests through projects that involve local communities and stakeholders.

More than 6000 families live in rural communities lacking basic sanitation and water service in a Basin that exports water to distant urban centers. For the last four years, VBBF has conducted a project for the construction of basic rural infrastructure to reduce negative impacts of rural population in their surrounding ecosystems. Two are the major concerns for VBBF: water pollution and forest degradation impact through wood consumption as energetic.

To face them, Green Technology Basic Rural Infrastructure (Ecotecnias, in Spanish) is built. There are four or them:

Rain-Harvesting system which includes a 10000 liters reservoir and filters to catch soap before realizing used water back to the ecosystem. This infrastructure is required to avoid the use of springs and small rivers for direct use for laundry, toilet, and even for consumption.

Wood-saving stoves: Cutting down on wood burning isn't just good for the environment, it's also good for families and communities. This stove cuts as much as 75% of the wood burning. This means approximately 2.75 metric tons per family per year.

Dry latrine: To reduce water pollutions, open air defecation must be reduced. Dry latrines, if properly used, can solve this issue.

Back yard garden: In a small piece of land, 10 meters long and 1 meter width, organic legumes and

herbs are planted. More important, this green technology infrastructure is basic for environmental education, hygiene education, training and capacity building.

The notable success achieved in this project is, in our opinion, the result of the education and training processes. This work is conducted by our monitors with groups of 15 up to 30 women that freely accepted to participate in the project. These groups are formed by women of the same community. Weekly visits by our staff provides with training and teaching building techniques. The lessons are presented to the group every week, and it is responsibility of each member to replicate lessons in their own house as homework. VBBF provides with materials and community members provide with labor force.

497 families have been benefited from the project in the last four years. We started with only 47 families participating in 2004. Last year we were able to benefit 282 families. This number represents less than 10% of the total families living in poverty in the Basin.

Half of our monitors are participants of the communities in early years. This is important for us, since it assures that knowledge is definitely transmitted to communities.

As said earlier, this project is Gender oriented. Female participants are the vast majority, and are always the future participants we look for. This is because they are more related to household function than men, and they recognize the value of the project easily: it represents better health conditions for children through improved water quality; better food conditions, and less time invested in wood harvesting, time that can be used in order activities at home.

The project is receiving an increasing amount of interest. First, by communities themselves. In early years it was complicated to constitute groups large enough. Now, the demand for participating in the project exceeds our training capacities. Second, the project has call interest of Government Agencies and Private Foundations. The aim is to work with 600 families per year to finish the work in less than 10 years.

## Results

- Female empowerment
- Better health and nutrition conditions
- Stronger local capacities
- Reducing in 880 metric tons per year green house emissions
- 87 rain-harvesting structures.
- 447 backyard garden for organic agriculture
- 372 wood saving stoves
- 347 dry latrines.
- Private funding: Pfizer, Televisa, SC Johnson, and individuals.

With 600 families fully equipped per year we can also be able to:

- Reduce in 1643 metric tons wood demand per year
- To protect landscape
- To protect soil
- To reduce water pollution.

# Human Values in Water, Sanitation and Hygiene Education

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Keywords: values, water education, behaviour change

There is a compelling case for creating a new water use and sanitation-friendly ethic in human settlements. Ethics in the water and sanitation sector is of growing importance, especially to ensure improved governance, and more equitable and efficient water and sanitation service. When we practice human values at work, they are internal motivators that help us do our best and reinforce good character, morality and ethics.

## What are Human Values?

Human values are an essential element of our human nature, and are positive qualities that are shared among people throughout the world. Human values are those qualities of human beings that are desirable, respected, worthy, esteemed, dominant and which are sanctioned by a given society.

They are universal and inherent in all human beings and are to be found in varying degrees in all societies, religious traditions and civilizations. Whilst everything that exists has its own value and value system, Human Values are more appropriately applied to humans who are capable of rationalizing, analyzing and applying these principles with accepted standard of approval. Bringing out and nurturing of the Human Values in the children during the formative years will result in caring and responsible adults in the future. They, in turn, will lay the groundwork for the character development of generations following after them. Human values-based water education inspires and motivates learners to change their behaviour with a view to promoting/adapting wise and sustainable use of water, sanitation and hygiene.

## A UN-HABITAT perspective

Human Values based Water, Sanitation and Hygiene Education (HVWSHE) is a process in which individuals gain awareness of their living environment and acquire knowledge, skill, values and experience, and also the determination, which will enable them to act – individually and collectively – to solve present and future water, sanitation and related hygiene problems.. The acquisition of knowledge and skills by themselves does not create a new water and sanitation ethic. It is through the application of human values in their day-to-day activities children make decisions that conserve and value water, practice good hygiene and sanitation practices.

The current water and sanitation crisis is increasingly viewed as a crisis of good governance. Good governance is critical to improve the efficiency, equity and sustainability of service provision. Experience, however from the past shows that efforts to promote good governance have not succeeded in bringing about any fundamental changes in behaviour and personal attitudes, and in the underlying values of the people that influence decisions.

This is where UN-HABITAT feels that water, sanitation and hygiene education, specifically a values-based approach to environmental education could make a major difference. A value-based water and

sanitation education initiative is a strategic entry point in bringing about positive attitudinal changes among both service providers and users, and in the longer term, can help develop a new water-wise and sanitation-friendly ethic in society, with children and the youth being the best ambassadors to bring about this change.

### **HVWSHE Experiences in Africa and Asia**

The journey of Human Values Based Water, Sanitation and Hygiene Education (HVWSHE) started in an Expert Group Meeting held in Johannesburg, South Africa from 30 April to 2 May 2001, which was exploring to take a new path in the development of a new ethic for water governance in cities. Since then UN-HABITAT has vigorously worked towards introduction and implementation of the Human Values approach to water education through formal, non-formal and in-formal channels of learning. This work first started in Africa, which after its successful implementation was brought into Asia in 2003 under the aegis for Water for Asian Cities Programme.

UN-HABITAT has been implementing Values-Based Water Education in nine demonstration countries (Cote d'Ivoire, Cameroon, Mali, Niger, Burkina Faso, Senegal, Ethiopia, Ghana, and Uganda) as part of its Water for African Cities (WAC) Programme. With support from the Swedish International Development Agency (SIDA) and the The African Institute of Sathya Sai Education (TAISSE), the human values based water education programme has proved itself as a truly path-breaking and innovative education initiative in Africa.

The remarkable results achieved by HVWSHE in Africa can be summarized as follows:

- Water related environmental education strategy for African cities;
- Tremendous generation of interest by cities (both participating and non participating) upon the project;
- Mainstreaming of HVWSHE in the curriculum
- Network and collaboration between education and water sector officials; and
- Extension of HVWSHE to Asian countries.

In the Asian context, and especially in perspective of its rich and diverse tradition and culture, we see that water, historically, has indeed been valued to a great extent in this region. Water is worshipped, and is linked with every ritual of human life. However, with the rapid changes the attached values has somewhat diminished over generations. HVWSHE thus plays an important role in eliciting the inherent values so that it can play a major role in behavioral and attitudinal change among the Asian population towards water ethics.

An understanding is slowly emerging that it is not enough just to increase investments related to water and sanitation but requires appropriate measures to ensure sustainability of investments and proper utilization of scarce resources. For this HVWSHE can be a panacea, which addresses the issues of environmental sustainability, social equity and economic sufficiency through behavioral change.

# Changing Sanitation Behaviour – Best Practices from Schools in India and The Philippines

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Keywords: ecosan, sustainable sanitation, school projects, India, The Philippines

Although the importance of water and sanitary facilities is acknowledged, in practice the sanitary situation in most developing countries is deplorable. When toilets are dirty and non-functional, open defecation is often the only option left leading to serious hygienic concerns, the risk of sexual harassment and snake bites as well as the pollution of environment and water bodies. Pathogens and parasites found in human excreta can result in a variety of illnesses, including diarrhoea leading to malnutrition and weakening the body's immune system. Most often children are the victims: They are more vulnerable to illnesses transmitted by excreta and the lack of appropriate sanitation facilities is one of the causes of drop-outs from classes.

Since many public and school toilet facilities are difficult to clean and maintain leading to odour problems and improper cleanliness, the user satisfaction and consequently the frequency of use are very low. These problems are related to poor quality, design and construction. In cases where conventional on-site sanitation such as septic tanks and pit latrines are used as public toilets, a regular emptying and collection service is required. Given that there is generally no safe treatment and disposal of the sludge, these types of public and school toilets may pose a threat to health and environment.

In comparison, ecological sanitation concepts offer considerable better conditions with respect to user comfort, economical and ecological sustainability, odour problems and maintenance. Giving a value to former “waste products” changes the personal attitude towards sanitation – the topic is no longer seen as a taboo but as a vital part of human life. Making reuse-oriented sustainable sanitation concepts a part of one's own lifestyle not only improves quality of life. It is also possible to gain renewable energy, irrigation water and fertiliser from what was before wastewater and excreta for disposal.

There is a great deal of positive experiences with ecological sanitation concepts at schools. Pilot projects have shown that accompanying information and education campaigns as a first step to introduce ecological sanitation concepts at school enhance the knowledge about healthy lifestyle among school communities. Hygiene education promotes practices that will help to prevent water and sanitation-related diseases as well as encouraging healthy behaviour in the future generation of adults. The provision of appropriate sanitation facilities in schools is a first step towards a healthy physical learning environment, benefiting both learning and health.

In the Philippines, the Periurban Vegetable Project of Xavier University College of Agriculture assisted the Christian Community for Social Awareness of the university in establishing an ecological sanitation concept in different communities of Lumbia, among them the Baluarte Elementary School. Before starting the project, orientation was given to 50 parents and teachers about the necessity of improving the inappropriate former school sanitation facilities. The sanitation concept was complemented by the provision of hygiene services such as hand washing facilities and washstands for anal cleansing. Since most parents are farmers, they also showed interest in reusing the ecosan products and replicate the system also in their households.



In India, the GTZ together with the Innovative Ecological Sanitation Network India supported the Navsarjan Trust to conduct various improvements for pupils and students. The Navsarjan Trust is dedicated at improving the living conditions of Dalits, the “Untouchables” in the Indian society. As it is still practice to force Dalits to clean pit latrines manually without any protection, more hygienic and sustainable sanitation systems are urgently needed. Capacity building in ecological sanitation, application of the WHO Guidelines for safe use of wastewater, excreta and greywater and hygiene education led to a re-consideration of sanitation practices and a behaviour change avoiding hygienic risks. A good example of a possible ecological sanitation system was installed at the vocational training centre “Dalit Shakti Kendra”. The ecosan system established consists of a common toilet bloc with hand washing facilities, a biogas plant for production of renewable energies and subsequent treatment of the digested slurry in humification fields.

The Navsarjan Trust also established ecosan projects at four primary schools in rural areas of Gujarat. The new sanitation facilities did not only improve the hygiene and thus the school attendance of girls, they also formed an essential part of hygiene and environmental education programmes at the school. By using excreta as fertiliser and greywater for irrigation, the school garden und greens flourished making the school visit more enjoyable. Their new sustainable toilets even motivated the pupils to build a toilet model which won the first price at a regional youth research competition. By implementing these good sanitation practices the pupils become motivated to adopt a similar system at their homes thus spreading the knowledge about sustainable sanitation from generation to generation.

This paper will derive the necessity of new holistic approaches to school sanitation and will present several of the good practice examples on ecological sanitation at schools in India and the Philippines.

# Facilitating Change in Behaviour Through NGO Intervention: The Experience of Streams of Knowledge and the Philippine Water Partnership

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Keywords: small water service provider, water cooperatives, water associations, round table discussion, partnership

## Introduction

Results of the MDG tracking indicated that the Philippines is being confronted by declining coverage rates in water supply. Given the current situation, it is most likely that the country may not be able to meet its water MDG targets by 2015. As of 2006, total water service coverage was estimated at about 80%. It must be noted that a considerable percentage is being provided by the so called small water service providers (SWSPs). Surveys indicated that from city to city, 20 –50% of residents are customers in informal markets, that is, they rely on SWSPs. Clearly, SWSPs provide water supply services to areas where the water districts and concessionaires cannot yet reach. Thus, they play a vital role in meeting the water demand of the country as these enterprises address the gap between what the government and the large water service providers can served.

## An Overview on the Small Water Service Providers

Defining who are the small water service providers in Philippine context proved to be problematic as there is difficulty on parameters such as scale of operations, type of system, and investments used to define SWSPs. However, the fact remains that between the concessionaires and water district who are the major water service providers, there exist a group water service providers who bridge the gap and cater to the needs of rural and urban population mostly informal settlers who do not have access to formal water systems. These so called SWSPs can be local government run utilities, cooperatives, rural and barangay water supply associations and small scale independent providers such as real estate developers, homeowners associations and peddlers. While not formally organized as a group, the SWSPs have been in business as water service providers for sometime. As a group, they are affected by a number of issues, such as : the lack of institutional or legal framework regarding their formal participation in WATSAN provision; commercial bank do not necessarily have lending programs for small water investments; and the unfavourable bulk water pricing policies has affected the viability of SSWPs. Furthermore, their capacity building needs were not properly addressed. The situation has affected the operations and attitude of SWSPs towards government. Most of the SWSPs have been independently operating with no formal assistance from the government.

## NGOs as Facilitator of Changes:

Cognizant of the potentials of SWSPs as effective partners of government in water service provision, the Philippine Water Partnership (PWP) and the Streams of Knowledge (STREAMS) has assumed the role of change agents by way of undertaking a series of roundtable discussions with SWSPs. The PWP is a country initiative composed of government, non-government, and the private sector that are actively engaged in various areas water resources management and development. On the other hand, STREAMS is a global coalition of resource centers engaged water and sanitation advocacy, capacity building, and action/applied researches.

The objective of the RTDs were to: understand the operation and management of SWSPs and the issues affecting them; facilitate the creation of a conducive environment by providing the necessary legal and institutional framework where SSWP can exist; assist SWSPs in meeting their capacity development needs and facilitate the formal organization of SWSPs. In essence, the outcome of the RTDs is to effect a change in the way government perceive SWSPs as well as SWSP attitude towards government intervention. This change in the perception of government towards SSWPs stems from the desire of government to harness the potentials of SSWPs engaged in WATSAN delivery in order to meet the needs of poor urban/peri urban communities at the same time contribute towards attainment of MDG goals.

STREAMS and PWP were successful in organizing a total of seven discussion in 2007 which culminated in the first SWSP National Conference in the Philippines. With the series of RTDs, perceptions, attitudes and behaviour of both the SSWPs and the government has undergone positive changes- changes that are expected to help the country meet its MDG targets. These landmark initiatives of the two NGOs were able to get the support of government, academe, funding institutions, the private sector in effecting a change in perception of the SSWPs as well as government's attitude towards SWSPs.

These change in perception and behaviour resulted in better cooperation and partnership between the SWSPs and the government. One concrete indicator of positive behavior change was the formal organization of the National Water and Sanitation Association of the Philippines (NAWASA) whose formation was facilitated by both STREAMS and PWP.

#### **The National Water and Sanitation Association of the Philippines (NAWASA)**

Formally organized under Philippine laws, NAWASA was registered with the Securities and Exchange Commission last November 7, 2007. At present, NAWASA represents the SWSPs in dealing with government and regarded as the voice of SWSPs in proposing policy reforms that would facilitate their engagement in water service provision.

Currently, STREAMS continues to “hand hold” NAWASA by providing technical assistance to the organization. Furthermore, STREAMS is currently undertaking a study on piloting a pro poor public private partnership in water service delivery for the urban poor, one objective of which is to facilitate the development of an enabling environment for engaging SWPS. Part of the initiative is the review of the current legal and regulatory framework as it impacts on the SWSPs.

The acceptability of NGOs such as STREAMS and PWP facilitating change for both the government and SWSPs is a key factor in attaining change in perception, attitude and behaviour of the 2 parties.

# The Study Change of Global Environmental and Human Changes on Sturgeons conservation with Emphasis on Food Security in Caspian Sea

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Keywords: Sturgeon, climate, Environment, Ecosystem, food

The Caspian Sea with a catchments area of 3.5 million square kilometers (km<sup>2</sup>) is famous for its population of sturgeon and, at its peak in the mid-1980s harbored some 85% of the world sturgeon population. The Caspian can be divided into three parts: a northern, shallow part (5-6 metres (m) deep) covering 80 000 km<sup>2</sup>, a middle part (average 190 m) covering 138 000 km<sup>2</sup> and a southern part (up to 1 025 m) covering 168 400 km<sup>2</sup>. The most important fauna of the Caspian Sea is the sturgeon, which constitute 85 % of the standing stock of the world's sturgeon population. The natural feeding behavior in sturgeons is reflected in their physiological and anatomical adaptations of the digestive systems. The amount and type of food found in the digestive tract of fishes depends on several factors such as food chain, seasonal variations, size and rate of digestion of food items.

Unfavorable environmental conditions and the increasing pollution threat of water bodies (rivers and seas) have caused deleterious impacts on the composition and abundance of aquatic populations as well as drastic declines in sturgeon stocks. Studies related to nutrition and biology of these species is among the effective factors that play a vital role in sturgeon catch.

Feeding intensity is influenced by several factors such as feeding bottom, season, water temperature, distribution pattern and density of feeding organisms. Detailed information regarding adult white sturgeon diet is lacking for the upper Columbia region of BC. In the Fraser River, B.C. eulachons were the most abundant prey species followed by sculpins (*Cottus* sp.), sticklebacks (*Gasterosteus aculeatus*), lampreys (*Petromyzontidae*), and juvenile sturgeon.

Water ecosystems are valuable sources in biosphere and can provide food supplies for human in future. In this regard Caspian Sea is one of the best water sources of world. This Sea is one of the best water sources of world since the past sturgeon and other natural stocks of Caspian Sea have been used as important sources of food and income for the people which live in coastal zones.

Despite the entire positive a negative measures carried out to prevent their extinction, human activities and climate play important role in sturgeon living mechanism. Unfortunately, this trend has changed after the break up of former Soviet Union.

The fisheries in the basin develop under the influences of complicated interactions of natural and anthropogenic factors which necessitate the elaboration of a system of purposeful measures providing conservation and rational exploitation of bioresources. In its turn, the definition of the most effective measures is possible only if based on an analysis of conditions formed during a period of time, assessment of priorities in change of ecological situation and productivity of the water body.

The problem of the conservation the Caspian Sturgeon and some representatives of this family from

other water bodies of concern to the world community. This paper shows that for food security and solve this problem the following measures need to be implemented:

- Halt poaching in a joint effort of Caspian Sea.
- Provide a pass of breeders to the spawning ground.
- Increase juvenile release all over the basin.
- Prevent pollution of the Sea with oil products and other toxicants
- Conduct fishing line with the common fishing regulations within the limits of scientifically based TACs and according to allocated quotas.

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# TIPS to Design Effective Behavior Change Interventions in Hygiene Promotion

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Keywords: formative research, hygiene behavior change, sanitation, hand washing with soap, household water treatment

Given the importance of hygiene practices to fight water borne disease and contribute to the achievement of MDG associated behaviors, innovative approaches are needed. Trials of improved practice (TIPs) is a formative research tool to help program planners select and “pretest” the behavioral practices they will promote. TIPs are effective in anticipating and preventing problems in the acceptability and proper application of a practice before major investment in promotional activities.. Members of the target audience try out and may modify options for improved practices developed through community research. TIPs help determine which behaviors to include, exclude or modify; which are priorities and whether sequencing matters; what are the most effective motivations and most significant barriers to adopting new practices; and what level of change in particular behaviors a program can expect.

As the basis for a major hygiene promotion activity, the USAID-funded Hygiene Improvement Project (HIP) conducted TIPs research in Madagascar to test the feasibility of key hygiene practices for households: treatment and storage of drinking water, safe disposal of child feces using latrines and potties; and hand washing with soap at critical junctures for the prevention of diarrheal disease. The research tested the extent to which some 100 families in four different regions could implement certain hygiene practices, or “small doable actions.” This approach requires a practice to be broken down into small steps and a negotiation or agreement made with families about what action they are willing to try out to facilitate consistent use. Two visits to the household occurred: one to engage the families and the other to follow up on barriers and facilitators as well as to discuss any modification the families introduced to the action or practice to make them more feasible. Each family tried only one practice related to one particular behavior.

Water treatment at the point of use is critical given that water quality tests of different sources of water regularly used by participating households proved the water to be contaminated. TIPs research identified boiling as the most common water treatment practice as Malagasy families commonly make “ranonapango,” a drink made by boiling water in a pot after burning leftover rice. However, the length of the boiling time exceeds that recommended by WHO—as soon as the water begins to bubble-- thus, the TIPs suggested a focus on promoting boiling for a shorter time. Handling of boiled water remains an issue given that it can be easily re-contaminated due to poor handling. One common solution, having a dedicated container for boiled water, presented difficulties for some families so future incremental steps to promote would include the use of either hard covers for wide-mouth containers or the use of narrow neck containers.

TIPs research suggested that the adoption of solar disinfection of water, although considered an easy method by participants, could be problematic given the scarcity of PET-type bottles especially in rural areas. Filtration is practically unknown in the four regions tested. The use of a locally produced hypochlorite (bleach) solution, Sur'Eau, emerged as the easiest water treatment option to promote along

with indications that promotion needs to emphasize the use of appropriate amounts of the solution.

Regarding sanitation, the TIPs pointed out the need and feasibility to promote latrines with a protected entrance, for example with something such as an empty rice bag, to facilitate use and the installation of a hand washing station close to the latrine to facilitate hand washing after defecation. The use of “tippy-taps” to dispense water for washing and rinsing hands and the use of ashes to replace soap would be acceptable options to promote hand washing.

Although TIPs confirmed that soap may be promoted for hand washing, commonly used cleansing agents for pots and pans include ash and sand. Consequently, these were also promoted as appropriate agents to wash hands at critical junctures. Rubbing both hands when washing them was identified as a specific action to stress as family members tended to wet and/or rinse their hands without rubbing them.

In summary, the use of TIPs uncovered specific elements of behaviors that needed to be emphasized given the circumstances and preferences of households and provided an opportunity to quickly assess their feasibility. Examples of small doable actions that are now promoted in Madagascar as a result of the TIPs research include the following:

#### **Water Treatment and Storage**

- Treat water used for preparing meals and drinking using Sur'Eau (hypochlorite), solar disinfection, Biosand filters or boiling
- If boiling water, let water boil only until water begins to bubble
- Keep treated water in a container covered with hard cover
- Clean container used for treated water at least once a week
- Use a ladle for extracting treated water from container

#### **Sanitation**

- Dispose of children feces in a latrine or bury
- Construct an affordable latrine to stop open defecation
- Protect the entrance to the latrine
- Leave a broom near latrine to clean it

#### **Hand washing**

- Install hand washing stations near the latrine
- Supply hand washing station with water and a cleansing agent
- Wash hands after cleaning a child and before preparing meals
- Rub hands when washing them at critical junctures using available cleansing agent

This presentation will further elaborate on the TIPs methodology and results and address the programmatic implications for promoting behavior change in hygiene and sanitation, in the Malagasy context.

# Innovative Participatory Monitoring System for Health and Hygiene Education Program

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Keywords: State of Art, Participatory Monitoring, Health and Hygiene, HHE, Women's Groups

Since “health for all” in 1979, drastic measures have been taken international and local communities, promotion of health and hygiene, especially among low income, poor and vulnerable groups. It is evident that promotion of washing hands with soap, which is only simple health practice, can reduce the one third of the diarrhoeal diseases transmission. This implies the importance of enhancing people's health knowledge and practices in eradicating waterborne and water-related disease which are preventable with simple behavioral change.

Although hygiene education being a vital device in changing people's behavior, the continuity of the health education programs are faded away once the outside assistance are terminated.

With the lessons learned, the Community Water Supply & Sanitation Project (CWSSP) in Sri Lanka has taken an initiative to formulate a sustainable hygiene education program, which is called ‘state of the art’ Health and Hygiene Education Program. It has unique features viz (i) health and hygiene education and (ii) participatory health monitoring.

Health Education is given to the project beneficiaries at village level, during the initial social mobilization period. Past experiences evident that the health education alone is not effective unless monitoring mechanism is established to review and reinforce the changing behaviors of people. Therefore, it is essential that there is an effective continuous monitoring system in place.

Participatory monitoring system adopted in the CWSSP has a number of innovative features and was attracted and appreciated by similar national level health development projects. This will be applied three times a year and conducted by the project beneficiaries themselves with the guidance of Health Authorities who are assisting them to conduct health and hygiene education program in their villages.

In addition to routine monitoring of health behaviors of their own, health status including the diarrhoea rates in young children in non-project areas are monitored by them for comparison purpose. Transmission of water borne diseases, money and time spent as a result of water borne diseases, hand washing practices, water storage, water disinfection, latrine usage etc. were the parameters being used for the health monitoring.

Once a project location is selected, a social mobilization program is implemented initially to mobilize beneficiaries and subsequently they form their Community Based Organization. Thereafter, all project activities including planning, designing construction of water supply schemes. Operation and maintenance etc. become the responsibility of the Community Based Organization. While and after the sub projects are completed, the CBO is taking all steps needed for monitoring of all project activities. Among these, monitoring of Health and Hygiene Education component takes a prominent



place. Data collected from the beneficiary groups are presented to the monthly CBO meetings and discussed jointly with the group leaders and the rest of the beneficiaries. Therefore, each one of the participant is made aware of the status of the Hygiene Education component and they are also made responsible for its effectiveness leading to reducing water borne health hazards.

Community Facilitators assigned by the project, during initial mobilization period itself, make the beneficiaries aware of the best health and hygiene practices. They are made to understand the benefits by being organized in to small groups with their neighbors. These small groups meet regularly in every week to discuss the progress of various project activities. At these weekly meetings, prominence given to monitor health and hygiene activities taking place in their small group level. They record details of their discussions, decisions taken, activities scheduled for the next week and also take remedial measures to issues identified. When it is revealed that a certain group member is not observing the requirements of HHE, group leaders take the responsibility to rectify the situation immediately. This monitoring mechanism through active participation of the members of small groups has been found to be very effective.

Women beneficiaries living in project locations represented by the small groups are formed in to special HHE women's groups. These women groups are met every week to discuss the progress. They take lead role in planning and implementing the HHE, also responsible for monitoring the program and each member is personally involved in monitoring. Participatory monitoring is very effective as all members in groups are drawn from the locality they live. Therefore, they could supervise the progress while attending to their day to day work even without spending extra time.

School going children in the village are also playing an active role in the implementation of the HHE program. During the initial mobilization period, children are formed in to HHE clubs. These clubs are formed at school and also at the pre-school level. Once both school and pre-school teachers are involved in the program, they supervise the activities of these children's clubs, after forming them. Similarly, the school and pre-school teachers are also involved in the HHE program together with the children. During the subject lessons, teachers ask the children as to how they observe and practice these health and hygiene practices at home and in school. Children are genuine in answering these queries. When the teachers observe that in some houses these health and hygiene practices are not observed, they immediately send a not to the respective family requesting them to rectify this situation. Also the child is there to follow up these until they are rectified.

These participatory monitoring measures are very effective in achieving expected outcomes in both HHE and also the Sanitation components in the project.

# Practical Observations Regarding Behavior Change with Respect to Household Water Treatment in Rural Ghana

Author: **Ms. Mary Kay Jackson** (Invited Speaker)  
Pure Home Water, Ghana

Co-Author: **Ms. Susan Murcott**  
Massachusetts Institute of Technology (MIT), USA

Pure Home Water is a social enterprise working in northern Ghana to disseminate household water treatment systems to rural communities without access to an improved water supply. In its three years' of existence, Pure Home Water has distributed approximately 12,000 clay pot filters to households and institutions in the Northern and Upper East Regions of Ghana, improving drinking water quality for an estimated 120,000 people.

Pure Home Water has focused primarily on selling the Kosim ceramic pot filter, a Ghanaian-manufactured version of the Potters for Peace ceramic filter developed in Nicaragua. Distribution has been done by several methods, including full price sale, subsidized sale, and free distribution of the product. Post distribution monitoring has indicated that the method by which the consumer obtained the filter does not significantly correlate with household behavior change and sustained use of the filter. Rather, behavior change is more closely related to two factors: the level of effort put into initial education about filter use, and continued presence in the community by Pure Home Water or the amount of post-distribution follow-up in the community.

# Pioneer Project Introducing Environmentally Friendly Technology for Water and Sanitation in Tanzania

Author: **Ms. Frida Lanshammar**  
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Keywords: environmental education, sustainability, East Africa, rainwater harvesting, compost toilets

In East Africa, most hotels and resorts are built without applying advanced technologies for sustainable water provision and sanitation. As a result, eutrophication of coastal waters and depletion of fresh water resources have increased tremendously in recent years. Since 1998 there is however an eco-lodge on a Chumbe, a small island close to Zanzibar town, Tanzania, which proves it possible to run a successful tourism project in Zanzibar without compromising nature.

The coastal region in Tanzania, including the Zanzibar archipelago, is a water poor area with an extremely fast growing population and exploding tourism industry. The freshwater resources on the island of Zanzibar are to a large extent dependant on seasonal rains stored in limited aquifers prone to saltwater intrusion.

Chumbe Island Coral Park Ltd, CHICOP, is a private company with not-for-profit objectives that has turned the small formerly uninhabited Chumbe Island into a fully protected marine and terrestrial nature reserve. Management costs and various research and education programs are now fully supported by proceeds from the eco-lodge. The park receives no financial support from the Government of Zanzibar or donor agencies.

The seven bungalow eco-lodge was constructed between 1994-1998 using state of the art eco-technologies such as rainwater harvesting systems on all roofs. The collected water is filtered through gravel and sand before it is stored in large closed cisterns combined with hand pumps to provide fresh water for showers and washbasins. The closed systems are particularly important in tropical areas to avoid providing breeding grounds for disease vectors such as mosquitoes. Further, the lodge has installed compost toilets based on the Swedish Clivus Multrum Composting Toilet system, which uses no fresh water and produces no sewage. Instead, the organic waste is decomposed and reduced to a nutrient rich dry matter with a sixth of its original volume. The aerobic composting process is powered by a sophisticated ventilation system using small wind-driven wheels which have been fitted on top of the ventilation pipes of the composting chambers. These generate an air draught needed for the aerobic digestion of the human and organic waste. The pipes reach above the tree canopy for maximum ventilation and an odour-free environment.

To avoid introducing unwanted nutrients to the surrounding environment, waste water from the showers, washbasins and kitchen pass through artificial wetland systems prior to being released. The waste water from the bungalows passes through gravel and sand filters before entering a sealed vegetation bed containing plants absorbing large amounts of phosphates and nitrates. This system makes it unnecessary with high-energy and industrially manufactured technologies, products and services for water purification.

Renewable energy from the sun is used to heat water, to provide energy for lights, freezer as well as sockets for recharging batteries. The eco-technology is used both for guest bungalows, the visitors' centre and all staff accommodation on the island.

Chumbe was the first eco-lodge of its kind in East Africa. It took four years of negotiations with the Zanzibar government before the required leases, contracts and building permits were granted for this innovative project and its locally unknown environmental technologies. The development of the island took another 4 years, as no contractors with the required experience were available in the country. Based on agreements with adjacent villages, the Chumbe Management preferred to employ local people even though they commonly lacked formal education and training. Hence, the building process had to be organised with expatriate architects training and supervising local workers. All development required substantial on-the-job training, on the construction, use, as well as maintenance of the innovative technological solutions. For example, introducing composting toilets was a real challenge, as local people commonly practice abolition and have cultural resistance towards touching the compost produced by human faeces. This challenge was however overcome through training and experience.

After 10 years of operating the eco-lodge, the Chumbe staff members are now very professional in the use and maintenance of all components of the eco-technology on the island, and proudly share their knowledge and experiences with all visitors.

Along with the conservation work in the marine park and forest reserve, Chumbe regularly provides training and environmental education for local and international students and schoolchildren, local government officials, NGO's, and other interested groups. Since 2002 more than 3,000 Zanzibari students and 600 teachers have participated in the extensive environmental education programme and learned, among other things, about sustainable water and sanitation solutions, eco-tourism, marine conservation, and coral reef ecology. The pristine marine park and forest reserve are often used for ecological research by both Tanzanian and foreign researchers and Chumbe has often been show-cased internationally as a well-managed nature reserve and genuine eco-tourism project. Chumbe has also twice been selected as a finalist for its eco-technology by the Aga Khan Award for Architecture.

# Change in Public Attitudes and Behaviors Over Time about Water Resource Issues in the Pacific Northwest Region of the USA

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Keywords: water quantity, water quality, water education, survey instruments, water conservation

Our research group is interested in measuring change in attitudes and actions by people addressing water resource issues. To measure change, we have developed a program to sample adults in our region every five years. Our first major study occurred in 2002. This paper will report change between 2002 and 2007. We plan to again take measurements in 2012, 2017 and 2022. The questionnaire developed in 2002 will be used for all assessments in this 25-year study. The four Pacific Northwest states comprise 33% of the USA's land area but contain only 12,000,000 people (4% of the USA's population). Water resources (both quantity and quality) are the most important environmental issue in the region. The population is fully literate and highly educated. Consequently, both traditional and sophisticated educational programs can be used to address water resource issues.

A 50-question mail-based survey was completed by over 1,000 randomly selected residents of the Pacific Northwest Region of the USA (Idaho, Oregon, Washington and Alaska) in early 2007 about public attitudes, aptitudes and actions taken toward water resource issues in the Pacific Northwest. The completed survey return rate exceeded 52%. This statistically designed survey was identical to a survey instrument used in 2002. The 2002 survey established base line data. The answers collected in 2007 were used to measure change over the last five years. Based on survey results the following water quantity changes have been made by the public in the region in the last five years: (1) almost 60% of respondents have installed a water saving device in their home; (2) 42.9% changed how they have used water in the house; (3) 49% changed their yard watering patterns; (4) 30% changed how they washed their vehicle; and (5) only 17.5% indicated that they have not instituted any water saving actions. Based on survey results the following water quality actions have been taken by the public in the region in the last five years: (1) 46.1% have changed the way they dispose of household chemicals; (2) 31% have changed their usage of pesticides and fertilizers in their yards; (3) 29.1% have changed their disposal methods for motor oil and other vehicle fluids; and (4) only 26.2% of survey respondents have taken no action to address water quality concerns.

A majority of residents of the region rely on television, newspapers and printed fact sheets as their primary sources of water resources information. However, in the last five years the use of newspapers, television, environmental agencies, citizen groups, Extension, Universities and schools as sources of water information has declined by 3, 3, 4, 5, 3, 1 and 2%, respectively. Only the use of the internet (+5%) as a source of water information has increased. Compared to the 2002 survey the choice of reading printed fact sheets and visiting web sites as preferred learning opportunities has increased by 9 and 2%, respectively. Conversely, the popularity of reading newspapers, watching television, viewing displays, attending short courses and taking courses for credit as preferred learning opportunities decreased by 6, 8, 4, 11 and 3% since 2002, respectively.

The 2007 survey results show that citizens are willing to voluntarily address important water quality and water quantity issues in the Pacific Northwest. Significant citizen changes in actions have occurred in the last five years. Printed educational materials are still much more important to people in the region compared to electronic media (internet). The survey results also indicate that public education by multiple agencies is more effective in promoting citizen action than the regulatory approach. Consequently, education is very cost effective when you consider that almost two-thirds of the region's residents made voluntary changes in how they individually deal with water quality and water quantity issues in the last five years. The public habit change will result in enhanced water resources (quality and quantity) over the next decade and beyond.

# From Reforms to Implementation: The Paradox of Financial Sustainability in River Basin Organisations in Developing Countries

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Keywords: developing countries, river basin management, Financial sustainability, emerging organisations, sustainability

The water reform process together with the awareness that river basins are the natural context in which fresh water occurs, supplying water. River Basins are the ultimate source of water required to satisfy competing needs in a given area, and provide the smallest hydrological unit under which water can be managed.

The water reforms process is currently ongoing in developing countries today. This process has been carried out through the presence of a genuine will and need for water sector reforms and in some cases from pressure to comply with structures imposed by international development agency or as loan conditions in line with global trends. All this has triggered the development and establishment of River Basin Organisations and Institutions.

Effective river basin management hinges on adequate financing for all basin activities which may vary from water allocation, offering stakeholder platforms and catchment management. Financing has been singled out as one of the factors contributing significantly not only to River Basin Organizations performance and effectiveness but also on their long term sustainability. With this rapid emergence of River Basin Organisations and Institutions, it is of importance to understand the process of sustaining River Basin Organisation so that they can effectively manage and control the water resources within their areas.

Establishing river basin organizations in it's self cannot solve the complex water issues within the basin. There is need for the organisation to be fully functional and capacitated. Even the most effective program faces two challenges: maintaining or expanding its capacity and sustaining its effectiveness over time. For an organisation to be financial sustainable it must therefore have the ability to generate its own revenue, fund existing projects and fund future developments as well as maintain the participation of all project participants or stakeholders, and respond to the changes in financial conditions.

In general the injection of funds and finances into any River Basin Organisation is based on the application of the following mechanisms; the polluter/ user pays principle, budget support and voluntary payments. This study focuses on the enhancement of financial sustainability in river basin organisations. A comparative study to establish how financial sustainability can be improved was carried out on both emerging and mature basin organisations. This was achieved by the use of an indicator based system, questionnaires and literature studies leading to the development of building blocks for financial sustainability.

Five indicator groups can be used to assess the financial sustainability of RBOs, these are:

- Indicators of strategic planning and financing
- Indicators of Service provision and income generation

- Indicators of Stakeholder participation
- Indicators of Financial accounting and reporting
- Price Setting Mechanisms

To bridge these existing gaps it is important to ensure that essential building blocks of sustainability are incorporated at both national and basin level. For financial sustainability the building blocks include creating an enabling policy and legal framework, building implementation capacity, strengthening planning and strategic management competencies, designing holistic functions, making an inventory of available resources, developing water use capacity and implementing effective and efficient pricing mechanisms.

Findings show that firstly, the management of water based on hydrological boundaries is now accepted as an efficient mechanism of managing resources, secondly, strategic planning and financing cannot be avoided as tools for setting tariffs and income generation and thirdly, the design of policy and legal framework are important in river basin management. The Guidelines developed show that there is need to create and an enabling policy and legal framework for holistic management of river basin organisations, prioritising the creation of inventories of available resources and the further development of water use capacities.



# Project WET and ActionEducation: Linking Education to Community Solutions

Author: **Mr. Dennis Nelson**  
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Keywords: awareness, education, action, solutions, funding

This paper will describe a children/youth water resources education program called Project WET (Water Education for Teachers) that is being replicated worldwide through the efforts of local and country ministries, water resources managers, educators, NGOs, and private partners. The educational materials and methods employed by Project WET are hands-on, science-based, and have been successfully adapted and used by water educators throughout the world in extremely diverse social, political, economic, cultural, and environmental settings. Case studies will be used to describe the rapid results process used by Project WET to assist agencies, corporations, and NGOs in developing their own unique school- and community-based water education programs. Project WET's Africa and Latin America and Caribbean regional water and sanitation education initiatives will be highlighted. With support from public and private donors, Project WET's Africa "water, sanitation, hygiene, and health" program will reach 1,000 schools and over 800,000 children/youth and will employ a pioneering new educational approach called ActionEducation™.

In its 24 years of operation, with a mission of reaching children, parents, educators, and communities around the world with water education, the Project WET (Water Education for Teachers) Foundation has created one of the most extensive sets of original education materials in the world, containing hands-on, interactive, science-based activities.

Project WET, with the support of hundreds of partners, has created the following education programs: Healthy Water, Healthy People (water quality, sanitation, hygiene, and human and environmental health); Discover a Watershed Series (bi-national rivers and watersheds); Wonders of Wetlands; Ground Water; Conserve Water (water scarcity and drought); Kids In Discovery series (KIDS) activity books, and new initiatives on risks related to emergency preparedness and floods, environmental restoration, and climate and change.

Project WET's work is guided by the following core beliefs:

- Water moves through living and nonliving systems and binds them together in a complex web of life;
- Water of sufficient quality and quantity is important for all water users (energy producers, earth systems, farmers and ranchers, fish and wildlife, manufacturers/industry, recreationists, and urban and rural dwellers);
- Sustainable water resources management is crucial for providing tomorrow's children/youth with social and economic stability in a healthy environment; and
- Awareness of, and respect for, water resources can encourage a personal, lifelong commitment of responsibility and positive community participation.

In the context of integrated and adaptive water resources management, Project WET's core beliefs have led to significant program growth through funding from public and private sector donors.

Annually, Project WET's global network of country partners (e.g., Project WET Uganda, South Africa, Hungary, Vietnam, France, Argentina, and Japan) conducts over 1,200 train-the-trainer workshops, reaching more than 30,000 school and community educators. The thousands of teachers trained in Project WET pedagogy have reached millions of students with interactive lessons in science and water resources management. Through new partnerships with global organizations and corporations, Project WET is positioned to reach significant numbers of people with water education.

To bridge education and sustainable change, Project WET's model includes a new approach called ActionEducation™, which is designed to directly link awareness and education with actions that lead to local solutions. In this context, action doesn't happen by chance; action and solutions are the focus of the education. ActionEducation™ is also vitally important to donors who are increasingly demanding results from their investments. The question posed to Project WET by some of the largest foundations in the world is, "how can Project WET contribute in a meaningful way to reducing serious water problems (e.g., help reduce the number of death caused by water-borne diseases or from natural disasters such as floods)?" More specifically, "how can the knowledge and education provided by Project WET be translated into action and solutions that can be documented?" This presentation will answer these questions based on experiences in over 30 countries.

[www.projectwet.org](http://www.projectwet.org)

# School Based Initiatives to Advance Sanitation Outcome among Children and Their Households

Author: **Mr. Alfred Niwagaba Zinabwine**  
Little Angels Primary School – Ntungamo, Uganda

Keywords: schools, sanitation, sanitation clubs, competitions, child- child

Poor sanitation is a national problem and every body's responsibility. In Uganda, it has effects on health status, education, trade and development. In the process it drains on the national economy and slows down the national poverty reduction intervention. Nevertheless, Government, NGOS, CBOS and individuals to improve sanitation have done many efforts to improve sanitation but less has changed. Much emphasis has always been put on household level in communities.

In all these efforts, Children have been sidelined and yet several studies have shown that most diseases suffered by children are related to poor sanitation conditions and lack of proper sanitation facility (Guidelines for school sanitation July 2001). Such survey results show the need to focus on children. Little Angels primary school situated in Uganda, Ntungamo district has initiated school based program to address hygiene and sanitation through using the child- child approach and child to adult approach.

There three strategies that have been employed at little Angels primary school Ntungamo to make the program successful; emphasis of hand washing after latrine use and with the use of soap, safe excreta management and recycling of waste management. All these strategies are managed and implemented by children in the school which are later replicated at their households.

It is generally recognized that childhood is the best time for children to establish life long sanitation behaviors since children are future parents and what they learn is likely to be applied in the rest of their lives.

They have important roles in the households, taking care of younger brothers and sisters and depending on the culture; they may also question existing practices at the household's level. So, if children are brought into the development process as active participants, they can become change agents within their families and a stimulus to communication development.

They are eager to learn and help, and if they consider environmental care and their role in this as important, they will take care of their own health and health of others. Being tomorrow's parents, children are also likely to ensure the sustainability of the programmes impact.

The formation of the sanitation clubs among children was one strategy of communicating hygiene and sanitation messages through drama, poems and debates. These clubs have patrons who a teacher responsible for the science subject as a result over 120 pupils are part of the sanitation clubs these children replicate the sanitation activities in their homes and fellow children make home visits.

The formulation of the sanitation action plan on semester basis was another innovation, a school based plan which was formulated with the participation of the children leadership created a sense of responsibility among the pupils of little Angels as a result were guided by the school sanitation club.

Increased food security with the use of excreta manure. The school garden is managed by the sanitation club in which vegetables such as cabbages, carrots, and egg plants are grown to supplement on nutrition at school. This is has motivated the children to be active in the clubs and to keep the sanitation in the school.

Sanitation school competitions have sustained sanitation in classes, school compound and in the dormitories, the school has been kept clean and also the children motivated by the end of year competition in their houses, where the best child is given a gift and free to contest for the head of leadership in the school.

However, the overgrowing population in the school has stretched the sanitation facilities in the school, where operation and maintenance has turned out to be a problem. Increase population has not been marched with the growing population.

In conclusion; this poster will highlight the implementation of sanitation project by children in the school and the multi benefits towards sustaining behavior that has led to increased enrollment of the girl children, improved performance of the school, reduced diarrhea infection and increased water access a model that has been replicated to the rest of the school in the district.

# Total Sanitation and Hygiene Behaviour from a Gender Perspective: Insights from India

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Keywords: Gender, Culture, Hygiene, Mainstreaming, Behaviour

It is well known that rural women in India are adversely affected due to poor sanitation conditions surrounding them. It is manifested in the form of perennial poor health among women and their household members, thereby affecting women's reproductive tasks and income earning opportunities. The 'culture of silence' that is commonly observed among women in rural communities is also responsible for their poor hygiene and health condition. Currently in India, there is a lot of attention by both the government and non-government organizations to make total sanitation a reality. Several agencies are engaged in implementing water, sanitation and hygiene programmes across the country. Experiences from the field are varied and indicate that wherever women have been involved from the planning stage of the programme systematically, sanitation programmes have moved towards success. This is however one aspect. In addition, the approach of implementing agencies is also crucial in involving and targeting women. The conventional approaches where women are treated as a special category for whom special programmes need to be planned still continue. This is the typical women in development approach with which most agencies are comfortable. However, what is observed is that such approaches by and large have not helped in sustaining the benefits of the sanitation programmes in the long run. This is the other aspect that needs attention. Addressing women's specific needs and planning the sanitation programme is very important to begin with and involve women, but there is a need to design innovative ways to sustain the programme in which the gender question comes in. The other related issue is hygiene behaviour which has a gender dimension. Observations from the field indicate that women regularly use the toilet and bathing space as for them it is a boon to have access to such sanitation facilities. They also motivate other women and children to use the toilet and change their behaviour. However, what is observed is that men may not change their behaviour. In many programmes, women are attempting to target men for involvement in sanitation and hygiene promotion so that they too can take up the responsibility of personal family hygiene. The outcome is mixed and wherever it has been successful, there is definite role of the implementing agency in sensitizing and motivating the men of the community. Therefore there is a need to bring in a gender perspective in the approach to sanitation and hygiene programmes that can have a transformatory impact on women and men.

This paper would discuss several examples from India, particularly comparing programmes implemented by the government and the non-government agencies (including other non-state agencies). The duration of the programme and the credibility of the implementing agency also has a role of play in its success especially from the point of view of change in behaviour towards use of sanitation facilities. The case of Gram Vikas in Southern Orissa is a case in point, where the NGO's approach has been to go for 100% sanitation facilities at the village level and unless that is achieved further support will not be provided. They have been successful in achieving their goals in terms of success primarily due to the village women. Some of the key lessons being – women have a good knowledge about local water and sanitation practices and any associated problems, which can direct interventions; women's interest in the family's health motivates them to bring about improvement; women use

group activities to reach other women and disseminate information about good hygiene and women are keen to involve men in the programmes. Similarly, approaches of women-focused NGOs working on sanitation such as Utthan in Gujarat will also be discussed.

The main outcome of the paper will be how different approaches of the sanitation programmes from the gender perspective have a bearing on hygiene behaviour which is a key to its success. Policy implications and how India can achieve the MDGs will also be discussed in the paper. Although there is a lot of documentation on different sanitation programmes in the country, yet there is a need for more experiences to be discussed from the point of view of gender mainstreaming in sanitation programmes.

# Behavior Change in Water and Sanitation Practices: Engaging Women's Groups in rural Uganda

Author: **Ms. Deborah Payne Mirembe** et al.  
Katosi Women Development Trust, Uganda

Keywords: water and gender, appropriate technology, hand washing, behavior change, women's groups

Sustainable change in community water and sanitation practices requires involvement of all stakeholders. In developing areas, however, it is important to recognize that women tend to be the main managers of water and sanitation practices in the home. This includes the collection and use of water and the construction and use of simple sanitation technologies such as drying racks, hand washing stations, and soak pits as well as the maintenance of latrines and cleaning up after children who perform open defecation.

Women's groups in Uganda commonly form for purposes of income generation, savings clubs, education, exchange of ideas, or simply for social reasons. While such groups may form independently of any NGO or government agency, if supported and educated such groups can serve as catalysts for behavior change in water and sanitation in the home. Katosi Women Development Trust of Mukono district, Uganda, is a network of 11 women's groups in villages on the northern shore of Lake Victoria. Initially formed in 1996, the organization expanded to include 11 self-initiated groups. Such networking has allowed for increased opportunities in adult education in water and sanitation, agricultural and economic endeavors.

In a community health survey carried out by members of KWDT results indicated a marked improvement in behavioral change for KWDT members over community members for the implementation and use of certain simple sanitation technologies and practices. These included boiling drinking water, the construction and use of hand washing stations with soap, solar drying racks, bathing areas, soak pits, appropriate refuse disposal and quality pit latrines.

The survey was carried out in the sub-counties of Nakisunga and Ntenjeru in 26 villages drawn from five parishes where KWDT women reside. The groups' water and sanitation committees (77 members from 11 member groups) worked as volunteers for data collection. Data collection was carried out after a two day intensive training on the process. The baseline survey was part of a larger project for the implementation of community wide water and sanitation education. Data was collected from 1000 households representing a population of 4,937 people.

Results indicated that membership with KWDT improved implementation of water and sanitation practices. 71% of KWDT members over 45% of community members surveyed had hand washing stations. 62% of KWDT members had toilets with a safe floor and super structure observing privacy as opposed to 47 % community members with similar conditions. 77% of KWDT members boil drinking water as opposed to 56% of community members. 74% of KWDT members carry out an improved form of waste disposal (burning or burying as a opposed to scattering) compared to 49% of community members. 70% of KWDT members had dishracks as opposed to 31% of community members. 81% of KWDT members have bathing areas. Of those 61% had soak pits. 59% of the community had bathing areas with only 39% of those with soak pits.

As KWDT members were trained to carry out the community health survey results may have been influenced by data collector bias. The construction of simple technologies also does not necessarily mean immediate behavior change. “Tippy tap” hand washing stations are simple to use, requiring only that a foot lever be pressed to allow water to flow from a suspended jerry can. However, the jerry can must be refilled once or twice a day to be affective. Such transitions from pouring water directly from a jerry can and washing one hand at a time to pouring water into the tippy tap first is not always immediate and can be influenced by such factors as water accessibility and proximity of the tap to the home. Use of simple sanitation technologies, though present, may not be 100%.

Membership with KWDT presents a range of opportunities for women that may have contributed to the results of the study. Such opportunities have included trainings on water and sanitation, zero interest loans for pit latrines and extension agents to identify ways to improve sanitation in the home. Some members of KWDT have also been trained as masons for the construction of pit latrines and water tanks. These women are regarded with higher esteem within the community due to having a technical skill. Members have also been provided agricultural training to improve income as well as access to cows for milk production. These opportunities increase access to personal funds for the construction of pit latrines and rainwater collection tanks.

Other secondary benefits of belonging to a women’s group included increased respect and influence in the community. Such respect can serve as an entry into the village for potential community wide behavior change. Members of KWDT have been trained to share information regarding improved water and sanitation practices with the community. As women create their own model homes, neighbors have identified the benefits of home sanitation practices and have implemented such practices in their own homes.

Results of the study suggest that supporting existing women’s groups can be an effective tool for implementing behavior change. Women’s groups are an appropriate target for NGOs or government initiatives working to implement water and sanitation programs. Such alliances not only adopt a bottom up approach for development, but also incorporate cultural and gender appropriateness.



# A Hybrid Approach in Hygiene and Sanitation Promotion to Achieve MDGs: The Case of the Learning by Doing Initiative in Amhara, Ethiopia

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Keywords: hygiene improvement framework, behavior change, systems approach, sanitation MDGs, community led total sanitation

Community Led Total Sanitation, or CLTS, is a promising approach which facilitates a process of empowering local communities to stop open defecation and to build and use latrines without the support of any external hardware subsidy. Since the approach was first pioneered in Bangladesh in 1999 CLTS has continued to spread, and the approach has been introduced in a number of other countries in Asia, Latin America and Africa.

To achieve Millennium Development Goals for sanitation and reach universal sanitation and hygiene coverage by 2012, the Government of Ethiopia invited the Water and Sanitation Program of the World Bank and the USAID-funded Hygiene Improvement Project to collaborating on the implementation the newly endorsed National Hygiene and Sanitation Strategy through innovative approaches. The approach, dubbed “Learning by Doing for At Scale Hygiene and Sanitation,” starts with the best tools and motivators of CLTS—local leaders “igniting” sanitation and hygiene behaviour change through the use of shame, pride, norms, local resources and incentives for collective achievement. These elements are rigorously integrated into a systems approach that “engages the multiples” – multiple sectors, multiple actors and multiple strategies to address multiple hygiene and sanitation behaviours.

This CLTS hybrid currently being implemented and evaluated in the Amhara Region of 19 million people, focuses on building regional and district level capacities to plan, implement, and monitor the various facets of this hybrid approach, which brings together the combined contributions of participating institutions in the hardware, software and enabling environment. Key elements of this approach include developing and managing effective implementation partnerships between government, NGOs, private sector and development partners; and strengthening the regional and district (woreda) capacity for hygiene improvement, including increasing the affordability and availability of local technologies. Successful implementation also requires multi-level advocacy, strengthening of household outreach, development of institutional capacity to implement community-based approaches to change including community led total sanitation; media support; and school hygiene and sanitation interventions, such as the installation of demonstration latrines and hand washing stations.

The intervention seeks to catalyze different leverage points to achieve sustainable behaviour change. In so doing, it relies on actions at multiple levels (regional, zonal, woreda, kebele, community), across multiple sectors (health, education, water, youth, women, private commercial), and using multiple communication channels (face-to-face, community events, religious institutions, school curriculum, mass media, advocacy, IEC, etc.).

At the local level, the behaviour change strategy relies on placing health extension workers (HEW) at the center of district and local-level hygiene and sanitation promotion— increasing their capacity to mobilize communities, to negotiate individually with households what the best sanitary options are for them. The approach assumes that HEWs need to be supervised and supported in addition to receiving appropriate recognition for their accomplishments and performance.

The initiative includes indicators to monitor progress and achievements. There are indicators addressing different aspects of the intervention including: enhancement of partnerships bringing together stakeholders engaged in collaborative efforts; improved institutional capacity for planning and implementation at the regional and district levels; and behaviour change at the household level. Efforts are being made to harmonize the use of indicators at national, regional and local levels, and across development partners and implementing stakeholders.

This presentation will explain the comprehensive approach, how is it being applied in Amhara, Ethiopia; highlight tools and guidance for replications; and review achievements to date.

# Menstrual Hygiene Promotion: A Neglected Domain of Hygiene Behaviour

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Keywords: poor school girls, menstrual hygiene, educating girls, influence behaviour, positive habits

Menstrual hygiene promotion is a neglected subject in the domain of hygiene behaviour for poor schoolgirls of the developing countries since people do not feel interested to talk about it for social taboo. Menstruation is the most contributing factor to school absenteeism and poor academic performance among schoolgirls. Around 50% of the school girls who drop out of school in secondary classes are because of lack of sanitary pads coupled with lack of separate toilet facilities and easy access to water sources within the schools. Many teachers and parents are ignorant about their added value to the education of girls. It is the most ignored area in hygiene especially for the rural areas. A study was made that how to accelerate this important issue without affecting the cultural values.

This study was made among school girls aged 11–16 in the rural area secondary school going girls of Bangladesh studying in class VI to X. They were asked about the type of sanitary protection used, frequency of changing pads or cloths, means of disposal during menstruation and facilities at their school and home. Girls were selected by cluster sampling technique in public secondary schools in rural areas. It is important to note that different NGOs are promoting School Sanitation and Hygiene programs at secondary schools where menstrual hygiene issues are absent or limited. Unfortunately, there is a lot of silence surrounding and it has been observed that many girls fear to ask their parents for sanitary pads. In Bangladesh only about 53 % schools had functioning water source, on average one latrine for 153 children, 19 % had no working latrine, 25% had only one latrine (Unicef survey, 2004). Interestingly, in most of the schools hygiene education packages are there but regrettably menstrual hygiene issues are absent and even female teachers are not interested to discuss this issue due to their lack of knowledge and culturally it is not accepted as an open issue of discussion. Although, it is a normal and natural process that occurs in all healthy adolescents girls but around 50% schoolgirls drop out in rural areas due to lack of sanitary facilities in the period and more importantly that in most of the hygiene education the issue is ignored as still it is considered as a no-go areas of discussion.

Data were collected in the secondary schools through an anonymous, open-ended questionnaire during off-period in class time. The study focused how to act to change the culture of silence on the menstrual hygiene issue. The study also identifies that all these activities have given a forum to discuss the basic needs of adolescent girls and influenced to incorporate in the class routine so that at least once in a week female class teacher could seat with the girls. A study was also conducted in the selected schools from which useful experiences and knowledge were gained how to influence the behaviour which has a positive influence on attitude.

The study also addresses different issues that are critical in guiding policy for the menstrual hygiene promotion. The situation in the project areas illustrates the problem that needs systematic and practical solution for behavioural change. The study area is a poverty prone area where majority of the girls are from lower income group. Use of sanitary pads are mostly absent among girls from rural and poor families and other aspects of personal hygiene were generally found to be poor too. Lack of privacy is

a serious problem. The main source of information about menstrual hygiene are sister in law or mothers or friends, but a large majority of school girls said they needed more information about sanitary use of cloths/ low cost pads. Menstrual hygiene should be linked to a hygiene education program in schools with active involvement of female teachers. A caring environment for menstrual hygiene has to be provided both at home and in schools and the issue should be made an open agenda while building latrines and water sources at schools.

To provide lasting relief against menstrual hygiene, the teachers and school management committees need to play central role and project to play a catalytic role. Now the time has come to prepare a concrete plan of action to develop a common policy to address menstrual hygiene issues as mandatory in all school hygiene education and promotion activities especially in rural secondary schools to reduce the drop out/ absenteeism of poor girls.

The outcome of the study will be an input to the sector stakeholders that how menstrual hygiene behaviour issue could be promoted allowing poor girls to visit school regularly especially through providing safe water sources and sanitation.

# The Role of Multi Disciplinary Research in Influencing Behavioural Changes for Pollution Mitigation and Environmental Restoration

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Keywords: Behaviour change, pollution, health, participation, Lake Victoria

Lake Victoria basin is in a danger of potential pollution due to increased exposure to growing human activities. For the past few years, research-based technical solutions have been developed and tried to mitigate the effect. Such interventions, unless are coupled with basic changes in human behaviour towards decision making at local, policy and legislative levels, less is likely to be achieved.

This paper shares the research findings and showcase experiences on the effects of behavioural change on health and environment as a result of information generated from research work by the Lake Victoria Research Initiative [VicRes].

Lake Victoria Research Initiative (VicRes) was established in 2002 through a series of consultations involving academics, researchers and stakeholders from universities and research organizations in East Africa, and Sida/SAREC. It was designed to offer opportunity to the East African Community partner states to undertake research that would contribute towards sustainable livelihoods of communities in the Lake Victoria Basin. The overall goals of VicRes is to promote sustainable livelihood and natural resources management in the Lake Victoria Basin and re-invigorate research and stimulate discussions on issues that affect people and environment of the Lake Victoria Basin. The program has twofold objectives; to enhance knowledge on land-human-environment interactions so as to justify interventions relevant to poverty reduction and environmental restoration, and to promote access to research findings in and outside the East African region for effective decision-making.

The guiding principle of the VicRes initiative was to build a platform of knowledge to form the launching pad from which the people in the Lake Victoria Basin would be rescued from the biting jaws of poverty. The knowledge would assist in the restoration of the environment and improve land-human environment interactions so as to justify interventions for improving the living conditions of the region's inhabitants. The project was perceived to improve access to research findings by users in the development of the Lake Victoria Basin and beyond, and to facilitate adoption and application of improved knowledge for sustainable development.

VicRes is supporting 357 researchers from 83 universities and research institutions in East Africa, in areas of pollution mitigation, better resource use and health related matters. The research fall in 87 funded research projects, each with an average of 3 researchers with one coming from each of the member states of the East Africa Community i.e. Tanzania, Kenya, Uganda, Rwanda and Burundi. Based on the areas of focus, the research projects are grouped into five broad categories called clusters.

Currently there are five clusters namely; pollution and heavy metals, natural resource management, land use options, aquaculture and fisheries and ethno-botany and indigenous knowledge.

The paper argues that for an active and positive behaviour change, problem identification for research issue must be conceive with the local communities in mind, with clear research objectives focused on the local problems. Community participation must then be instilled right at the start of the research, with options, solutions and identified areas of change generated and aligned to the practical community's needs; considering the community's history, its local power base and its socio-economic values. The similar end loop must encompass policy makers and those who are able to influence legislative inclinations.

The paper further argues that such action oriented is research is best done by multi-inter-disciplinary teams which are capable of analyzing problems and solutions beyond geographical and disciplinary frontiers, and are able to build rapport among various actors in the area of concern. Based on more than five years experience in funding research, lessons are drawn and experiences shared for enhancement of research practice and grant-making in eastern Africa.

The paper concludes that; values, positive behaviours and integrity are best inculcated through participation, and are sine qua non to sustainability of local resource use; that policy and decision makers behaviours is very important in their decisions towards resource use and that comprehensive pollution and environmental degradations initiatives that are build on behavioural changes are likely to yield more impact.

# Developments in Applying Franchising Principles to Improving Water and Sanitation Services Reliability

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Keywords: Water, Sanitation, Franchising, Operation, South Africa

A Water Research Commission (WRC) of South Africa scoping study completed in 2005 (and reported on at the 2007 World Water Week\*) found that the concept of franchising partnerships could alleviate and address many challenges in the delivery and management of water and sanitation services. Generically, franchising:

- transfers appropriate skills transfer to local personnel,
- brings ongoing support, mentoring and quality control, and
- provides backup at-a-distance skills together with the incentive, on the part of the local (franchisee) personnel, to call for those at-a-distance skills and, on the part of the franchisor, to make them available, because there is a binding contract between them and a shared reputation.

To emphasise: franchisees service providers, dependent for their livelihood on the success of their businesses, have a strong incentive to perform, and also enjoy the benefit of the franchisor's expert guidance and quality assurance.

Franchising partnerships for water and sanitation services operation and maintenance would, at the same time as delivering the service, provide an ideal stimulus to support the development of local micro enterprises within the municipal service delivery environment.

Ongoing WRC research, at the time of writing being prepared for publication, has since 2005 very much further explored and established the concept of franchising partnerships in water services -- three-party partnerships, that is, between franchisor, franchisee and the owner of the water services infrastructure. Findings indicate that many opportunities lie in the franchising of suitable parts of the water and sanitation services value chain -- of activities inter alia "suitable" for small enterprises in that they can be readily systematised. A selection of these has been modelled, so that they can be made available to emerging entrepreneurs as the basis of viable businesses. Interested potential franchisors and municipal water services authorities have been identified. Procurement issues have been identified. Principles for embarking on water and sanitation services franchising (for use by services authorities, potential franchisors and potential franchisees) have been drafted.

Presentation of this proposed paper will therefore bring to the August 2008 World Water Week significant insights on new developments in applying franchising principles to improving water and sanitation services reliability.

Funding for pilot implementation has been budgeted by Irish Aid and by the South African national Department of Water Affairs and Forestry.

Help from the franchisor would be of particular value away from the major urban centres. For example – few rural municipalities in South Africa can afford to employ competent qualified staff, and

this directly results in periodic unreliability of supply and frequent non-compliance with national standards relating to, for example, wastewater treatment works effluent quality. Significant improvements would soon be seen if the generally under-qualified and under-resourced water and sanitation services staff could have this ongoing support, mentoring and quality control -- or if the municipality could partner with micro enterprises which would, through franchising, enjoy the necessary ongoing support, mentoring and quality control from the franchisor, and would have quick access to skilled assistance when they needed it.

The cost of the higher skills levels, which are needed only intermittently, is spread across many sites – thus cost per franchisee, or per municipality, is low.

\* Under the title “Better water services operation through local franchising”, an introductory paper on water services franchising partnerships was presented to the World Water Week of August 2007.



# Replicating and Scaling-up the Community Health Club Methodology to Achieve Behaviour Change in Support of Integrated Water and Sanitation

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Keywords: hygiene behaviour change, community health club, demand-led sanitation, self-supply of water, women in Africa

Hygiene behaviour change is key to improving family health and alleviating poverty alongside the provision of safe drinking water and sanitation yet it remains the most elusive aspect of community development. Different strategies have been tried over the past forty years: the 1960's were characterised by a top-down 'Social Planning' approach that ignored the potential of community participation; the following decade saw a reaction to this autocratic method, with the 'Health Belief Model' of the 70's which, although didactic, did acknowledge beneficiaries as thinking actors in their own development; then the Water Decade of the 80's heralded in the 'Age of Empowerment' with VLOMM technology providing communities with a greater management role although mainly through contributions of time and labour. It was not until the 90's that participatory methodologies, such as PHAST, became the accepted *modus operandi*. Despite the overwhelming response from eager communities to solve their own problems as partners in development, doubts remain whether PHAST was cost-effective and whether behaviour change was sustained (WSP, 2006).

Challenged by Stockholm Water Week 2008 to supply a 'down to earth strategy which can be shown to impact individual and societal behaviour and create meaningful sustainable change', this Paper describes the Community Health Club (CHC) Methodology that has been proven to meet these criteria, including replication and scaling-up. The Paper provides statistical evidence from the pioneering project where it was first started in three districts of Zimbabwe 12 years ago and goes on to describe how the methodology has been taken up in Sierra Leone and Uganda.

Research data from Zimbabwe (Waterkeyn, 1999) showed that in two districts, within two years, a total of 297 CHCs with 13,555 members had been given 4,563 health sessions in weekly meetings by 17 facilitators (Environmental Health Technicians) at an average cost of 63c (US\$) per beneficiary, and that 3,600 VIP latrines had been constructed. In 2002, a survey of 1,250 households was conducted in these same areas observing 18 proxy indicators of safe hygiene. Tsholotsho District had an average improvement of 47% ( $p > 0.0001$ ) between health club and non health club households (Waterkeyn and Cairncross, 2005).

Although this research indicated that health clubs in Zimbabwe had achieved some of the highest rates of behaviour change found in the literature at the time, some questions remained as to whether this methodology could be equally successful in less well-developed countries, and through other NGOs or local governments. However, since 2005, the CHC approach has been replicated to several countries across Africa: Guinea Bissau, Sierra Leone, Uganda, Rwanda and recently in South African high-density informal settlements and rural areas.

In 2001, villagers in Sierra Leone returning home after ten years of appalling conflict started to rebuild their lives and communities. In Bo and Moyamba districts, 50 CHCs were established in 23 villages to support a water and sanitation programme (CARE, 2003). In these largely Moslem communities, every household in each village was represented in the CHC. Within one year 8,000 people had changed their behaviour from open defecation to 100% safe sanitation. Although quantitative research still needs to be undertaken, a Rapid Rural Appraisal showed differences between health club and non-health club villages, with clear differences in the appearance of young children and general organisation of the village. The adoption of the CHC methodology has since been taken up by other NGOs in Sierra Leone, with a training manual published (CARE, 2005) adapting the CHC Approach for a Rights-Based Approach to conflict resolution and development.

In 2004, in Gulu District of Northern Uganda over 90% of people had been sheltering in congested IDP Camps for the past 18 years. Sanitation had become an impossible challenge and lack of space between the makeshift huts had apparently precluded the construction of latrines. Into this challenging environment 116 CHCs were started in 15 camps assisted by a local NGO (HIDO) whose facilitators were stationed at each camp (Okot et al, 2006). Within a month there were over 15,552 health club members, and hygiene practices began to alter almost immediately. At four months, records showed that over 6,000 bath shelters had been constructed and 3,372 pot racks, as well as 1,552 hand washing facilities. By the end of eight months almost 12,000 latrines had been built in the IDPs, The CHC approach has now taken root in Northern Uganda, where HIDO is providing training for other agencies and has since expanded CHC activities into other districts.

In Zimbabwe, despite the collapse of the country, recent research indicates that many of the original Community Health Clubs (now over a decade old), continue to have a life of their own without external support. They are involved in a wide range of income generating and 'self-reliance' activities that are way beyond the initial focus on hygiene behaviour change. Giving a new meaning to the term 'sustainable livelihoods' in the fastest shrinking economy in the world, many CHC members are selling their own vegetables and herbs from productive upgraded family wells (self-supply) and, with the proceeds, women are improving their kitchens, building onto their homes (with toilets) and educating their children. ([www.africaahead.com](http://www.africaahead.com))

With this replication of the CHC approach now in East, West and Southern Africa, in both Moslem and Christian, urban and rural communities, a body of evidence is slowly being gathered that gives strong indication that this CHC strategy may provide the missing link to cost-effective behaviour change for holistic sustainable development with a particular ability to strengthen social capital.

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# Arsenic Monitoring and Mitigation in District Rahim Yar Khan – Punjab

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Keywords: water sources, arsenic, community, mitigation measures, blanket testing

Following the arsenic crisis in Bangladesh and other neighboring countries, Pakistan recognized the need for assessing arsenic contamination in drinking water sources. A preliminary investigation was undertaken in 1999 by the Government of Pakistan, with technical and financial assistance from UNICEF, which indicated the presence of arsenic above the permissible level in many ground water sources. It was subsequently followed by a national survey in 2001 by the Public Health Engineering Department (PHED) and Local Government and Community Development Department (LG&CDD), again with UNICEF assistance. The analysis confirmed that almost 30% samples had arsenic contamination in excess of the WHO guideline value of 10 parts per billion (ppb) and 7% samples were above 50ppb.

The national survey led to the identification of those areas in Pakistan that were particularly vulnerable to serious arsenic contamination, where more detailed testing was required and where remedial measures must be pursued. Three districts in southern Punjab (Rahim Yar Khan, Bahawalpur and Multan) fell in this category. Accordingly, during 2002-2004, the first round of arsenic field testing was conducted, which consisted of about 12,000 samples, with five samples from each village. About 20% of these samples were analyzed in the laboratory at the Pakistan Council of Research in Water Resources (PCRWR). The lab analysis of about 2,400 samples revealed that approximately 23% of water sources had arsenic contamination over 10ppb and 3% over 50ppb.

During 2004, In Rahim Yar Khan, about 3,000 samples were collected from 31 villages. About 40% of these samples exceeded 10ppb and 20% exceeded 50ppb. Around 47,000 samples were tested during 2005-2007 in Rahim Yar Khan by the Department of Health, with support from UNICEF and Human Resource Development Society (HRDS). The test results showed that 46% sources have greater than 10ppb and 17% sources with over 50ppb arsenic concentration. Test results showed that extent of contamination varies tremendously within a union councils as well as in the district.

So far blanket testing has been carried out in 14 union councils whereas selected testing has been carried out in 21 union councils. Based on the testing conducted so far, the results show that around 55,000 people (including 28,000 children) are at risk and are drinking arsenic contaminated water with more than 50ppb concentration. The blanket testing also revealed that there are 147 villages where more than 30% drinking water sources contained arsenic over 50ppb, some at the dangerous levels of 200-500ppb. Such villages needed immediate attention in terms of appropriate action for mitigation. Mapping of the areas was essential in order to determine the priorities for mitigation measures among union councils.

A communication campaign was also carried out in the district so as to make people aware of the hazards of arsenic poisoning and stop drinking contaminated water and to adopt safe drinking options.

It was critical to provide the affected communities with low cost, sustainable and acceptable technical options for arsenic mitigation, both at household and community levels. Pakistan Council of Research in Water Resources (PCRWR) in collaboration of UNICEF came up with a low-cost technology that could remove arsenic as well as pathogenic bacteria. It was planned to test the acceptability of these technologies at the household level as well as at the school or community level. Similarly safe water options including deep boring water supply schemes, use of PUR sachets and households filters were identify and introduce to the community.

This paper will describe experiences of the arsenic testing and mitigation measures in District Rahim Yar Khan.

# Policy Guidelines, Regulations and Standards of Reclaimed Water and Reuse in Jordan

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Keywords: reclaimed water, reuse, health, standard, quality

In this paper I will present Jordan experience as a developing country in reclaimed water reuse activities, updating reclaimed water standard to reflect the international knowledge, safe implementation of water reuse, enforceable water reclamation standard, providing sanitation services to protect the public health, and it will be finalized by a full description of Wadi Mousa reuse pilot project as a model in the region for using reclaimed water in a safe manner.

Jordan has very limited renewable water resources of only 143 cubic meter per capita per year which is basically at the survival level. In Jordan water is becoming an increasingly scarce resource and planners are forced to consider any source of water which might be used economically and effectively to promote further development such as reclaimed water. This important resource, reclaimed water, has been considered from the highest level of Jordan government that it has a full value to the overall water resources of the country as stated in the Jordan's water Strategy, formally adopted by the Council of Ministers in May 1997 (Wastewater shall not be managed as waste; it shall be collected and treated to standards that allow its use in unrestricted agriculture and other non domestic purposes, including ground water recharge.). As a result, reclaimed water as a non-conventional water resource is one of the most important measures that have been considered to meet the increasing water demand of the growing population and industrialization. Over 60% of the Jordanian population is connected to sewerage system and raw wastewater is discharged to 22 wastewater treatment plants to be treated for minimum discharge standards and reuse requirements stated in the JS 893/2006 taken in consideration the WHO guidelines requirements for public health and proper sanitation. About 112 MCM in the year 2006 and 116 MCM in the year 2007 were treated and discharged into various watercourses or used directly or indirectly for irrigation and other intended uses and it is expected to increase up to 262 MCM in the year 2020.

With the current emphasis on environmental health and water pollution issues, there is an increasing awareness of the need to dispose and reuse wastewater safely and beneficially. In Jordan, appropriate standards and guidelines for water reuse are an important requirement to rely on reclaimed water as a resource, therefore; the previous water reuse standards JS 893/2002 were reviewed, and issued in 2006 as a technical base. The revised standards allow for a wide range of water reuse activities including, where economic conditions allow, highly treated reclaimed water for landscapes, cut flowers and high-value crops, and for lower cost smaller-scale treatment and reuse activities with restricted cropping patterns. Reclaimed water use in Jordan will result in the conservation of higher quality water and its use for purposes other than irrigation. The monitoring of reclaimed wastewater quality involves many distinct activities to give reliable and usable data. A monitoring program for reclaimed water is designed according to standard number 893/2006 to collect representative samples and analyze them through quality assurance complying with ISO 17025. The generated water quality data from these monitoring programs provide information about the reclaimed water quality and ensure its safety for irrigation and other intended uses. Decisions for improvements and reuse permission are taken depending on the quality of reclaimed water for each treatment plant.

In an effort to integrate reclaimed water resources in national water planning, the government of Jordan, with support from the US Agency for International Development (USAID), has been for the past six years implementing several projects for direct water reuse activities. Wadi Mousa Water Reuse Pilot Project is one of these projects that seek to demonstrate that reclaimed water reuse can be reliable, commercially viable, socially acceptable, environmentally sustainable and safe. To protect the environment around Petra, which is a UNESCO World Heritage Site and the second wonder in the world, the high-quality treated wastewater coming out of the treatment plant is being used to irrigate a nearby model farm to demonstrate the safe and effective use of reclaimed water in irrigating high-value crops of environmental and phytosanitary suitability. Jordanian farmers in Wadi Musa, near the historic city of Petra, were the first in the area to receive leases to irrigate with treated wastewater depending on implementing comprehensive environmental monitoring programs to monitor the potential impact of reclaimed water reuse on fauna and flora as well as ground water quality. These farmers are directly benefiting from the pilot demonstration farm, to show that reclaimed water can provide safe and reliable irrigation for some types of agriculture with several different irrigation methods.

The farm grows field crops such as alfalfa, maize, sunflowers and Sudan grass, tree crops including pistachio, almond, olives, date palms, lemons, poplars, spruce and junipers, and many varieties of ornamental flowers including iris, geraniums, petunias and daisies. A demand for the farm's cut flowers was created in several of Petra's tourist hotels. Hotel managers have said they will purchase all the flowers that can be produced at the site, demonstrating the economic benefits generated from the project. The demonstration site receives regular visits from professionals, school children, journalists and residents of nearby towns who come to enjoy the lush greenery. In conclusion, Greater efforts have been made to conserve water by providing non-conventional water supplies to deal with the demands of agriculture and other uses. However, several challenges have still to be overcome in terms of wastewater treatment and reuse such as scientific, public acceptance, institutional and legal aspects.

# Antenna-Wata®: From the Development of a Chlorine-Producing Technology to Sanitation Programs

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Keywords: drinking water, chlorination, low-cost technologies, research, local autonomy

Access to drinking water is a universal right for all and one of the priority objectives of the millennium. Millions of people suffer daily from waterborne diseases – cholera and diarrheas in the first place – transmitted by common parasites, viruses and bacteria. While in Occident they are rare and most often benign, diarrheas actually represent the second cause of mortality in the world. In developing countries, waterborne diseases persist or reappear as epidemics because of their highly transmissible characteristics, the absence of drinking water networks and wastewater treatment systems.

Amongst other techniques, chlorination has proved to be a very efficient way of killing pathogens in water, because of the very strong effect of chlorine over pathogenic micro-organisms. The very low toxicity of chlorine and its persistent effect made it by far the most common water treatment technique in northern countries. Nowadays, developing countries willing to chlorinate water in order to make it safe for human consumption have little choice but importing chlorine from richer countries, which appears to be both costly and hazardous. Bleach is distributed but quantity and prices are barriers for affordability, and quality often drops during storage.

Today, a low-cost technology allows the local production of concentrated active chlorine (sodium hypochlorite) from salty water, and thereby, the organization of household-based chlorination programs. Moreover a very low-cost, highly sensitive and reliable method has been developed for the quality control of water chlorination.

Antenna-Wata® devices: local production of low-cost chlorine – Antenna Technologies, a Swiss NGO based in Geneva, has therefore developed a handy, affordable device, allowing the local production of a chlorine concentrate from salty water, through an electrolysis process : Antenna-WATA® devices work with any source of 12 Volts DC, min. 4A (car battery, solar panel, DC power supply...). The “Standard” model of the devices can produce about 20 litres of concentrated chlorine per day. Once it is produced, these 20 litres allow the treatment of 80’000 litres of drinking water, covering the daily needs for about 5’000 people. Last but not least, the concentrated solution of active chlorine can be used as a disinfectant for any premises, just like bleach. Its low alkalinity also makes it a suitable disinfectant for wounds (Dakin’s solution).

Antenna Technologies developed two additional models of Antenna-Wata®: the Mini-Wata® fits in a standard plastic bottle and is most suitable for small communities of up to 300 people (3 litres of concentrated chlorine per day), whilst the Maxi-Wata® was designed for large drinking water production facilities covering the needs for 40 to 80’000 people (about 200 litres of concentrated chlorine per day).



Cost issues: “health-oriented services” are sustainable – With the Antenna-Wata® devices, the production of concentrated chlorine only costs the price of salt and electricity. This low production cost therefore allows the producers/distributors to choose a reasonable selling price (usually around 0,3 US\$ per litre of concentrated solution). The “profit” margin remains high and the demand being important, all the costs of a complete service can be covered (salaries, electricity, home-based chlorination services, fuel, brochures...). Nevertheless, chlorine remains extremely cheap and affordable for the populations as these initiatives remain “non-profit”. All in all, this allows the development of sustainable sanitation programs.

Water sanitation programs at the scale of a city – Most of Antenna Technologies’ experience with regard to the use of the devices comes from the Great Lakes region (DRC, Democratic Republic of Congo). Since 2006, in several cities of this area (Goma, Kalémie, Bukavu, ...), where waterborne diseases are particularly endemic, Antenna Technologies Great Lakes equipped and trained to Health “Community relays” with Antenna-Wata® devices. The objective is that they become responsible and autonomous in the fight against waterborne diseases. In Kalemie for example, a 200’000 inhabitants city bordering the Lake Tanganyika, 84 Health Community relays were trained as “chlorine agents”, to ensure the production and selling of chlorine, the chlorination of drinking water, quality control, as well as continuous promotion and information with regard to waterborne diseases. Drinking water chlorination is achieved at specific sites crossed by women after water provision (e.g. wells, by the rivers and the lake), or directly at home. An investment with motorcycles, bicycles and a boat helps with the mobility of these agents.

In order to change behaviours, strong promotion of chlorine and information are continuously stimulated through radio broadcastings, tee-shirts, brochures and display panels. This social marketing is accompanied by the involvement of the communities themselves, community leaders, religious groups, or women associations. Health services, public authorities and other NGOs are also involved, in order to improve the overall coordination, and to consider as much as possible the local reality, the already existing networks, and the socio-cultural aspects for household water treatment system.

In Kalemie, after 6 months of implementation, already 40% of the population knew sodium hypochlorite and its use, while 20% knew the correct dose of chlorine to be added in a jerrican. One third of the population of Kalemie consumed chlorinated water. Acceptability can vary depending on personal beliefs, traditions or religions. For example, followers of the Kitawala and Postolo beliefs refuse to drink chlorinated water, and hardly explain their reasons. However, cholera incidence already decreased by 80% in highly endemic areas for the city. This initiative is hoped to be sustainable: evaluations on the long term will give a better idea of the real impact of our program.

# Need for National Governments to Adopt a Policy on WASH in Schools for Improved Child Health

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Bread of Life Development Foundation, Nigeria

Keywords: WASH in schools, handwashing, child health, water policy, sanitation

In 2003, The Bread of Life Dev. Foundation, a Nigeria non-governmental organization started a Water, Sanitation, and Hygiene (WASH) campaign in selected schools in Lagos state, Nigeria, for the purposes of teaching the School pupils basic Hygiene and sanitation practices, particularly hand washing with soap.

Description of activities executed under this Project between 2003-2007 include:

- Identification and choice of one primary school in a rural area of Lagos state, Nigeria; to serve as model for the campaign- Mothers Pride Montessori Private Nursery and Primary School, Abule Egba
- Formation of Water, Sanitation, and Hygiene “WASH CLUB” comprising 25 students drawn from primary classes 3-6 (ages 6-12) in the school. Objectives of the WASH CLUB is to improve the physical and mental growth of school children, boost school enrolment, reduce incidence of deaths through water related diseases such as cholera, diarrhoeal and dysentery, and ensure cleaner and healthier school environment.
- Delivery of Wash information for members of the Wash club monthly, through classroom lectures, drama sketches, role-play, video documentary and the like. Distribution of information, education, and communication materials to members of the Wash clubs.
- Meetings with school management to encourage them to set up gender sensitive toilets in the school. Because studies have shown that absence of such decrease school enrolment by the girl child during ages of puberty
- Evaluation forms filled by parents of school children to determine how their wards practice Wash ideas at home.

In 2006, we received a grant of about \$991,500 (about N123,000) from Japan Water Fund to enable us construct a Block of gender sensitive toilet in the model School, and produce WASH related information materials. The toilet was constructed at a total cost of \$800 (N98, 930.00), about \$100 higher than the amount estimated for it in the project proposal.

Type of Toilet constructed with the grant: 1 Block of two toilets for male and female children. Flush water System, fitted with Rain harvesting Plastic pipe. Mode of Construction: Direct labour. Hand washing facility: Wash Hand basin, Liquid detergent, Disinfectants, Napkins, and Water Supply. Beneficiaries: About 500 students

Stakeholder participation: Project planned and implemented with the support/involvement of school’s management, and the parents of the school children.. Project is co-funded by Schools management that provided a land space for the construction of toilet, and Hand washing material. Two of the schoolteachers are trained on Wash related issues, and in turn impact knowledge on school Children. Parents endorse a membership application form pledging to support their children participation in the Wash club project.

Sustainability: Toilet facility is maintained by School's management, that allocates funds for the monthly purchase of hand washing materials, and water supply to augment that accessed from Rain water harvesting.

Scale Up of the WASH project: The Bread of Life Development Foundation, a non-governmental organization is now implementing the Water, Sanitation and Hygiene, (WASH) campaign in about 20 other schools within the neighborhood. We recently organized Train the Trainers Workshop to equip two School Teachers from each of the schools with the Skills and knowledge to start WASH campaigns in their respective schools.

### **Presentation of the results/findings**

The project has shown that with about \$800 (about N1000, 000.00), a block Gender sensitive toilet can be provided. The continue failure of private and public schools to provide water and sanitation facilities for their pupils is therefore unpardonable.

Our experience in this project shows that most schools in Lagos state, Nigeria particularly in rural communities and low resource settings do not have good water and sanitation facilities.

Knowledge of WASH related issues is also very poor among the students, teachers, and the parents. The consequence is that most children continue to needlessly suffer from the effects of WASH related diseases.

We also discover that they are not standards or regulatory mechanisms for ensuring that Public and Private schools provide basic and sanitation facilities for their pupils. This may be as a result of the fact that the WASH concept is yet to be embraced by Nigerian National and State Governments We are also discover that the management of privately owned schools are willing to provide these water and sanitation facilities in their schools if they are encouraged to do so.

### **Conclusions and recommendations**

The present situation where school pupils and even teachers defecate in unsanitary conditions and at times nearby open spaces can no longer be tolerated. We therefore recommend that the Nigerian government, should as a matter of national priority and also set up the process for the launch of WASH nationally and at other decentralized levels, and commence actions plans for the implementation of this programme.

National Governments should set the pace by ensuring as a Policy that all public schools are provided with basic water and sanitation facilities including gender sensitive toilets.

As a corollary to the above, Private schools management should also be educated about the necessity of water and sanitation infrastructures for school pupils. We advice that the existence of basic water and sanitation facilities should be a condition for registration of Private schools, and renewal of the registration of old ones.

The National and state governments, as well as management of private primary schools, should also set up water classrooms for the purpose of promoting hygiene education to their pupils. This also demands that teachers should be trained in this concept to enable them pass on the information and knowledge.

# Water Quality in French Health Care Facilities at the Cross-roads of Several Perspectives

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Keywords: Health care facilities, drinking water, certification, nosocomial diseases, environmental health

## Introduction

The management of the quality of care in French health care facilities (HCF) is operated under the light of numerous control institutions.

With regard to the management of water quality, the following control systems predominate:

- Local health authorities perform regular inspections of the system; the referential of these inspections is a technical “guide of water in health care facilities” edited by the Ministry of Health;
- HCF are also submitted to a mandatory certification of their activities, managed by the High Authority of Health (HAS);
- Newly built and refurbished HCF will soon be able to ask for a certification of their environmental performances, when the specific High Environmental Quality (HQE) referential will be validated.

## The French Guide of Water in HCF

The French Guide of Water in HCF was developed in 2002 in a context of evidence of nosocomial contaminations due to bad water quality (*Legionella*, *Pseudomonas*,...). It is organised in two distinct parts, the first one aiming at facilitating the identification of water uses in a HCF, the second one containing technical recommendations for the diagnosis, repairing, maintenance, and eventual corrective actions.

In the first chapter, 14 different categories of waters used in hospitals are defined; covering water not submitted to any treatment, water specifically treated in accordance with HCF usages, sterile waters and technical waters. For each category of water, target levels and frequencies of control are proposed.

The second chapter takes a technical perspective of water installations inside HCF. It first proposes a method of analysing causes and locations of water degradation, following an approach similar to the HACCP one. After this chapter, a series of technical recommendations is listed.

This guide is a very comprehensive tool for professionals who manage the quality of water inside health care facilities. However, it provides only recommendations and not obligations; and it cannot be used as such, due to its complexity, by local health authorities for inspections.

## The HAS certification

The HAS certification aims at controlling that the management of health care facilities is patient-centred and permanently improved. All health care facilities are submitted to a certification procedure every four years.

The certification manual is organised in 44 “references”, which include the verification of 138 criteria. Water quality management is tackled by the criteria #15.b under the title “the maintenance and the control of water quality are adapted to its different uses”. Five elements of appreciation are proposed, focusing on the control of water quality and the existence of maintenance protocols.

Two remarks can be put forward:

- owing to the fact that auditors are mainly quality systems and medical experts, and that the “water criteria” is lost among 137 other criteria, auditors necessarily cannot review all measures taken in details;
- the five proposed elements of appreciation call for a strict implementation of the Guide of Water above cited. Clearly, the Ministerial guide, all complex be it, is the scale against which the performance of HCF in the domain of water quality management is rated.

### The HQE certification

The High Environmental Quality (HQE) label was created in France in the 2000’s to assist the movement of French building entrepreneurs towards design and construction concepts with low environmental impact and energy consumption. HQE proposes a series of 14 “targets”. These targets cover various environment and health aspects of design and construction, such as integrated choice of products, systems and construction methods, energy management, water management...

Under the control of the MAINH (National Assistance Mission for Hospital Investments) and the CDC (Caisse Des Dépôts), a HQE referential targeted to HCF was developed. A first version will be validated in February-March 2008. This referential will maintain the 14 targets of the initial referential. Water management is dealt with by targets 5 and 14.

Target 5 is oriented towards the preservation of water resources. It is broken down into 3 sub-targets, i.e. reduction of drinking water consumption, rainwater management, wastewater management.

Target 14 is oriented towards the management of drinking water quality. Inspired by the official technical guides (including the Guide of Water for HCF), it is organised into 5 sub-targets relative to materials, network structuring, temperature control, water treatments and commissioning. Particular attention was paid to the conditions of management of temperature inside hot water networks, in particular in looped system. Strong elements of maintenance were also added.

### Conclusions

Overall, although definitive conclusions cannot be taken before a few years of implementation, it seems that the existing referential guides show good complementarities.

- The guide of water in health care facilities appears as a “bible” which defines the best solutions to be attained in the mid-term;
- The HAS certification scheme offers the possibility for existing HCF to measure their operational performance in terms of water quality management. Water management may appear as not very developed in this referential; however certification auditors can take inspiration in the Ministerial Guide of Water, in particular the chapter on water categories;
- The HQE certification will provide an additional rating possibility focused on the design and construction phase, a phase which is not covered by the HAS certification. Furthermore, the HQE referential takes into account in a unique referential different priorities of HCF, i.e. energy savings, environmental friendly management, comfort of the patient and fight against nosocomial disease.

# Assessing Risks and Benefits of Chlorination: Exposure Modelling and Valuation

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Keywords: Chlorination, Risk assessment, Risk-benefit assessment, DALYs, DBPs

While chlorination continues to help provide safe drinking water worldwide, the epidemiological evidence of a relationship between chlorination by-products and bladder cancer is very convincing. It also appears that at least two human reproductive outcomes (small for gestational age and preterm delivery) are to some extent adversely influenced by the by-products of chlorination. Ongoing research, including the EC-funded HiWATE project, aims to clarify whether other health outcomes (colon cancer, male fertility, spontaneous abortions, etc.), as indicated by preliminary, yet inconclusive, evidence, are associated with such chemicals. Although mechanisms are still unclear, toxicological evidence points in the same direction; extensive research and monitoring is being carried out in several countries, and particularly in the United States. While chlorination use is widespread worldwide, it is not the only disinfection method that can be used; in some situations, no disinfection is used; in other cases, chlorine dioxide has been used instead of traditional chlorination. Since concentration of by-products is at least partially associated with organic matter in water, decreasing water availability, and hence quality, it may increase the magnitude of the problem. With different management options available and with health outcomes at stake of obvious public concern, policymakers need tools to make use of the best available science to make decisions in the face of uncertainty, and with significant costs associated with alternative treatment options.

To better inform risk assessors and managers, available and new epidemiological evidence should be assessed and modelled systematically to derive risk estimates. This aim entails a series of challenges. First, the risks associated with chlorination by-products cannot be evaluated in isolation, since reducing or abandoning chlorination would increase risks of microbial disease. As a consequence, a comparison of risks and benefits, commonly termed risk-benefit assessment, has proven necessary, implying that a common metric is used to weight risks from by-products against risks of microbial disease, and potentially to determine a range, if not a single, of optimal treatment doses. To this end, we have explored three alternative methodologies (burden of disease, health care costs, public perception) and selected DALYs (Disability adjusted life years) as the primary metric for comparison. A methodology is described to compare DALYs including burden of disease estimates that take into account past exposures and cohort stratification of the target population. A community that chooses to reduce exposure to chlorination by-products will face more microbiological risks, while the reduced risks from chlorination by-products will be apparent only with time, especially for cancer. In order to improve risk assessment in the case of HiWATE project, a method of open risk assessment is applied. Overall, the purpose of open risk assessment is to improve societal decision-making in a risk situation by providing relevant information about the risk situation in a quantitative form. Properties such as mass collaboration, i.e. anyone is allowed to contribute, and value judgements are included in the assessment as essential and explicit parts of the risk assessment process.

Furthermore, epidemiological and exposure research has highlighted that non-drinking exposure, including bathing, swimming, showering, cooking, etc., is more relevant in contributing to cancer

and reproductive risk than drinking water consumption. Therefore, the exposure model has needed to take into account personal habits, making use of currently limited datasets. Initially, exposure routes have been determined for each habit. For example, for showering, exposure occurs primarily through inhalation and dermal absorption, while ingestion is generally considered negligible. Inhalation depends on the frequency and duration of the shower. Dermal absorption also depends on frequency and duration of the shower, but also on the body contact surface. All these model parameters have been modelled, per type of habit. The exposure model was built taking into account the recent study by the US EPA, which has recently conducted an assessment study on disinfection by-products; the model has been modified in this exposure assessment given the different and more limited dataset available in Europe, and potentially elsewhere. For instance, the EPA study indicated that shower chlorination by-product exposure also depends on water temperature and water flow rate (volume of water used), and we have built an optional model to address these two model parameters. Other missing information from Europe related to the type of buildings and therefore about the flow of volatile by-products in different rooms in a house.

More generally, epidemiological evidence has underpinned the identification of hazards addressed (DBPs and health outcome), and is used for dose-response modelling, which has required different specifications of the exposure modelling. In fact, epidemiological studies have used different measures of exposure, such as, in the case of showering, shower frequency, shower duration or the combination of the two, or proxy variables. Finally, a series of management options, using real scenarios from Europe, will be used to explore alternative risk settings and the exposure and valuation models have been designed to this end. The exposure, valuation and dose-response, once implemented in a full risk-benefit model, will serve as a basis for municipality or water utility level assessment of risk and benefits of chlorination that can be adapted to different contexts (Europe, North America or elsewhere) with limited effort and will provide an improved tool for scientific input to decision-making.

# Household Water Treatment to Prevent Diarrhoeal Disease: Effectiveness, Cost Effectiveness and the Challenge and Policy Implications of Scaling up

Author: **Dr. Thomas Clasen** (Invited Speaker)  
London School of Hygiene & Tropical Medicine, United Kingdom

Providing safe, reliable, piped in water to every household is an essential goal, yielding optimal health gains while contributing to the MDG targets for poverty reduction, nutrition, childhood survival, school attendance, gender equity and environmental sustainability. While committed strongly to this goal, and to incremental improvements in water supplies wherever possible, the World Health Organization and others have called for interim approaches that will accelerate the health gains associated with safe drinking water for those whose water supplies are unsafe.

Interventions to treat and maintain the microbial quality of water at the household level are among the most promising of these approaches. In many settings, both rural and urban, people have access to sufficient quantities of water, but that water is unsafe. Effective point-of-use interventions—if used correctly and consistently—can significantly improve the microbiological integrity of the water at the point of ingestion, and thus deliver some of the health benefits of improved water supplies.

This presentation will summarize the evidence concerning the effectiveness and cost-effectiveness of household-based microbiological water treatment for the prevention of diarrhoeal diseases, a leading killer especially among young children. Recent studies have shown household based-interventions (boiling, chlorination, filtration, solar disinfection and flocculation/disinfection) to be highly effective in improving microbiological water quality and reducing disease. The cost of actually delivering these interventions to the target population will be presented, along with their cost-effectiveness. Most of these approaches meet internationally recognized benchmarks for highly cost-effective interventions. There is also evidence that the cost of deploying the interventions could be wholly or largely offset by savings to the public sector and householder from reduced outlays for the treatment of waterborne diseases. Moreover, studies suggest that householders are often willing and able to pay for some or all of the costs of such interventions.

Despite evidence of its effectiveness and cost-effectiveness, however, the promise of household water treatment will not be realized unless it can achieve scale – both in terms of coverage and actual uptake by the target population. Analogous household-based environmental interventions, such as Guinea Worm filters and long-lasting insecticide treated nets, provide important lessons in scaling household water treatment. Promoters are using commercial, quasi-commercial (social marketing), and non-commercial (public and NGO) strategies to expand coverage. Nevertheless, with the exception of boiling which has important shortcomings, programmes to promote household-based water treatment interventions reach only a small fraction of those without access to improved water supplies, and an even smaller portion of those who may benefit from the intervention. Recent trends in coverage will be presented, and the special challenges of expanding access and uptake, particularly among the most vulnerable populations, will be discussed.

By offering vulnerable populations with the tools to treat their own drinking water, household water treatment has the potential for empowering the unserved to take charge of their own water security



as they continue to take steps toward improved supplies. Nevertheless, the intervention has important limitations compared to household connections. The talk will close with a discussion of the policy implications of promoting household water treatment.

# Demonstrating Health Impact through the Implementation of a WHO Water Safety Plan

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Keywords: Management, Safety, Health, Brazil, Water

Demonstrating Health Impact through the implementation of a WHO Water Safety Plan is a health-based approach to improving drinking water quality.

Until the end of the 19th century drinking-water quality was usually verified by means of its aesthetic appearance. From the beginning of the 20th century, after several waterborne diseases outbreaks around the world, it became clear that there was a need for the development of technical and regulatory tools, which, in an objective way, defined what could be considered potable drinking-water. Therefore, drinking-water quality control became based, as it is today, on numerical 'guideline values' (or maximum contaminant levels) for constituents of water or indicators of water quality, gathered in national standards or international guidelines. However, for several reasons (e.g. analytical or financial constraints, chemical and microbiological emerging contaminants, sudden changes in water quality and the difficulties of 'on-time' monitoring) laboratory drinking-water control is at present widely recognized as not enough to ensure drinking-water safety.

In this sense, preventive management by means of a holistic approach, entailing a systematic assessment of risks throughout a drinking-water supply from 'source to tap', is now considered the preferred approach to drinking-water safety.

## A Multi-Sectoral Approach to Improving Public Health

The U.S. Centers for Disease Control and Prevention (CDC) has joined with the U.S. Environmental Protection Agency (EPA), the Pan American Health Organization (PAHO), the Federal University of Vicosá, the Ministry of Health – Brazil, and the Coca-Cola Company to promote and implement a World Health Organization's Water Safety Plan (WSP) methodology, in collaboration with Brazilian government authorities.

Brazilian legislation encompasses elements of good management practices and the principles of risk management approaches, in particular the multiple-barrier and the hazard analysis and critical control points (HACCP) approaches. However this is not organized as a system-tailored hazard identification and risk assessment methodology, 'ready-to-use' by drinking-water suppliers. Nevertheless, the Brazilian legislation requirements provide a suitable platform for integrating the concept and principles of Water Safety Plans (WSP).

A WSP is a comprehensive approach to assuring drinking water safety to identify, assess, monitor, and manage risks inherent in a water delivery system from 'catchment to consumer.' It comprises a supply system comprehensive assessment, effective operational monitoring, and management. WSPs use a systematic preventive approach rather than a reactive approach to problem-solving by identifying all points in the drinking water system where contamination could compromise the water reaching consumers – the minimization of contamination of source waters, the reduction or removal

of contamination through treatment processes and the prevention of contamination during storage, distribution and handling of drinking-water.

Along with the implementation of the Drinking-Water Surveillance National Program, the Health Ministry has set a Water Quality Surveillance Task Force within which the updating of the drinking-water legislation is tackled as a continuous process. Given that its next official updating is due in 2009 and in view of the recent advances brought by the 3rd edition of the WHO Guidelines for Drinking-Water Quality, the WSP subject became a focal point of the Surveillance Task Force's agenda.

In this sense, Brazil was represented in the Environmental Health and Water Safety Plan Regional Workshop held in Buenos Aires (May 2005), afterwards submitting a proposal of a WSP pilot project to PAHO/CDC/EPA Partnership Program (August 2005). In accordance with the criteria anticipated by the Partnership Program (e.g.: system size, results replicability, political and administrative stability, commitment of local partners, technical and economical feasibility, system information availability) the town of Viçosa was selected for the pilot project development, and the Federal University of Viçosa (UFV) as the executor institution. Around the same time, in addition to submitting the proposal to PAHO/CDC/EPA Partnership, the Brazilian Ministry of Health decided to support, both financially and institutionally, the development of the WSP-UFV pilot project.

#### **Partner Organizations**

In Brazil, the Ministries of Health, Cities, and Environment are involved. They will work in conjunction with the municipality of Viçosa and the University to implement the project:

The Federal University of Viçosa is one of the largest universities in Brazil and an academic leader in civil engineering. Faculty at the university, including the WSP Project Manager, are currently working to re-write Brazilian drinking water regulations.

The U.S. Environmental Protection Agency is the United States regulatory agency that covers drinking water quality. EPA's mission is to assist where possible to share its successes and lessons learned with international organizations and other governments.

The Coca-Cola Company is the largest employer on earth and the number one consumer of water in the beverage industry. It is committed to assist communities where they operate in improving drinking water quality.

PAHO is the World Health Organization's Regional Office for the Americas. It is dedicated to improving the health and living standards of the countries of the Americas and forms part of the United Nations system.

CDC's National Center for Environmental Health assists national governments world-wide with technical assistance and expertise in how to prevent and control environmental health hazards that are detrimental to human health.

# An M&E System for Scoring Compliance of Rural Water Supply and Sanitation Projects to South African Policy, Design Standards and Norms

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Keywords: monitoring, evaluation, scoring system, compliance, standards and norms

The South African government was mandated in 2004 to halve poverty and unemployment by 2014. Government recognises that, while the provision of infrastructure and basic services will not directly alleviate poverty or stimulate economic growth, it will be critical to sustain economic growth. Consequently, the South African government has committed to addressing water supply and sanitation services backlogs by 2008 and 2010 respectively.

In support of this, every poor South African is provided with a subsidy for access to a reliable supply of 6 kilolitres of potable water per month within 200 metres of the household and, at a minimum, a safe and reliable Ventilated Improved Pit toilet.

The National Department of Water Affairs and Forestry (DWAF), as the regulator of water service in the country is responsible for monitoring water sector performance, including conformity to national norms and standards, and making regulatory interventions to improve performance and/or to ensure compliance. DWAF is required to monitor:

- policy outcomes, i.e. whether water and sanitation services are provided in line with policy requirements of at least basic levels of service.
- policy impacts, i.e. whether the water service is delivered according to the quantity and quality criteria stipulated in the Strategic Framework for Water Services; and
- progress of international and national targets, i.e. Millennium Development Goals (MDGs) and national targets.

In fulfilling its role, the National DWAF initiated the development of the Monitoring, Evaluation and Reporting Strategy and Theoretical Framework for water supply and sanitation projects in 2006. The DWAF has adopted a triangulation approach to their monitoring and regulating role, where data and information are gathered from multiple sources to verify (spot check) the implementation of water and sanitation projects.

A key element of this Strategic and Theoretical Framework is a Spot Check Assessment process (research methodology and research tools), which was developed and piloted by the Council for Scientific and Industrial Research (CSIR).

The 2007/08 spot check assessment of rural water supply and sanitation projects will assess the compliance of water and sanitation projects (household, subsidy housing, clinics and schools) to the following two main aspects and their underlying components:

- Compliance to policy requirements: The Strategic Framework for Water Services of 2003 defined basic services and basic facilities. These definitions are interpreted and are included for the development of the assessment tools. The assessment tools are designed to assess these policy compliance requirements of water reticulation and sanitation projects.
- Compliance to norms and standards: The compliance of the bulk water and sanitation systems (i.e. supply and treatment) and household/clinic/school entities (i.e. taps and toilets) is assessed against technical and design norms and standards. These norms and standards are specific to the type of project being assessed.

A Spot Check Assessment entails the gathering of data/information through direct objective observations, short interviews with beneficiaries and short interviews with maintenance and operations personnel at project sites, to obtain a general view of a situation at a certain point in time at the project. The responses to observation and interview questions are captured on a Checklist, specific to a project type. Presently, 72 types of checklists have been developed to cover all water supply and sanitation projects.

Data captured from these checklists are analysed with SPSS and distilled into specific models pertaining to project types. Each project was assigned a compliance score. For the 2006/07 spot check assessments the compliance of a project was reflected as a point between 0 and 100:

- A project that scored between 95 and 100 points will be considered as a “compliant” project (i.e. complies with the standards and norms as set by government).
- A project that scored below 95 points will be considered as “non-compliant” (i.e. does not comply with the standards and norms as set by government).

The threshold of 95 points for compliance/non-compliance of a project was selected based on in-depth discussions with a number of scientists, statisticians, water and sanitation specialists and relevant role players.

The 2006/07 spot check assessments made use of the above scoring system and threshold for compliance/non-compliance. When defining an individual project as compliant, it was found that the number of compliant projects was only 20% in total across all project categories. This pointed to the fact that there were certain projects that had very low levels of compliance; for example, none of the household sanitation completed projects were found to be compliant, while only 2.6% of household water completed projects were found to be compliant. In line with the findings on compliance scores, significantly more water and sanitation bulk projects were compliant than water and sanitation household projects.

However, the 2006/07 scoring system limited placing projects into two broad categories of compliant or non-compliant, whereas the proposed scoring system for the 2007/08 spot check assessments will group projects into seven different categories of compliance/non-compliance. The threshold for compliance/non-compliance of 95 points will be retained and will still be applicable for the 2007/08 spot check assessments.

This paper discusses the research methodology and process that was developed for the Spot Check Assessments of water supply and sanitation projects in terms of their compliance with policy requirements, standards and norms in South Africa, including details on the requirements of a compliance for a project, the models that were used to score the projects and the actual scoring system applied to the projects.

# Water Supply and Health Issues in the Aral Sea Disaster Zone

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Keywords: water, health, rational use, Aral Sea, disaster

A presentation will be given on a ground water rational use and improving of existing water supply system in the Aral Sea disaster zone small villages.

Uzbekistan is becoming a desert and the situation is grave. An ecological disaster was set in motion in this region beginning in the 1950's, when water was diverted from the two rivers, the Syr-Darya and Amu Darya, that flow into the Aral Sea. These irrigation diversions, to increase agriculture production, triggered one of the largest ecological accidents in the history of mankind. Some 35 million people living in the base of the sea have been affected. Winds lift salt and dust from the dry Sea flats and carry them hundreds of kilometers polluting distant water basins, farms and settlements. The fishing industry in Uzbekistan has been bankrupted.

In addition to the diminution of the major body of water, there is the additional problem of failure of delivery of the region groundwater systems. This problem is most serious during the summer when the demand for water sharply increases. During such times the population is left to consume poor quality surface water. In jeopardy is the health of the region entire population. Infectious intestinal diseases, often caused by contaminated drinking water, are a primary cause of a high rate of childhood death in Uzbekistan and the Aral Sea basin. The maternal death rate is also one of the highest in the world. The Republic of Uzbekistan and other Central Asian countries have stocks of underground waters which are immune to external pollution. However these waters are characteristically high in salt and hardness. If technologies can be applied to overcome these negative characteristics, then the underground sources could be used to sustain human, agricultural and industrial needs and, also over time, to restore some of the stock previously diverted from the Aral Sea. The development of these technologies should ideally be factored into a comprehensive water management system plan.

The drying of the Aral Sea has been an environmental disaster in Central Asia, particularly in Uzbekistan. Given water problem is the world's most pressing environmental challenge. This Central Asian environmental crisis prefigures dying lake and river disasters to come in other countries.

Water, air and land pollution, critical health problems, the collapse of the fishing industry, diminution of agricultural lands, industrial bankruptcy and calamitous reverberation have effected all walks of the in the Aral disaster zone. In addition to the diminution of the major body of water, there is the additional problem of failure of delivery of the drinking water supply systems. This problem is most serious during the summer when the water demand sharply increases. During such times the population is left to consume poor quality surface water. In jeopardy is the health of the region entire population. Infectious intestinal diseases, often caused by contaminated drinking water, are a primary cause of a high rate of childhood death in Uzbekistan and the Aral Sea basin. The maternal death rate is also one of the highest in the world.

Exacerbating the situation is misuse of remaining water resources. The research have proposed an investigation of current water use in a small rural villages in the Aral Sea disaster zone, as a means of devising a rational water use model rural villages of Uzbekistan.

Not only are there infrastructure deficiencies and the need to upgrading to modern technology, there is also the need to train water resource managers to remedy these deficiencies and to advance modern technology. The primary challenge facing water delivery specialists in Uzbekistan is to balance competing water supply demands. There is the need to halt depletion of water in the Aral Sea and, ideally, to augment the waters in that basin. There is also the need to develop qualitative water delivery systems in a country that is newly formed. As a newly formed independent republic Uzbekistan needs to advance the nation by developing a strong economy as well as meet the demands posed by population explosion. These necessities are dependent on highly functional water delivery systems. The available water resources have, for decades, been systematically over used and also prudent management has been lacking. State of the art water management systems and conservation technologies, while known among specialist, have not been introduced to major effect. Not only are there infrastructure deficiencies and the need to upgrading to modern technology, there is also the need to train water resource managers to remedy these deficiencies and to advance modern technology. For real progress to be made in the short to medium term, technology students and professionals from Uzbekistan and other Central Asian nations need to be trained in state of the art techniques of water management. This is so because of the extreme environmental problems, because of the need to advance economically and because of the need to meet the demands of a growing population. These specialists need to become professionals of international caliber in order to champion environmental sustainability in their respective countries and for Central Asia at large.

A rational water use model in the Aral Sea disaster zone village will be used for other cities or villages for improving municipal water supply system, health and an ecological situation as well.

# Watalys, Safe Water and Efficient Disinfection, Anytime, Anywhere!

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Keywords: safe water, sanitation, waterborne diseases, disinfection, chlorine

Today, over 1 billion people do not have access to clean drinking water, although the knowledge and technology currently exist which offer solutions to remedy this sad reality.

Three Geneva-based entrepreneurs won the 2005 swiss De Vigier award, thereby concretely demonstrating their commitment to tackle one of the major challenges of the 21st century.

In order to do this, they created BULANE, a social enterprise whose aim is to develop and commercialise systems for the disinfection and purification of drinking water that are easy to use, inexpensive, and effective. Their objective is to provide innovative solutions for the supply of drinking water to poor regions, with the proviso that they must guarantee the complete autonomy of the users.

Bulane is a privately held company incorporated in Geneva in March 2006. Unlike traditional business entrepreneurs, Bulane primarily seeks to generate “social value” rather than just profits. And unlike a great majority of non-profit organizations, Bulane works not only towards immediate, small-scale effects, but sweeping, long-term change.

In order to fight waterborne diseases, BULANE has developed and commercialized a simple and easy to use device. This breakthrough is called Watalys®.

WATALYS® is a point of use generator of sodium hypochlorite. It is a lightweight portable device (13.5 cm – 176 grams) designed for 12V field operations. This device, by electrolysing salt water, enables the production of a chlorine-based disinfectant solution (sodium hypochlorite), which conforms to WHO standards. Watalys® is extremely simple to utilize, and is used to produce a very powerful disinfectant solution.

One WATALYS® device provides safe water for 100 to 6,000 people daily for several years. Besides, the innovative design enables simple and efficient upward scalability, pushing the upper capacity limit to a theoretical infinite population.

WATALYS® uses leading edge technology titan electrodes with sophisticated proprietary coating which provide an utmost Cl<sub>2</sub> production yield. Under nominal conditions, one device generates up to 14 grams Cl<sub>2</sub> per hour. It is robust and has been developed with the field constraints as key technical specifications.

It operates on car battery, solar panel or any ad hoc 12V DC source. No maintenance is required other than rinsing with clear water.



WATALYS® reduces the costs of disinfection by a factor of ten – compared to other chlorine based methods – on the one hand, and at the same time, frees populations of the need to purchase and store chlorine, by producing it in situ and on demand.

WATALYS® is well designed and well suited for NGO's and institutions dealing with health, potabilization and sanitation.

**WATALYS® is a 2 step method:**

Step 1: produce a concentrate to use for water and premises disinfection using the WATALYS® electrolytic cell.

Step 2: use the WATALYS® concentrate to chlorinate water or diluted for premises disinfection.

WATALYS® concentrate is easy and safe to store, measure and use. No weighing. There is no other residual product, no waste. Bottles and storage vessels are reused.

Since WATALYS® concentrate is produced fresh, you save on transport cost and storage. Also, the quality of the concentrate (free residual chlorine – FRC) is guaranteed.

The chlorine level (FCR) in the water treated with WATALYS® concentrate is easy to verify using pool testers and DPD tablets.

The water treated with WATALYS® is protected from further contamination until the point of consumption.

Taste and smell of the treated water is almost unnoticeable. Drinking water treated with WATALYS® concentrate has a higher acceptance due to more pleasant taste and less aggressive chlorine odor.

Chlorination using hypochlorite has the major advantage of ensuring clean water throughout the distribution system whereas the effect of other disinfection techniques -such as ozone, ultraviolet light and ultra-filtration -is much more temporary. In addition to purifying water, chlorine not only helps to remove unpleasant tastes or smells, it also helps eliminate unwanted nitrogenous contaminants, and control the growth of slime and algae in distribution pipes and storage tanks.

Today, most of world's drinking water is made safe with the help of chlorine. It is an essential part of the purification processes used by water companies to supply our homes, industry and ensure that discharges of wastewater to rivers and seas are safe.

Watalys is in use in over 25 countries in the world. Major users are NGOs and Health organisations. it is also used on household level for house cleaning and water disinfection.

Bulane has initiated a partnership program with the Ministry of Health of Madagascar who has decided to adopt Watalys on a national level.

Bulane has released its first film which is available on the website:

<http://www.bulane.com/media.php?lang=en>

Or on Youtube: <http://www.youtube.com/watch?v=wfM8UkxgJ8U>

# The Challenges of Rural Drinking Water Supply Related to Pollution Control at Local Level in China in the Context of Millennium Development Goals

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Keywords: rural drinking water supply, water quality control, sustainable development, human health, integrated policy and planning

This paper considers the situation of rural drinking water supply in China and provides a brief of discussion on control of water quality at local level in relation to human health, economic development and future challenges in practice.

According to the MDG Report (UN, 2005), there were more than 1 billion people whose income is less than US \$ 1 a day in third-world Asian countries, over half of them being in China and India (UN, 2005). This was confirmed on December 7th 2005 by Chinese officials, who stated that there were more than 260 million people still in serious poverty in rural areas of inland China (State Council, 2005). The economic conditions of rural areas are far behind urban areas including drinking water and sanitation. This threatens the Chinese economy and people's health in rural areas.

Rural water supply is a critical factor in China's economic growth. The development of appropriate tools for assessment of the effectiveness of water provision is essential for drinking water quality. The Chinese government has paid high attention to rural water supply in terms of operation. It can be seen that China has adopted different techniques and policies for control of drinking water quality in order to avoid a potential danger to human health in terms of different periods. These include: building water facilities and infrastructure to support drinking water supply system and improve rural sanitary conditions, formulating water sanitary standards, increasing investment, creating water projects and programmes, providing technology and co-operating with global organizations for improvement of rural drinking water supply. The current policy is to provide safe access to drinking water in rural areas and the implementation of sustainable development of water supply to meet the challenges of rural water conditions and global concerns of the Millennium Development Goals as a whole.

The paper is intended to identify and explore effective integrated management of water resources by environmental institutions to tackle rural sanitation problems and how to combine this with environmental tools and policy for rural water supply in practice.

The issues that the paper considers are the situation of rural water supply in relation to water quality control, sustainable water resource management and human health at local level to analyse how they can connect with the planning and policy of today's China and also evaluate the advantages and disadvantages, and reflect on what should be improved in rural drinking water supply in China.

The paper answers the research question regarding what roles the considerations of the stakeholders play in rural water supply and how to implement sanitary water supply in rural areas.

The development and application of the research has involved collection and evaluation of relevant

and original information based on government documents related to drinking water supply, pollution control, economic development and human health and case studies undertaken in rural areas of China. The study provides concrete examples of planning related to rural drinking water supply and human health.

Discussion of outcomes: safety of drinking water supply in rural areas of China has been influenced by several factors: un-suitable water planning and policy between regions, installation of water constructions, unsustainable funding, diversification of local government management leading to lack of integration and dis-organization; lack of techniques and awareness of sanitary operation in practice of rural water supply.

The paper suggests that the way of improvement of drinking water quality management should be for central government to devolve powers to regional or sub-regional level which would then have more effective access to and control of implementation by local agencies and be more representative of all stakeholders. It may be suggested that rural water supply and pollution control could be privatised at the sub-regional level to increase the perceived value of this public resource while overall control and co-ordination remains with central government in the public interest.

# Point-of-Use Disinfection of Drinking Water using Cationic Antimicrobial Surface Coatings

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Keywords: Point-of-use, Disinfection, Treatment, Antimicrobial, Coating

The world's clean water crisis is one of the most pressing public health issues of our time. Over one billion people worldwide lack access to safe drinking water supplies. Waterborne pathogens are among the leading killers of infants and children in poor countries, responsible for roughly two million deaths each year. In settings that lack the resources to install centralized water treatment and distribution infrastructure, point-of-use (POU) drinking-water treatment devices have been shown to provide significant health benefits. To achieve maximum distribution and use, such household-level devices should be inexpensive, easy-to-use, highly effective against waterborne pathogens, and compatible with existing water usage patterns and preferences. A range of POU products are currently employed worldwide, each with different benefits and drawbacks. These products are generally based upon traditional means of water disinfection: chemical treatment (e.g. chlorine and iodine), filtration, and physical inactivation (e.g. heating and ultraviolet irradiation).

This paper introduces a new technology for POU water treatment: non-leaching cationic antimicrobial surface coatings. These coatings produce biocidal surfaces that inactivate waterborne pathogens on contact. The coatings remain permanently bound to the surfaces, and do not alter the composition of the water. This mechanism of action promises devices that combine the efficacy of chemical treatments with the user appeal of filter technologies, providing products that are highly effective, easy-to-use, and do not change the taste and odor of water. The coatings can be applied to a variety of substrate surfaces, enabling a wide range of potential implementations; they are low-cost and relatively easy to apply. Products based upon this technology have the potential to offer a valuable new addition to the toolbox of POU device options.

Our research has focused on quaternary ammonium silane (QAS) coatings, which combine a detergent-like quaternary ammonium compound with a silane group that provides robust surface bonding. Quaternary ammonium compounds have been shown to be effective against a wide range of bacteria and viruses, and the antimicrobial properties of QAS coatings have been known for several decades. The biocidal action of the coatings is believed to be linked to charge-based interactions between the quaternary ammonium compound and the bacterial cell membrane (or virus capsid or envelope). In this paper, we report on the application of these coatings to low-cost drinking water treatment.

We present the results of experimental studies on filter columns packed with QAS-coated sand. Raw water is disinfected through contact with the antimicrobial coating as the water passes through the sand column. Initial results are promising: using laboratory challenge water, small prototype devices have demonstrated more than 6 log (99.9999%) inactivation of *E. coli* bacteria. Flow rate in these initial devices is approximately 1 liter per hour; residence time in the bed is about 2 minutes. Due to the hydrophobic nature of the QAS coating, pre-use wetting procedures are required to ensure even flow through the column. We use both chemical and biological assays to verify that the coating is not leaching into the water and that device efficacy is indeed due only to surface interactions.

This presentation will detail our experimental work to date and explore the potential of this technology as well as the remaining obstacles to its implementation. Our future laboratory work includes testing the efficacy of prototype devices against a range of waterborne pathogens and assessing the longevity of the coatings when exposed to various realistic challenge water compositions. The ultimate design of new household-level water treatment devices that utilize these coatings will take place using an iterative process that incorporates design feedback on prototypes from potential users in a number of different field sites.

# The Problems of Monitoring and Protection of Main Rivers of Central Asia

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Keywords: Aral Sea basin, River waters, monitoring, contaminants, Collector-drainage waters

Irrigated lands have a special value for countries of Central Asia. For example in Uzbekistan occupying only 15 % of farmland, they give more than 95% of all agricultural production. However, the sizes of irrigated lands in the region are limited by shortage of water resources, which are already exhausted and polluted.

The purpose of our long-term researches was an estimation of the influence various types of pollutants on the basin of the rivers of Amudarya and Syrdarya. Samples of river waters were selected from the upstream and downstream currents of the investigated rivers in territory of the Republic of Uzbekistan.

We investigated the contents and temporary-time distribution of more than 20 polluting substances in the river waters of the Aral Sea basin within 2003-2007 years. As a result of study there were determined dissolved oxygen, COD, BOD, macro cations and anions, pesticides and other pollutants.

The water of Amudarya river have mineralization level of 1227,3mg/L (When maximum Permissible Concentration (MPC) on the average is 1,2 ). In the hydro post of the Termez city (middle stream of river) it has 642,3mg/L (0.6 MPC), and in the village Kzyljar near Aral Sea (downstream of river) it increases to 1527,7 (1.5 MPC). The River of Amudarya and its tributaries are characterized by low COD and BOD values typical for rivers of arid zones. Therefore, the average BOD value gradually decreases from upstream to downstream. In the range of Termez city the value of COD on the average has made 5, 5- 27,6 mg O/l, making on the average on the river 17,2 mg O/l. The level of pollution of the river by petroleum is high, on the average 0,07 mg/l (1, 4 MAC).

The contents of ammonium, nitrates and nitride nitrogen is low, their average sizes on water flow has made 0.02 mg/l(0,1MAC), 0,036 mg/l (2,0 MAC), 0,009mg/l(0, 45MAC).

The contents of alpha-HCH – 0,004 mkg/dm<sup>3</sup> (0,4 MAC), gamma HCH – up to 0,002 mkg/l (0,2 MAC), DDT and its metabolites are not found out.

On size of an index of the polluted substances (IPS) the quality of water of Amudarya has worsened in ranges of Tuyamuyun and village of Kzyljar also has passed from class II to class III of the moderately polluted waters.

The basin of Syrdarya is located in area of large industrial companies like JSC “Electrokhimprom”, Alti-Aryk oil refining factory, lime factories, urban clearing structures. Waste waters from such industrial companies influence quality of water resources of the basin. The 6 regions of Uzbekistan are situated in territory of the Syrdarya river basin: Andizhan, Namangan, Fergana, Tashkent, Dzhizak and Syrdarya. Waste waters are dumped to Syrdarya and its inflows.

About 2 millions of hectares of lands are irrigated in the Syrdarya river basin. The channels with total volume of water fence of 23,12 km<sup>3</sup> per one year are constructed for irrigation. Water use from the river has increased from 70 % in 1960 up to 95 % in 2007. At the same time, volume of the collector-drainage water, generated in the basin, has made 13,5 km<sup>3</sup> per one year.

The water mineralization of the river has increased to 1216,7 mg/L (1.2 MPC) on average. The oxygen mode in 2003-2006 was satisfactory, concentration of the dissolved oxygen at a level 11,35 mg O/l that corresponds to a level of the last year. On the current of the river the contents of organic substances (on COD) varied within the limits of 10,1-16,8 mg O/l.

Water is most polluted by organic substances in ranges below Bekabad city and Nadejdinsky settlement, where the maximum value of COD has made 27,1 mg O/l and 35,3 mg O/l accordingly.

The pollution of water by ammonium, nitrogen nitrate and nitride has increased 1,5-1,6 times. It has made – 1,97 mg/l (0,2 MAC), 0,046 mg/l (2,3 MAC), 0,05 mg/l (0,1 MAC) accordingly.

The contents of phenols on current of the river varied a little and has made on average 0,001 mg/l (1 MAC) that corresponds to a level of the last year.

Pollution by petroleum has increased insignificantly, but did not exceed MAC – 0,045 mg/l (0,9 MAC). The contents of copper has not changed, and the contents of zinc and chrome in comparison with previous year has increased 1,4-1,6 times and has made 0,8 mkg/l (0,8 MAC), 5,6 mkg/l (0,6 MAC) and 1,4 mkg/l (1,4 MAC) accordingly.

The presence of HCH isomers was marked at a level of 0,002 mkg/l (0,2 MAC), DDT and its metabolites are not found out.

On chemical structure in all phases of hydrological mode, water concerns to chloride class (seldom sulphate), group of sodium or calcium.

### **Conclusion**

The main sources of pollution of river waters of the Aral Sea basin are collector-drainage waters from irrigated agricultural land. Annual volume of it is about 32-34 km<sup>3</sup>.

Our long-term research has revealed that the dump in river waters is highly mineralised, containing fertilizers, pesticides and herbicides collector-drainage waters from agricultural lands are basic reasons for essential deterioration of water quality of the Amydarya and Syrdarya rivers basin in the middle and downstream currents.

The large volumes of polluting substances, including ammonium nitrogen and organic pollutants, are dumped to the rivers from cattle-breeding complexes. The situation is worsened by complete absence of sewer networks and working clearing structures.

# WASH in Schools – Scaling up Water, Sanitation and Hygiene Education for Schools

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Keywords: WASH, School, Sanitation, Hygiene, Education

UN Population Fund predicts that there will be acute shortage of freshwater by 2050. About 3 billion people do not have adequate sanitation facilities, and 11,000 children die of water-related diseases every day. In India, one fifth of urban population and three quarters of rural population do not have access to safe drinking water unless there will be no integrated water management strategy. It was pointed out that globally, 2600 million people defecate in the open while in India, 700 million people lack access to sanitation facilities and resort to defecate in the open. Diarrhoea claims the lives of 2 million children around the world every year while one million children in India die of diarrhoeal diseases each year directly as a result of drinking unsafe water and living in unhygienic conditions.

The health profile of Kerala State in India is said to be low mortality-high morbidity syndrome. Poor sanitation and hygiene are the most critical routes of transmission of infectious diseases. Lack of basic amenities compels people to resort to practices such as open-air defecation. Acute poverty, poor hygiene and inadequate garbage disposal and drainage facilities have further aggravated the matter. This leads to a high rate of waterborne and water-related diseases like diarrhoea, gastroenteritis, worm diseases, typhoid, cholera, polio and amoebic dysentery.

In this context, we would like to intensify our activities in schools as “WASH in schools- a sustainable model for better hygiene behaviour and healthy environment” in order to stimulate children for a behavior change.

WASH Coalition in Kerala State (South India) has launched a programme in certain selected schools in the southern districts of Kerala called “WASH in Schools” with an objective for better hygiene behavior and healthy environment in schools. The basic concept of this initiative was that schools are considered as ideal places of learning for children and they have a crucial role in the process of community development. Schools can be able to stimulate children for a better behavior change. If there is adequate facilities on enough safe drinking water, sanitation and hygiene facilities in schools, children as well as teachers can act as role models of the society. This will definitely influence the communities for a better change in their attitude and approach. WASH school committees, Eco-clubs, Parent-teachers associations (PTAs) and Local Panchayats (PRIs) are found to be the major driving forces of WASH in schools.

Stakeholders of the programme: Basically, WASH in Schools is a collective effort by the stakeholders of the sector including Parent-Teachers Associations (PTAs), School directors, Local self-governments (Panchayats), CBOs, NGOs, self-help groups and other grass-root organisations.



Area of coverage and target population: Schools in 4 districts of Kerala State in South India have been selected for the implementation of this initiative. A total of 100 schools were selected for this programme as Phase-1.

### Activities

- Awareness will be given to school children on water-borne and water-related diseases.
- Awareness camps, symposia, seminars, children congress, water quiz, competitions, rallies, will be conducted in all selected schools as part of WASH Campaign. Selected children will be sent to State and National level competitions and incentives will be given to those selected. Further, WASH posters will exhibit and display in all selected schools.
- To constitute "WASH school committees" and "Eco-clubs" in the respective schools with the co-operation and participation of pupils, teachers, parent-teachers association (PTA) and other stakeholders.
- Parent-teachers associations (PTAs), school directors, panchayats (PRIs) and other local stakeholders will take the responsibilities for the construction of water supply and sanitary facilities in the respective schools.
- Children's project/models based on safe drinking water, sanitation, hygiene promotion will be invited in children congress. Innovative projects will be selected for further studies.
- Monitoring and evaluation will be carried out on drinking water status, health status, sanitary status and hygiene behavior of children as well as the local communities through epidemiological surveys.
- Simple disinfection methods of dug wells and available water for drinking will be demonstrated to children in order to reduce water-borne morbidity. Intense awareness will be given to mosquito eradication.
- During rainy season, medical camps will be conducted in rural and semi-urban schools as part of WASH Campaign in association with PHCs, CBOs, NGOs, Local Self-Governments (PRIs), civil organisations and other grass-root bodies in order to prevent the out-break of water-borne diseases.

Key recommendations based on the lessons so far learned from Kerala on WASH in Schools:

- Partnerships with governments, donors, community-based organisations (CBOs), non-governmental organisations (NGOs), teachers, children and school administrators are essential elements to achieve the sustainability of school sanitation and hygiene education programmes.
- To highlight the duty of all stakeholders to convey the message that "children are effective agents of change and schools are the ideal places of learning for children; and that they have a crucial role in the process of community development"
- All children have a right to basic facilities such as school toilets, safe drinking water, clean surroundings and information on hygiene.
- To support efforts to implement environmental awareness/school sanitation/hygiene education in school syllabus for a healthy school environment.
- Capacity building is needed at all levels.
- Child friendly especially girl child and disabled friendly water and sanitation design options essential.

# Improving the Well-Being of People with HIV/AIDS through Meeting their Water and Sanitation Needs

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Keywords: HIV/AIDS, WATSAN, Equity, Equality, Discrimination

## Introduction

Everyone needs clean water and sanitation for good health. But people living with HIV/AIDS (PLWHA) are particularly vulnerable to the health impacts of inadequate water and sanitation. In seeking to protect themselves from infection, or cope with the symptoms, their needs for clean water and sanitation increase. In spite of their increased need for water and sanitation (WATSAN) often their needs are not addressed in current water and sanitation programs. Exclusion of any group from water and sanitation access not only affects the well being of this group but also puts the entire community at increased risk through the spread of disease. Therefore addressing their needs will yield public health benefits for the whole community. Ensuring equal access through the provision of improved facilities will not only improve community health but, through improved awareness, could potentially change attitudes to PLWHA thus in turn improving their access to WATSAN and other facilities.

Despite extensive literature on HIV/AIDS, documentation on linkages with water and sanitation is limited, and programming in the two areas is rarely linked. WaterAid Ethiopia, therefore undertook a pilot research in this area in Addis Ababa.

This research investigates the needs of PLWHA in water and sanitation, their constraints on meeting these needs, and ideas for addressing them through water and sanitation programming by NGOs and government in Ethiopia so that to improve their well being as well as that of the general community.

## Key findings

### **PLWHA have increased need for water and sanitation**

The needs of most PLWHA respondents for water and sanitation have increased since they tested positive for HIV, especially during the symptomatic phase. Fever increases the need for bathing and washing, and diarrhoea and fever require drinking more water. Diarrhoea, which was experienced by two thirds of the HIV positive sample respondents, increases the need for nearby latrines. Drinking more water also helps reduce side effects from anti-retroviral treatment (ART), used by half of the HIV positive respondents. Increased washing and bathing helps prevent water related opportunistic infections.

Bereket is HIV positive, and lives in a local government rented house, where he shares a communal latrine. He has frequent diarrhoea which does not respond to medication, but he always has to queue for a long time to use the toilet.

### **PLWHA suffer reduced access to water and sanitation**

Although the need of PLWHA for water and sanitation is higher, they have limited access to facilities.

Most respondents buy water from private vendors or communal tap stands, and use shared latrines. A minority had no access to latrines at all.

About one third of respondents experienced reduced access to water and sanitation facilities, due to discrimination or sickness, and this means that their needs are not always met.

Abeba has HIV and suffers from frequent diarrhoea, but the nearest kebele toilet is 6 minutes walk away. It is also dirty, with 30 households sharing the same toilet. So she uses a potty in the house, which her husband and children then take to the latrine.

Other problems faced by PLWHA in water and sanitation include insufficient number of communal taps and latrines; inconvenient opening times for communal taps; the high cost of buying water from vendors; and poor maintenance, especially of latrines, which increases the perceived risk of sickness.

### **Discrimination**

Discrimination in WATSAN access is often part of a complex web of discrimination, which also affects housing, employment, medical services, social life and childcare. Discrimination against PLWHA in water and sanitation use is widespread, and at least one third of respondents had personal experiences. These ranged from refusal to share water containers or washing lines to locking of taps, bathrooms or latrines. It is not limited to those using shared facilities. The minority who have private facilities faced some of the most extreme forms of discrimination from close family members, or private landlords. Discrimination is often based on fear of contracting HIV through any form of contact. Respondents claimed that discrimination is worse in latrine use than water because people believe that the latrine can more easily transfer the virus from a sick person to a healthy one.

Solomon used to live in private rented accommodation. As soon as he started to visit the latrine frequently, his neighbours suspected him of having the HIV virus and locked him out from the toilet and the water tap and made him pay extra money for the water he was using.

### **Recommendations**

- Programming in HIV/AIDS and WATSAN should be integrated;
- PLWHA should be included in the planning, implementation, monitoring and evaluation of WATSAN programmes;
- Advocacy is needed to tackle discrimination.
- Inclusive facilities should be incorporated in WATSAN and health programs to ensure wider accessibility by chronically sick people and other vulnerable groups like people with disabilities and in general by the community

### **Actions taken so far**

- Radio program, Focus group discussions and community training manuals aimed at changing attitudes within the community.
- Planning of an inclusive design pilot to ensure broader accessibility to the community.
- Development of a policy brief and HIV/AIDS mainstreaming guidelines to be used by partners and others in the sector.
- Working in partnership with organizations like Integrated service for AIDS prevention and support organization (ISAPSO) and Handicap international.

# Sanitary-Microbiological Monitoring of Water Objects of Megapolis Recreational Zones as the Precautionary Action on Preservation of Population Health

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Keywords: Monitoring, Bacteria, Intestinal Viruses, Sewage, Health

The problem of the organisation and control of virus pollution of water objects, economic-household sewage, and water in water supply system, is one of the most actual problem, in connection with growth of case rate of intestinal virus infections in population with the fekal-oral mechanism of the transfer, extended on the basis of realisation of the water factor. Intestinal viruses, getting to environment with human emissions, can pollute sewage, waters of the open reservoirs, centralised and decentralised water supply systems and potable water. It is known more than 120 various viruses which get to environment with excrements. It is enteroviruses, including viruses of a poliomyelitis (three serotypes), Coxackie A (types A1-A24); Coxackie B (types B1-B6); ECHO (types 1-31); new enteroviruses (types 68-71); rotaviruses (6 types); adenoviruses (37 types); reoviruses; viruses of a hepatitis A and E; caliciviruses; coronoviruses; astroviruses; viruses of Norfolk, etc. These viruses lead to diseases of different aetiology, severity level and character of organs and systems lesion.

The work purpose consisted in the analysis of a sanitary-bacteriological and sanitary-virologic condition of the water environment in water area of the Nevsky Bay and east part of Finland Gulf in July – October 2007 according to natural supervision and in connection with building of constructions of protection of St.-Petersburg from flooding. The basic features of work consist in complex character of detection of bacterial and virus pollution markers of water area of the Nevsky Bay and an estimation of the population health level of a megapolis.

Material for research were data of laboratory researches of the water samples, selected from different stations of the Nevsky Bay and east part of Finland Gulf. Water samples were selected in areas of an arrangement of hydrology-hydrochemical and sanitary-bacteriological stations. Concentration of water tests was carried out on the basis of «Methodical recommendations about the sanitary-virologic control of environment water objects» (2006), using a membranous filtration. The analysis of disease of the population was spent according to statistical forms of the account.

Level of bacterial and virus pollution in the Nevsky Bay and east part of Finland Gulf in many respects depends on numerous sources of pollution, including decentralised drains. In September – as a result of numerous researches of a sanitary condition and an estimation of self-cleaning processes in reservoirs – high enough degree of intestinal bacteria and viruses contamination (a virus of a hepatitis A and rotaviruses) in separate sites of water area of the Nevsky Bay recreation zones is established.

The water area of the Nevsky Bay and east part of Finland Gulf in 2007 is characterised rather not by high level of faecal pollution. Considerable contamination of water samples by intestinal bacteria

and a viruses in recreation zones testify to pollution of Neva by faecal runoffs. A condition of water area of a southern site of a Nevsky Bay recreation zone in the end of October (2007) is satisfactory. The tendency to improvement of ecological conditions in a southern part of the Nevsky Bay after start in operation of south-west sewage treatment plants is marked.

The presented results of sanitary-microbiological researches and results of mathematic-statistical processing of laboratory data testify to specificity of indicators of water of the Nevsky Bay and east part of Finland Gulf during the various periods of year and are basic for definition of markers of the most actual infections – a virus hepatitis A and rotavirus gastroenteritis. The abundant quantity of bacteria in water promotes longer survival of enteroviruses. Modern methods of mechanical and biological sanitation do not provide full clearing of sewage from enteroviruses, and they are the basic tank of intestinal viruses in the nature.

Data about some infectious and non infectious children and adult population diseases on city areas specify, basically, on synchronism of dynamics of diseases on years – on the one hand, and on the expressed quantitative distinctions of levels of diseases on recreation areas. During the 2000-2007 period sharp intestinal infections is firmness various on areas: maximum levels took place in Vasileostrovsky, Nevsky and Moscovsky areas; minimum – in Petrogradsky and Kalininsky areas. Case rate of a virus hepatitis A – using cumulative data of 2000-2007 – was highest in the Admiralty, Kurortny (Resort) and Central areas; the lowest – in Kronshtadt, Prymorsky (Seaside) and Moscovsky areas. In 2007 case rate in Kurortny (Resort) area was in 4,3 times above case rate in Kolpino. Rotavirus infection case rate among children and adults in 2000-2007 was maximum in the Nevsky area and Kronshtadt, minimum – in Petrogradsky and Kalininsky areas.

Thus, it is possible to reach decrease in concentration of enteroviruses in water spending repetitive clearing. It is one of ways of decrease of viruses concentration on an aquatic environment of recreation zones and depression of a case rate risks in the population of a megapolis.

# Open Risk Assessment of Drinking Water Contaminants – Involving Stakeholders

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Keywords: Disinfection by-products, Microbial contamination, Open risk assessment, Stakeholder involvement, Mass collaboration

HiWATE (Health impacts of long-term exposure to disinfection by-products in drinking water, [www.hiwate.org](http://www.hiwate.org)) is an EU-funded research project which aims to investigate the potential human health risks (e.g. cancer, premature births, small for gestational age, semen quality, still birth, congenital anomalies) associated with long-term exposure to low levels of disinfectants and disinfectant by-products (DBPs) in water for humans. To ensure microbiologically safe drinking water, waterworks disinfect water before pumping it to the distribution system. Chlorination has residual disinfection effects in drinking water distribution system. When chlorinating the drinking water, waterworks should optimize water treatment process and chlorine dose so that it is effective enough for removing pathogenic microorganisms from water, and on the other hand minimize the formation of DBPs. The project attempts to find the right balance between disinfection/DBPs and microbial load by quantitative risk assessment, comparing alternative treatment options and produce burden of disease estimates (using disability adjusted life years, DALYs), health care costs and risk perception rankings. The study will make use of existing studies/databases and newly collected information. The outcome of this project will contribute to improved risk assessment and management. Stakeholder involvement is an important and in some aspects a crucial point, which needs to be accounted for during the risk assessment process.

Stakeholders are any people or organisations that may have some interest related to the issues of the risk assessment. In environmental health risk assessment stakeholder involvement is important in several different aspects. Most importantly it contributes to 1) improved knowledge about the phenomena being assessed, 2) increased acceptance of the assessment outcome and decisions based on it, and 3) inclusion of diverse viewpoints and values.

An integrated risk assessment aims at creating shared understanding about complex phenomena and acceptance of assessment outputs among and between diverse interest groups:

- Among the scientific experts
- Between scientists and decision-makers
- Between scientists and stakeholders (including public at large)
- Between decision-makers and stakeholders

In HiWATE project, stakeholder contributions are sought according to the following framework:

- Input to issue framing: perspectives, critics, and suggestions
- Input to the assessment: information, data, critics and suggestions
- Feed-back on the results: critics and suggestions

HiWATE applies open risk assessment (ORA) method which attempts to answer to the following question: How can scientific information and value judgements be organised for improving societal decision-making in a situation where open participation is allowed? According to ORA, stakeholder involvement is organized by means of mass collaboration. Mass collaboration is a way of organizing knowledge in an open environment, where a large group of unorganized people can participate, share information and questions, and utilise the products of others. A famous example of such an approach is Wikipedia, the open encyclopedia in the Internet.

When an integrated risk assessment is performed according to the ideas of mass collaboration, stakeholders are given access to discuss and give their comments on the issues being assessed in a wiki system (an information system allowing users to edit the contents, such as Wikipedia). In practice, anyone is allowed to contribute (i.e. bring in information and value judgements that are within the scope of the assessment), unless there are explicitly specified reasons to restrict participation in the particular case.

Communicating information that is understandable to the stakeholders is an important issue for succeeding in stakeholder involvement in an integrated risk assessment. All other activities, from consultation and informed participation to negotiation and resolution of grievance, will be more constructive if stakeholders have access to accurate and timely information about the assessment, its possible impacts, and other aspects that may have an effect on them. The use of mass collaboration as a means of organising stakeholder involvement aims to improve the quality of assessment content and the applicability of the output as well as to improve the efficiency of the assessment process. Examples of ongoing open risk assessment processes already exist on an open website (<http://heande.pyrkilo.fi>).

HiWATE is a three and a half year Specific Targeted Research Project, funded under the EU Sixth Framework Programme for Research and Technological Development by the Research Directorate-Biotechnology, Agriculture and Food Research Unit. (Contract no Food-CT-2006-036224). The project started in October 2006 and it involves 15 partners in nine countries.

# Support for Arsenic Filtration Efforts (SAFE) Progress the Hardcore Poor Livelihood in Bangladesh

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Keywords: Arsenic, low cost technology, LEDARS, MIT and CAWST, Sponsorship

Arsenic is a highly toxic known human carcinogen that naturally occurs at high concentrations in drinking water in many countries of the world. As of January 1, 2008 an initiative has begun that will raise money for the installation of low-cost household arsenic filters to treat drinking water in the highest arsenic areas of lower income countries. The initiative is purposely small-scale in scope so that that successful implementation in high priority areas can be achieved quickly and with no associated organizational overhead costs. This initiative begins with a year 2008 goal of raising \$40 per filter for the installation of 100 household arsenic filters for 100 families in very high arsenic areas of Bangladesh. Overall Bangladesh is the country in the world most severely impacted by arsenic in drinking water and it is also a country that suffers from chronic rural poverty in many areas. Arsenic contamination of drinking water in Bangladesh is widespread and causes a variety of cancers and also causes skin lesions (arsenicosis) in adults and children 10 years old and younger.

This arsenic filter funding support effort is being given the name SAFE (Support for Arsenic Filter Efforts) for ease of reference purposes. SAFE is base on the following concepts:

## Basic Approach of SAFE

- SAFE is being initiated to address the need to install effective low-cost arsenic filters in high arsenic areas in developing countries for households that have been specifically identified as not having access to alternative safe water sources.
- Because funding resources are limited and many families in Bangladesh are currently drinking water with high arsenic levels, a basic concept of SAFE is that the need for filters be prioritized from a basic public health risk standpoint. All arsenic filters is installing only in households that have been identified as at high risk based on factors such as: levels of arsenic in the drinking water source currently being used by the household, the number of arsenicosis patients in the household, etc.
- The arsenic filter that are installing is the Kanchan Arsenic Filter (<http://www.informaworld.com/smpp/content-content=a783095262-db=jour>) which was originally developed by the Massachusetts Institute of Technology (MIT) working with the Nepali environmental organization ENPHO with follow-up support provided by the international non profit Centre for Affordable Water and Sanitation Technology (CAWST) in Calgary, Canada (<http://www.cawst.org/>).
- After the Kanchan Arsenic Filter won a World Bank Development Marketplace award in 2003, thousands of these filters have been installed in Nepal and UNICEF-Nepal is planning to distribute thousands more filters to high arsenic areas of Nepal in 2008. Because of the widespread nature



of the arsenic problem in Bangladesh, UNICEF is not working in the districts/villages that is the focus of SAFE.

- The Kanchan Arsenic Filter has been field tested in Bangladesh for the last 10 months by MIT, LEDARS and CAWST as part of applying for formal technology certification by the Bangladeshi government and the Canadian technology certification specialists OCETA (<http://www.oceta.on.ca/arsenic.htm>).
- Field testing conducted in Bangladesh has demonstrated the Kanchan Arsenic Filter's ability to remove arsenic to levels below the Bangladeshi drinking water standard even when the levels in drinking water wells are more than 15 times the acceptable standard. Somewhat uniquely, the Kanchan Arsenic Filter also acts as a household-size slow sand filter, removing many microbiological pathogens that are a leading cause of high infant mortality rates.
- This fund raised through family-to-family, school classroom or club to family, or individual to family and is being used directly to put filters in the houses of families at high-risk. For example, a school classroom with 20 students might collect an average of \$2 per student and sponsor the installation of an arsenic filter for an extended family household in Bangladesh that is currently drinking highly contaminated water. Alternately a family or individual in North America can provide safe water to a high-need Bangladesh family.
- For each filter funded, the donor family, classroom or individual is providing the following information:
  1. location and family name of household where the arsenic filter is being installed,
  2. information about the actual arsenic concentration in the tubewell currently used by the family and
  3. a digital picture of the actual installed filter and the home it is installed in.
- Filter construction will be coordinated by LEDARS a Bangladeshi non-governmental organization that is working closely with the MIT and CAWST on arsenic filter testing and training projects. LEDARS (formerly Gana Unnayan Sangstha) began working closely with MIT and CAWST after all three organizations were top ten finalists for the Kyoto World Water Prize presented in 2006 in Mexico City at the World Water Forum (<http://www.worldwatercouncil.org/index.php?id=1385>).
- After being installed, the filters funded by this effort is being visiting for filter evaluation purposes by Tom Mahin, JICA and Asia Arsenic Network. Initial drinking water well testing and village site visits to evaluate potential appropriate households for SAFE funded filters were conducted in December of 2007 by Tom Mahin and Mohon Mondal, Executive Director of LEDARS with logistical support provided by Asia Arsenic Network-Bangladesh staff.

A school student, houses holds members, club members who is contributing to the safe water in the south west region of Bangladesh, dream the hardcore poor in the locality. Though this is a house hold technology and its maintaining is easy this technology is getting more popular to the community. This approach will be the pioneer in the work where people dying for want of drinking water.

# Community Based Structures as an Entry Point to Better Health

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Keywords: community, structures, clubs, behaviour, health

## Background

Health data published by the WHO during the last few years indicates that a number of deaths, particularly among children, are due to diseases which could have been prevented if proper hygiene and sanitation habits were practiced.

As a result Voluntary Action for Development embarked on working with community based structures in Wakiso district in Uganda, as strategy to ensure appropriate behavior change and sustainability of sanitation and hygiene education to address this situation.

This intervention has been supported by SIMAVI Netherlands since 2004 and it's based on intensive action oriented sanitation and hygiene education programmes focusing more on the behavioral changes of individuals, families coupled with related infrastructure improvement.

Establishment and empowerment of community based structures in schools and villages has been a driving force to the success of the intervention.

## Community Based Structures (CBS)

Community based structures at the village level include community monitoring teams(CMTs), water user committees(WUC's) and local leaders while at the school level they include school health clubs (SHC's).

CBS have reinforced community participation in water, hygiene and sanitation education which has facilitated maximizing of the potential benefits of water supply and sanitation improvements. School health clubs members are chosen by the patron from primary 3- primary 7, the club consists of 15-20 members.

WUCs are responsible for mobilizing community members to contribute local materials needed in construction, overseeing construction, ensuring proper operation and maintenance of the water sources.

CMTs are responsible for sensitization of community members about water, hygiene and sanitation issues, monitoring progress, house to house discussions, documentation of progress and providing feed back.

SHC's are responsible for ensuring good hygiene and sanitation standards in the school through mobilizing, training other pupils about hygiene and sanitation.

CMT & WUC work in close collaboration with local leaders who offer support in form of mobilization and enforcement of sanitation by laws.

## **Approaches**

Several mechanisms have been utilized by CBS to enhance sustainable hygiene and sanitation behavioral changes in the communities.

### **Community participation**

This is one of the aspects emphasized when setting up CBS's whereby community members participate in election of CMTs of ten members and WUC's of seven members. CBS's reinforce community participation in project activities whereby WUC's mobilize community members to contribute local materials needed in water source construction and to contribute towards and operation and maintenance fund.

The CMT encourages community members to set up good hygiene and sanitation structures like hand washing facilities, dish racks, safe latrines and bath shelters to enhance behavioral changes.

SHC's engages children and parents to participate in ensuring good water and sanitation conditions in the communities.

### **Trainings**

CBS are trained for 3 days in resource mobilization and management, monitoring, roles of each members, gender, cultural issues, and water and sanitation issues with emphasis on low cost solutions to sanitation needs, operation and maintenance.

SHC's are trained in child to child approach, water, hygiene and sanitation issues and life skills. CBS's later transfer the knowledge acquired to other community members through holding rallies, villages meetings and house to house discussions.

### **Monitoring**

WUC's and CMTs have conducted house to house visits where they monitor progress of hygiene and sanitation improvements offer advice to household members and record status on community monitoring chart. WUC's monitor the general cleanliness of the water source and its functionality. SHC's through outreach activities have monitored water and sanitation situations at household level as well as offering support to vulnerable community members like the elderly and disabled by establishing appropriate structures for them. School health clubs developed a work plan which has been used in monitoring of water and sanitation situation in the school.

### **Use of the media**

SHC's participate in radio programs whereby they disseminate hygiene and sanitation messages through discussions, music and drama. This has facilitated spreading the gospel of water and sanitation to a wider community in a dramatic way.

### **Gender**

The CBS's are gender sensitive in such a way that both males and females are well represented on the committees. This enhances participation of both males and females in water and sanitation activities.

### **Observations**

- SHC's have enhanced behavior change even beyond the school to community level through outreach programs.

- Poor hygiene and sanitation situations make children prone to water and sanitation related diseases thus improved conditions at the school are critical to the health of school children. Hence clean, well designed sanitation and hand washing facilities in schools, coupled with effective hygiene education will have enormous health benefits.
- Effective participation of CBS in hygiene and sanitation promotion has enabled community members to realize the need for improved sanitation in their households.

### **Results**

- Reduced incidences of water and sanitation related diseases.
- Children's role as ambassadors for change in their families and communities has led to behavior change in their families and communities.
- Increased awareness about hygiene and sanitation issues at the school and community level.

### **Conclusion**

This poster will highlight the various strategies which CBS have utilized to foster and sustain behavioral changes. The role of community based structures in hygiene and sanitation promotion needs to be explored further to stimulate community driven initiatives implementing their rights in pursuit of improved environmental health.

# Preventing Endemic Parasitic Diseases in Rural Communities of Developing Countries – A Challenge to Sanitation and Water Supply

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Keywords: preventing, diseases, water, sanitation, communities

Parasitic diseases have remained endemic in rural communities of developing countries with significant economic and public health consequences.. Current studies have revealed that poor sanitation infrastructures and repeated exposure to infected water either for the purposes of recreation or occupation perpetuate the cycle of transmission and infection. Between March and December 2007, aggregated studies of the prevalence of some important parasitic diseases were carried out in rural communities of Ebonyi State, Nigeria. Diseases studied included schistosomiasis, intestinal helminthiasis and dracunculiasis. These diseases are basically sanitation and water related. Results from these studies were meant to serve as indicators of the level of sanitation and water supply towards achieving the Millennium Development Goals (MDG). From the studies, prevalence of urinary Schistosomiasis among school children in rural communities of Ebonyi State ranged from 1.70%-70.0%. People engaged in swimming and bathing in infected water bodies had the highest prevalence. Ponds, streams and numerous quarry pits filled with water are the probable transmission sites as they harbour the snail intermediate host of *Schistosoma haematobium* in these areas. In another study, a survey of intestinal parasites was conducted in various rural communities and sub-urbs of Ebonyi State. The purpose of the study was to determine the prevalence of intestinal helminth parasites among children aged 4 –16 years. A total of 3780 faecal samples were collected from the study subjects and examined for parasite eggs, ova, larvae or segments using direct smear method. Out of this number 2880 (76.1%) of the children were infected with various species of worms. This indicated a high prevalence of infection. The following parasites were identified: *Ascaris lumbricoides* (51.5%), Hookworms (22.2%), *Enterobius vermicularis* (2.3%) while 310 cases of mixed infection (8.1%) were recorded. Those without access to good toilet facilities had a prevalence of 88.3%, which was considered very high. Poor sanitation and dirty environments; inadequate toilet facilities; and lack of portable water were key factors responsible for transmission. In another study, the rate of contamination of some common fruits and leafy vegetables sold in three major markets in Abakaliki metropolis, Ebonyi State was assessed. The leafy vegetables and fruits were bought directly from the rural farmers and examined for helminth ova and larvae by the formal-ether concentration method. All the vegetables and fruits were found contaminated by helminth ova or larvae or both, with the fruits being more contaminated than the leafy vegetables (52.9% and 47.1% respectively). *Telferria occidentalis* (fluted pumpkin leaves) recorded the highest contamination rate (23%) while *Talinum triangulare* (water leaf) recorded the least contamination (8.3%). *Ananas cosmosus* (pineapple) recorded the highest concentration rate (15%) while *Psidium guajava* (guava) recorded the least rate of contamination (5.6%) for the fruits. Helminth ova and larvae recorded were *Ascaris lumbricoides*, *Trichuris trichiura*, Hookworms, *Strongyloides stercoralis* and *Enetrobius vermicularis* with *Ascaris lumbricoides* being the most frequently encountered (60.3%). Defecation on open farmlands and pollution by untreated sewage accounted for the high level of contamination of fruits and vegetables. The resurgence of guineaworm in some rural communities also calls for concern. An active case search conducted in Ebonyi Local Government Area of Ebonyi State in November, 2007 yielded two positive cases.

UNICEF hand pumps and water facilities in hitherto guineaworm endemic communities had broken down which underscores the need for proper management, monitoring and evaluation of water and sanitation projects. These studies revealed obvious gaps in the implementation of health, water and sanitation Programmes leading to poor impact of existing water and sanitation policies, especially in rural communities. The paper discusses in detail, a model for A Top-Bottom-Top approach. This if implemented and sustained will close existing gaps and enhance management and evaluation of water and sanitation projects and greatly reduce the burden of water-related health problems, especially in rural communities of developing countries.

# WASH; a Vehicle for Achieving Health Related MDG Goals – An Impact Assessment

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Keywords: water, sanitation and hygiene, community,, impact, Prevention

Health, as officially defined by the World Health Organization is a state of complete physical, mental, and social well-being, not merely the absence of disease or infirmity. The significance of safe water supply to populations is endorsed as one of the eight principal components of Primary Health Care and the global Millennium Development Goal of connecting all households to a reliable source of water that is reasonably protected from contamination (WHO, 1978; UNDP, 2003). Access to improved water supply is not only a fundamental need and human right, it possesses considerable health and economic benefits and inadequate access to water supply and sanitation limits opportunities to escape poverty and exacerbates the problems of vulnerable groups, especially those affected by HIV/AIDS and other diseases (DWAF, 2003; WHO/UNICEF, 2005).

Poor water quality and lack of access to improved sanitation continue to pose a major threat to human health. The situation is not different in Nigeria. In the fifteen years from the MDG baseline year of 1990, rural sanitation coverage rates have risen just 3%, from 33% in 1990 to 36% in 2004 and rural safe water supply coverage is 31% (WHO/UNICEF JMP, 2006). Relatedly, Nigeria's diarrhoea prevalence rate, at 18.8% (NPC/ORC Macro, 2004), is very high. This leads to high child mortality rates due to direct deaths from diarrhoea (diarrhoea is the second largest killer of children in the country, behind malaria) and to other diseases linked to high diarrhoea prevalence. Poor sanitation is also a major contributing factor to low education enrolment and achievement rates, to malnutrition and to poverty as a whole.

This paper attempts to demonstrate WASH related preventive human health benefits by presenting findings of an impact assessment of the FGN/UNICEF/DFID supported WASH program (2002-2007) in selected focus communities of Zamfara State, Northern Nigeria. The FGN/UNICEF/DFID WASH program through Government institutions supports specific focus communities in selected focal Local Government Areas (LGAs) in 8 states of Nigeria with cash and technical assistance for piloting replicable and sustainable approaches for WASH services delivery. Zamfara is one of such states.

Zamfara is one of the Nigeria's poorest states, with a range of socio-economic challenges including sub-standard infrastructure and a lack of basic services. It is in the North West Region, which has the lowest hand-washing rates<sup>1</sup>, the second highest diarrhea rates and the highest under-five mortality rates in the country (NPC/ORC Macro, 2004). In rural areas the main occupation is subsistence farming and cattle rearing (the presence of a large number of cows in households and communities adds to the sanitation problem). People are predominantly Muslim and the purdah system of gender segregation is widely practiced.

After 5 years of implementation of the FGN/UNICEF/DFID WASH program in Zamfara, a study was conducted to assess its impact in selected UNICEF focal and non-focal communities in the State up to September 2007.

The study was carried out in six communities in six Local Government Areas (LGAs) in Zamfara State i.e. three focus and three non focus. A descriptive cross-sectional study design was adopted. Data was collected using survey instruments viz structured questionnaire, in-depth interviews, focus group discussions (FGD) and observation checklist. In addition, GPS was used to determine the location coordinates of the various facilities particularly the water points.

## Results

The results of the study were in line with the findings of an evaluation of the FGN/UNICEF supported program (2002 -2007) in six states within the C field zone from 2002 – 2007, which showed that on average, improved water supply access had improved from 23.57% to 51.05%, sanitary means of human fecal disposal from 33.16% to 61.88% whilst sanitary refuse disposal access had increased from 29.85% to 54.26%.

The Zamfara impact study indicated that access to improved water supply was >100%, 30% in the sampled focus and non focus communities respectively. General rural state wide access was 26% (Zamfara State Official Handbook (1999). Health related benefits include the reduction of guinea worm from 67 cases in 2002 to zero in 2007. The WHO values hours saved at the average wage rate for unskilled labour ( Hutton,2004). Using the Nigerian minimum wage rate of \$46.65/ month in relation to the reduction in time from about 6 hours to < 15 minutes in 61.9% of the focus communities, The time saved can thus be valued at \$8383.33 per community per year and \$4,769,347.32 state wide. Other related health benefits include a 50-60% reduction in cases of typhoid, shigellosis and skin infections and an average of 11.2% reduction in cases of malaria was also reported in the focus communities.

With regard to household sanitation the study indicated that 57% of households in the focus communities had access to upgraded latrines versus 0% in non focus communities. This is against the 29.4% state wide access (Zamfara State Official Handbook (1999).

With regard to institutional sanitation, percentage access by the learners is 124% and 50.08% in focus and non focus schools respectively, benefits of this as perceived by respondents include an improvement in girl enrolment in schools. Other perceived impacts, include health improvement (36.1% and 8.3%) and women involvement in decision making/access to resource control ( 73.5% and 46.9.5) in focus and non focus communities respectively.

## Conclusion

Water, Sanitation and Hygiene impact on the health, social and economic well being of recipients, the sector needs to advocate more for WASH as a vehicle to achieving the Millennium Development Goals related to poverty, health and education.



# Monitoring Sanitation Programmes Using a Specific Information System. Application to 'Water Facility' Projects in Tanzania

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Keywords: Sanitation, monitoring, Geographic Information System, Wat&San programmes, ACP-EU Water Facility program

Accountability and efficiency are relevant aspects in any development programme, and although their concept is clear, how to achieve them still remains an elusive goal. Monitoring may enhance management decision-making in order to attain both objectives.

Water and sanitation programmes often take several years to be properly implemented if their sustainability is pretended to be guaranteed, and this often entails a high rotation of the staff within the NGO committed to the programme's implementation. Furthermore, these programmes rely on community participation and therefore a large number of stakeholders is required. All these aspects amplify the need of monitoring. In a WatSan programme, when the sanitation and hygiene promotion aspects are highlighted, monitoring gets even more relevant. Those programmes do frequently fail to deliver benefits to society over the long term, and it is believed that a proper monitor should help to further understand the causes which prevent the expected aims of the programme from being achieved.

The Spanish NGO Ingeniería sin Fronteras – Asociación para el Desarrollo (Engineering without borders – Association for the Development) has been implementing WatSan programmes in different rural districts of Tanzania, fostering sustained access to water, proper sanitation and campaigns of hygiene promotion. Since 2006 this NGO has been working with the European Commission (the latter as the main donor) under the ACP-EU Water Facility program. This kind of programmes require a significant amount of money and long programme implementation phases, and both aspects have entailed the NGO to implement an appropriate Monitoring Information System as an efficient tool to improve the management of its programmes. The goal is to easily access to relevant information while enhancing the capacity to control all different stages within the programme.

The sanitation component of the programme focusses on building demonstrative latrines for some beneficiaries (chosen in a participatory way) of the elected villages of intervention. Those latrines are aimed to be efficiently build, as school latrines, in order to foster replicability in the village. After a massive promotion campaign (including schools), villagers willing to improve their latrines can purchase some of the required materials from the NGO, while in a learning-based approach they will be committed to carry out its construction with assistance of local masons previously trained. Materials are to be provided gradually as latrines are getting built. To monitor these processes it is essential to understand the reasons which can cause failures or enhance efficiency, while using GIS to support the process may also help on organizing the logistics of the materials.

With regard to the hygiene promotion campaigns, this NGO relies on the Participatory Hygiene and Sanitation Transformation (PHAST) methodology. This methodology was developed by WHO and as other participatory techniques it requires the input of a wide variety of stakeholders. It highlights

the need to properly implement a MIS, since it should allow to easily detect failures and promote appropriate alternatives to overcome inefficiencies.

The design of a Management Information System first requires the definition of the relevant data needed to monitor the program, and it was done based on a comprehensive analysis of previous programmes (not only which type of data was monitored but also the way it was collected).

The final version of the MIS has two different parts: a data entrance interface and an analysis interface. The first part is a database developed with Microsoft Access, since it is friendly to use and has a comprehensive user's help, both features aimed in order to facilitate capacity building. On the second one, some applications have been designed in order to analyse and exploit information kept on the database through a systematic way. At the same time, not only the information needed but also the indicators required to monitor the performance of the program have both been defined considering the requirements and inputs established by the staff working in the field, taking benefit of their experience. This interface has been developed in two different ways, extracting information on a geographic basis (using gvSIG, a GIS open software) and printing graphics about the evolution of different processes (using Microsoft Excel, where information on the database upgrades predefined graphics).

Examples of the usefulness of such monitoring tool range from the analysis of the spatial performance of Phast promoters, the relationship between the physical location of the family and its hygiene and sanitary habits, the effectiveness of the demonstrative latrines in promoting sanitation in the areas surrounded, or which neighbourhoods are getting off track on the sanitation improvements. At the same time, more standard analysis can be made, such as relationship among the tribe of origin, the income and the incorporation of new hygiene habits, since data from social census are also included.

As Bond (1999) states, participation, learning and flexibility are the three key elements required to define the relationship between beneficiaries and management. Therefore, and to sum up, MIS is needed since it does not only collect in a systematic way all the information produced, but also facilitates even spatial analysis, especially needed to improve sanitation programme's performance.

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# HIWATE – Health Impacts of Long-term Exposure to Disinfection by Products in Drinking Water

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HIWATE is a 4 year European Commission part-funded collaborative project under the Framework Programme 6, started in 2006 and to be finalised in 2010. The consortium comprising 16 partner organisations across Europe with the overall aim to investigate potential human health risks associated with long-term exposure to low levels of disinfectants (such as chlorine, ozone, and other compounds) and disinfectant by-products (DBPs) occurring in water for human consumption and used in the food industry. The study will comprise risk/benefit analyses including quantitative assessments of risk associated with microbial contamination of drinking water versus chemical risk and will compare alternative treatment options and best practice in minimising the amount of DBPs. The outcome will be improved risk assessment and management. The study will make use of existing studies/databases and newly collected information. The main objectives of the project are:

- to determine the DBP composition and levels in drinking water in various regions in Europe; to identify the determinants of DBPs and develop predictive models;
- to assess the risk for gestational age, premature birth, semen quality, stillbirth and congenital anomalies in relation to disinfection practices and levels of DBPs, including any gene-environment interactions where possible
- the assessment of the risk of cancer, particularly bladder cancer and colon cancer, in relation to DBP levels, including any gene-environment interactions
- running several case studies across Europe, to conduct risk/benefit analyses including quantitative assessments of risk associated with microbial contamination of drinking water versus chemical risk, compare alternative treatment options, and produce burden of disease estimates (e.g. DALYs)
- to review the water and health policies, current disinfection practices and best practice in Europe, USA and worldwide in relation to water disinfection.

# The Right to a Healthy Household and Environment, Foundations for Restoration of the Population in a Displacement Situation

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Keywords: Displacement, Acute Diarrheic Disease, Family Sanitary Module, Healthy Households, Hygiene and health habits

Displaced populations in Colombia usually settle down in marginal areas located in the outskirts of towns and cities, where they find sanitary and public utilities' problems, due to the increase of the number of residents with displaced people. This situation is becoming every time more critical. Households affected by displacement are under more precarious conditions, with practically no access to public utilities. Only 44 out of every 100 displaced people's homes have wells and water sanitation systems, with scarcely one fourth having sewage connections, and 6 out of 10 counting with garbage collection and disposal (PAHO/WHO, 2005).

At the end of the year 2004 Plan carried out an integral attention programme for displaced children in the "Brisas del Poblado" neighbourhood of the city of Quibdó, department of Chocó (Colombia), aimed at contributing to the re-establishment of child rights, from a psychosocial and differential attention approach. This programme included an intervention line to improve living conditions, reducing risk factors that favour infection and propagation of diseases that prevail during the early years.

According to the diagnosis of the "Brisas del Poblado" neighbourhood at the end of the year 2004 (Trasopaz, 2004), this neighbourhood was made up of 176 households that gave shelter to 876 people, distributed in 181 families, 42% of which corresponded to families under displacement conditions (WFP, 2004). According to the healthy household perception survey that was applied in June 2006, as far as access to water and a correct disposal of excrements is concerned, it was found that 100% of the families supplied themselves with rainwater, 54% drank non-treated water, 60% left their excrements at the ring road of streams and 24% on open fields, being this one of the main causes for the high indexes of acute diarrheic diseases in children of less than 5 years, which reached 41.9%.

Plan's and the Community's intervention in this neighbourhood incorporated the concept of healthy housing and environment promoted by PAHO/WHO, for which there was participation and support during the concept development phase and during its execution with permanent advising and accompaniment. The intervention was focused on the handling of factors or elements around households that can cause diseases, and consisted of ensuring the minimum physical conditions to break the oral – faeces cycle in homes, together with an information and change promotion process in behavioural usage and habit standards related to hygiene, through the construction of a family sanitary model that included the following alternative and adequate technologies:

1. Correct disposition of excrements: Dry ecological toilet (separating bowl, chamber pot and deposit tanks for excrements and urine)
2. Water supply : Rainwater collection and storage (cover, pipe and tank)
3. Treatment for drinking water and food preparation: Ceramic candle filter
4. Correct food preparation: Sink and counter for food preparation

5. Food protection: Cupboard protected with nets to avoid mosquito infestations and dustbin with lid
6. Personal care, washing of hands and of clothes: Bathroom and wash house
7. Environmental protection: Grease and infiltration trapdoors; garbage collection and disposal
8. Adoption of correct hygiene habits: Organisation and training process with communities and families

Taking into account that this was an intervention in which some technological alternatives with which the community was not familiar were used, we started with the construction of reference units (pilot models) in 4 households in March 2006, where all the technologies described above were installed. These reference units permitted to orient the community about the intervention's convenience, its acceptance and technical conditions that had to be taken into account, community participation processes and other issues of interest to explain to the rest of the community members. The second phase was about intervention of the neighbourhood's remaining 172 households in the month of August 2006 and ended in the month of April 2007. Intervention in each household was differential and negotiated with each family according to their particular conditions, in such a way that intervention on families and not on the household was the priority. Nevertheless, this phase did not consider installation of ecological dry toilets, because there were still some doubts about their operating and maintenance conditions, as well as about their acceptance in the community.

By means of this intervention a dramatic impact on the reduction of acute diarrheic diseases was achieved in children of less than 5 years of age (from 41% to 11%). This was due to the intervention's integration that considered that the incorporated technologies are the way to have the best sanitary conditions, that is, the implementation of these technologies would have no sense without the knowledge about epidemiological cycles associated with ill-practice of hygiene and health habits.

Acknowledgement, action and training activities to build knowledge and strengthen healthy attitudes were supported by environmental recognition, the role of critical actors that transform reality, team work, participants' experience, individual participation from each one of them, exchange of experiences and knowledge, and recognition of others as featuring actors of their environmental and quality of life improvement.

# The Effects of Water and Sanitation Interventions in Laini Saba Village of Kibera Informal Settlement: A Case-Control Study in Kibera, Nairobi

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Keywords: Informal Settlement, Water, Sanitation, Hygiene, Kibera

## Introduction

Kibera is one of the largest slums in Africa and is afflicted by problems related to poor sanitation, lack of safe and adequate water and poor hygiene. In an effort to alleviate these problems AMREF in partnership with the community led by their local organisation by the name MRAMMA, initiated a community based health care programme to address these problems. AMREF facilitated the community to develop, operate and maintain water supply and sanitation facilities as well as promote safe hygiene practises. At the time of the study, 45 water tanks had been installed and 259 household and 3 communal latrines had been constructed. The project also trained 150 Trainers of Trainers (ToTs) in sanitation and hygiene. These ToTs thereafter trained the rest of the community. the community was also trained how to operate, maintain and manage water sources, as well as proper management of solid and liquid wastes, improving ventilation and lighting and disease vectors and vermins control.

## Purpose

To evaluate the effects of water, sanitation and hygiene interventions on community health among the informal Kibera inhabitants.

## Objectives

To measure the effects of water, sanitation and hygiene interventions on related diseases, assess the level of project sustainability and identify best practices that could be replicated in future and areas of weaknesses for improvements.

## Methodology

A case control study design was adopted where a comparison was drawn between Laini Saba village (intervention group) and another similar village (Lindi, the control group) all in Kibera. The households to be included in the sample were identified through systematic sampling by skipping three houses and then picking on the fourth. 517 and 534 respondents were interviewed in Laini Saba (Intervention) and Lindi (control) respectively. Data collection was done using focused group discussions, key informants, questionnaires, literature review and review of health centre records and observations. Coding, entry and analysis were done using a computer programme, statistical package for social sciences (SPSS).

## Results

Analysis of demographic information and information on housing revealed no marked differences between the two communities. There was no significant difference in the age, sex, marital status and

educational level of the respondents. Similarly, the size of the households and the occupancy was almost the same for both villages.

On prevalence of related diseases, there was a significant reduction in water, sanitation and hygiene related diseases in Laini Saba as opposed to Lindi. The proportion of people who had suffered from water and sanitation related diseases 2 weeks prior to the study was higher in Lindi than Laini Saba.

Access to water facilities in Laini Saba village had actually increased due to the project interventions. Water was more affordable in Laini Saba and the residents were using more water per person per day.

Access to sanitation facilities had increased in Laini Saba compared to Lindi and more people used flying toilets(offensive flinging of faecal matter onto neighbouring roofs) in Lindi compared to Laini Saba.

Knowledge and practice on personal hygiene (hand washing) and food hygiene was higher in Laini Saba than in Lindi .Sanitation coverage was also found to be higher in Laini Saba than in Lindi. There were more and well maintained drains and improved collection and disposal of refuse in Laini Saba as compared to Lindi.

### **Conclusion**

Though both Laini Saba and Lindi fall short of the WHO standards of accessibility, access to safe and adequate water and improved sanitation and hygiene have increased in Laini Saba therefore it can be concluded that Laini Saba people greatly benefited from this project. This demonstrates water, sanitation and hygiene interventions have tremendous health benefits in informal settlements /slums despite all the odds faced by the inhabitants.

### **Recommendation**

There are numerous health and socio-ecomic benefits from water sanitation and hygiene interventions and these can turn around the desperate and hopeless situations that afflict poor people in informal settlements/slums. we recommend a combined water, sanitation and hygiene model for improving health and livelihoods in the informal settlements.

# Sustainability Evaluation of Water, Sanitation and Hygiene Interventions in Central America

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Keywords: sustainability, water, sanitation, hygiene, evaluation

The American Red Cross (ARC) and Centers for Disease Control and Prevention (CDC) collaborated on a sustainability evaluation in communities that received ARC interventions in response to Hurricane Mitch in 1998. The sustainability evaluation of these interventions used indicators to measure continued effectiveness and performance of the interventions. This sustainability evaluation was conducted in 2006, four years after a 3-year survey was completed in 2002.

The goal of this evaluation was to determine the sustainability of the water and sanitation interventions implemented by ARC in Central America post-hurricane. Local community services had been disrupted as a result of the hurricane. A 3-year survey of the health improvements was completed by CDC in February of 2000, 2001, and 2002. This health survey also included an infrastructure evaluation that served as a baseline for this work. The 3-year survey was done in eight communities in four countries—El Salvador, Guatemala, Honduras and Nicaragua. Improvements in health were measured using indicators. This sustainability evaluation was conducted in six of eight communities that received ARC interventions and were part of the initial health survey.

The sustainability evaluation was composed of four components: a household-level interview, a community-level interview, water sampling and analysis from homes and community systems and an infrastructure evaluation. The household interview included a questionnaire that obtained data that focused on three interventions – water, sanitation, and hygiene education. Data collected evaluated hand washing behaviors, the condition of latrines, and the presence or absence of coliforms in household drinking water samples. The community-level and infrastructure questionnaires were the same as those used in the previous 3-year survey and evaluated the management of the water system and physical structure of the system.

In general, the ARC post-Mitch water and sanitation projects were sustainable after 4 years on a regional basis. However, this general result masks some important differences in results for different program elements as well as important differences among individual communities. Physical infrastructure interventions were generally more sustainable than hygiene behavior interventions, although some communities were also experiencing large scale problems with their physical infrastructure.

Overall, communities in which there was an active water committee with long-standing members had better functioning and maintained water systems. The systems that were generally well operated and managed in 2002 continued to be well operated and functioning at the same level in 2006.

Based on the results from the sustainability evaluation, CDC identified areas that needed additional attention to further enhance their success and ultimately sustainability. Improvements in these areas would enhance the cost-effectiveness of this program and would also be applicable to future water and sanitation projects in disaster response. Improvements in these areas would also be applicable to



development situations and can help to ensure a sustainable water, sanitation, and hygiene program. These issues can be considered when implementing future water and sanitation projects in disaster response and development situations.

### **Local Demographic Trends**

- Ensure that site selection and project designs effectively take into account local demographic trends (both population increases and declines) and employment opportunities.

### **Water source – water system**

- Ensure that adequate attention is given to ensuring that water fees are set at a level that will allow sustainable operation of infrastructure
- Project design that considers the possible consequences of severe storm events, such as hurricanes or even the typical annually rainy season to avoid washouts from high flows in rivers or streams
- Evaluation of water source capacity to ensure that communities themselves and interventions are sustainable, ie. proper source selection and location. Although chlorine disinfection of water supplies is an excellent public health intervention, it should not obviate the selection of a good quality, well protected water source, especially in areas where chlorine supplies are not readily available
- Ensure adequate attention is given to forming, training, and providing ongoing support to local administrative structures (like water committees) to operate water infrastructure.

### **Sanitation facilities**

- Ensure adequate attention to provide ongoing support to local administrative structure (water committee) to ensure the proper ongoing use of sanitation facilities, such as in the case of composting latrine projects.

### **Follow-up support**

- All of the communities would benefit greatly from follow-up from authorities or organizations with water and sanitation skills for problem solving. In addition, all communities, in particular the more isolated ones would benefit from knowing where and how to seek support (financial, materials, technical assistance) for maintaining systems.

### **Additional indicator development**

- Develop more focused and effective indicators for water/sanitation/hygiene education programs. For example, this sustainability evaluation suggested that continuity of water service may be an important indicator that was not included, whereas per capita water use did not turn out to be a useful indicator. The World Health Organization's (WHO) qualitative service factors (quality, quantity, continuity, coverage, and cost) may be helpful in developing better indicators (WHO, 1997).

# Environmental Impact Assessment of Covering Agricultural Drains in Egypt

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Keywords: Environmental Impact Assessment, Human Health, Covering Drains, Contamination Risk, Social Survey

The demand for water in agriculture, industry, and municipal uses has been increasing in Egypt due to population growth and increases in aggregate income. The agricultural sector is the largest consumer of water in Egypt. It is exceeding 85% of the total gross demand for water. The total agricultural land is about 3.36 million hectares that is almost entirely depended on irrigation. However, the increasing demands for food production require more attention for reclamation and cultivation of more agricultural areas. Consequently, the irrigation water consumption increased from an estimated of 30 BCM/year in 1980 to about 63 BCM/year in 2000 (Allam, 2004). This increase has been possible by increasing in drainage water reuse and groundwater abstraction, consequently, a decrease in the fresh water outflow to the sea. Therefore, the Egyptian government has undertaken large scale projects to reuse drainage water (UNDP, 2002).

In Egypt, the agricultural open drains network cross numerous villages and towns where they are subjected to excessive misuse. Solid wastes and waste water are disposed into these open drains that lead to add pollution load to drainage water and restrict Egypt's strategy of reuse drainage water. Therefore the Egyptian government started a national project of covering agricultural drains which cross villages and towns to protect them from pollution. Covering can assist provide protection but also introduces new problems. However, it is important to assess the risk of this alternative and its impact on the environment and the health of people to measure its feasibility. Therefore, the main objective of this study is to assess the contamination risk and the environmental impact of covering agricultural drains in residential areas in Egypt. Three drains in the western delta named Al-Serafi, Shobrakhit, and Al-Amreya were selected to be surveyed and monitored for this study. Eight water quality monitoring parameters were measured along one year based on monthly measurements to assess the contamination risk of the covering drains. This program was including in-situ measurements and water samples collection to be analyzed at the laboratory. The effect of covering drains on water table depth besides the drains in residential area was also measured through boreholes that were drilled in the side of the drains. Moreover, the impact of covering agricultural drains on residents' habits, habitat and health was measured through a social survey.

It could be concluded that the covering of drains in residential areas does not solve the problem completely. This could be attributed to the fact that the existing covering does not solve the problem of solid and liquid wastes but simply transfers it to either upstream, downstream or both. The data prevailed that the water characteristics changed and deteriorated through the covered distance because covering converts the condition of wastes through the covered distance from aerobic to anaerobic. This causes emission of toxic gases like H<sub>2</sub>S and CH<sub>4</sub> that cause serious problems. Moreover, covering the drains prevent seepage of subsoil water into the drain that causes water logging problems and affect

surrounding lands and buildings foundations due to the high hydrogen sulphide content of human wastewater. The social survey prevailed that covering drains affecting positively 36% and negatively 64%. This is attributed to the absence of a planned management system, the lack of experience in maintenance with this type of work and the difficulty of maintenance that leads to blockages and increase the problem with odours, flies and mosquitoes. However, it does not mean that the drains should not be covered as well but it could be recommended to resolve the causes of pollution and improve the solid and liquid waste management in the area. Sewage should be treated before being discharged into the drains and ventilation should be increased in the covered part to improve the water quality. Planned maintenance schedules should be prepared and cleaning equipment is required in order to maintain the drains properly.

# Health Risk Assessment in Case of Negative Environmental Factors Action

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Keywords: risk assessment, drinking water quality, human health, contamination of environmental, sanitary norms

Ecological risk assessment (i.e. health risk, caused by pollution and negative environmental action) – is the main deal of health services at the present time.

According to WHO statistics, 2000 of 10000 human diseases are of technological origin, 80% from which are caused by low-quality water consumption.

As numerous researches show, exceeding of permissible concentrations of arsenic in water system causes different skin diseases and increases cancer risk. High cadmium concentration in the water causes kidney diseases. Barium presence in the water leads to increasing blood pressure. Selenium is the cause for hair and fingers' loss. Connection between blood, neural system, kidney and other diseases generation and certain organic compounds' (benzol, benzopyren, dioxin, endotal, etc) presence in the water has been determined.

Toxic action of dioxins and heavy metals in human body may be revealed only in next generations, because toxicants have long half-life (from several months in water medium to decades of years in soils). Herbicides and pesticides also exhibit high level of danger to human health, as they have been detected in many ground water samples. And it is known, that it is ground water, which is used as fresh water source in some countries. Today Minsk citizens get 2/3 of water from underground sources and the rest – from surface ones. There are 16 artesian and one surface water wells in the capital. Nearly 570 thousands of Minsk citizens consume water from surface source of Vileyka-Minsk water system.

In large industrial cities the concentration of nitrates and nitrites is of such level, that water in the most water wells is given 5th-6th quality category. According to the ecological gradation's classification, mentioned above categories are determined as dirty and very dirty water.

Local authorities declare that drinking water in Minsk meets all necessary sanitary norms and its drinking quality surpasses that of in Moscow, St. Petersburg, Kiev and other European megalopolises. But this could be hardly believed, because sometimes tap water has a very bad smell and color. Findings of Belarusian scientists show, that number of illnesses, caused by disappointing environment quality, especially by low-quality drinking water, increases in Belarus from year to year.

In order to reveal early ecologically conditioned diseases a problem of human's health risk assessment in case of unavoidable influence of toxic substances, independently of their concentration and medium type, appears.

In researching, different factors of environment that were causing or were able to cause at certain circumstances negative influence on human health were determined as follows: radiation pollution,

air pollution by chemical carcinogens, soil pollution, noise and so on. A separate factor, which is one of the main factors – is low-quality drinking water. Water quality determination was made according to sanitary norms, accepted in Belarus. In this case priority index of medium equals to 2.

The method used supposes consideration the results of water system sampling tests of organoleptic, chemical, toxicological and microbiological indicators. Estimation of water pollution is made considering all of these indicators.

All measured or calculated indicators of environment pollution, exhibiting negative action on human and environment, have been integrated into unified algorithm for computing complex indicator of ecological risk. On the basis of developed algorithm the authors have made a PC application, that can calculate integral indicator of ecological risk, conditioned by influence of several negative environmental factors of different origin, and gives information about object's safety state. While developing this application the authors used different methods, sanitary rules and norms, papers, officially active in Belarus at the present moment.

Minsk City population is app. 2 million people, that is 1/5 of the Belarus population. Only 10 % of it can afford consumption of filtered water. And only 5 % can afford buying bottled water. The rest population uses tap water. And this with necessity leads to increase in number of ecologically dependent illnesses.

At the present moment there is big ground to introduce urgent and constructive measures on governmental level on this problem. In order to radically improve water quality as human health source, it is needed to support natural purity of water reservoirs, atmosphere and soils around the territories of water wells, ban sewage water dumping, full of biogenic elements, improve water-preparation technologies and introduce other measures.

Only a rich country with healthy economy can cope with such problem. Unfortunately, Belarus is not one of such countries. At the present moment Belarus has many other more urgent problems, so the problem of drinking water quality improvement is a question of far future. "We are so rich in water that we don't want to hear questions about water". For today – this is an individual problem of every family and everyone.

The presented work is one step forward in the long way to the society, without sick people.

# Sanitary and Environmental Risk Management : Case of the EU Ecosan Project in Four Peripheral Sectors of Ouagadougou, Burkina Faso

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Keywords: excreta, risk management, sanitary/environmental risks, sanitization, monitoring

Since 2002, CREPA has undertaken a research programme on Ecological sanitation (ECOSAN), which covered progressively ten member countries. A number of pilot projects (20-100 toilets per site) in these countries gave opportunities adapt the ECOSAN concept, “from toilet to field”, to the local conditions. After the research phase with satisfying results, the Regional Ecosan Program engaged in a dissemination phase (scaling up). In this way, CREPA also got funding from the European Union to implement ecological sanitation in 4 peripheral sectors of Ouagadougou, the capital of Burkina Faso. The EU Ecosan project while aiming to build 1000 urine diverting dry toilets and put in place collection circuits, storage facilities and reuse of sanitized urine and faeces from the 1000 toilets, is the first large scale urban Ecosan project in West Africa. The project is strongly supported by local municipalities who begin to understand that Ecosan be a sustainable approach for excreta management.

If the technical, socio cultural and agronomic aspects are relatively well known, it is not the same with the risk management of an Ecosan system at a larger scale. A weak management somewhere along the chain (from defecation to the consumption of agricole products cultivated with sanitized urine and faeces) can lead to sanitary and environmental risks that compromise and bring doubts on the Ecosan concept. Therefore the risk management is of much significance for the success of the project. The risks were analysed at 6 stages along the Ecosan chain:

- Household level : Different types of urine diverting dry toilets (and urinals) are proposed to the households. Faeces and urine are generated at this stage. The behaviour of people in relation to the use and maintenance of the facilities is very important. What happens with visitors who use for the first time the Ecosan toilet, if they don't have enough information on the new concept and toilet?
- Collection and transport stage : Faeces and urine are collected from the households and transported with chariots. The handling of Ecosan products by collectors must be done carefully.
- Sanitization stage : in relation with municipalities, sites will be identified and some facilities will be constructed to store collected faeces and urine to ensure sanitization. What are the risk factors for the people working on these sites? How to make sure that workers at this stage respect the instructions for the necessary storage time to ensure sanitization?
- Delivery to farmers stage : how to make sure that the products delivered to farmers are well sanitized and come from the recognized sanitization sites?
- Use in agriculture stage : In what ways and conditions the Ecosan fertilisers are used on the field?

- The global level of Ecosan system management: The methodology used in the study is AMDEC (Analyse des Modes de Défaillance, leurs Effets et Criticité). This methodology fits very well to this Ecosan Project as a system with many components. The risk analysis is based on the combination of the frequency (how often) and the gravity (consequences) of identified risks. The risk-degree is then determined and the risks are classified according to the classification made by the small team who conducted the study. The results indicate that the risks are present to a different degree on all the levels on the chain, with highest risks at household level and on the level of the sites of sanitization. 80% of the risks were judged as important, this showing the relevancy of this study topic.

The suggested management plan focuses on risk control at the level of the sites of sanitization and also on the actions of information, training and sensitisation of the various actors along the chain. The adaptation of the legal framework and a good organization of the actors are also important conditions.

On the basis of this study, a working group has been set up with members from the Ecosan project, the Ministry of Environment and Ministry of Health. This working group will do a scientific monitoring of the risks at different stages and try to prevent the development of eventual parallel Ecosan circuits not controlled by the authorities.

# Alternative Methods to Eliminate Fluorine from Water

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Keywords: Fluorine in water, Cactaceae, Nopal, Savila, Water purification

The presence of Fluorine compounds in tap water is a naturally occurring fact in many countries of the world. The main source of exposure to fluoride is tap water. Fluoride exposure is an important public health problem in several Mexican states.. Fluorine in drinking or cooking water causes a wide spread illness called chronic fluorosis. Recent studies have shown that bone cancer in male children was between two and seven times greater in areas where water was fluoridated. Another study has shown that fluoridation of water is linked to uterine cancer deaths. Fluoride gradually builds up in the bones and causes adverse changes to the bone structure. Quite a few studies have shown that fluoridation leads to increases in hip fractures. The tensile strength of the hip is destroyed over time by fluoride ingestion. Fluoride compounds in water and in supplements do not provide any significant cavity-protecting effects. All of the recent large-scale studies of water fluoridation have shown that there are no positive effects. That is why countries without fluoridation have shown an equal improvement in dental health as those with fluoridation. There is scientific evidence that excessive fluoride exposure leads to increased levels of caries. Even pro-fluoridation scientists admit that there is not any properly-conducted research showing that fluoride supplements help prevent cavities. Municipal water supply for domestic and industrial purposes is provided by 23 wells distributed along the Lagos de Moreno territory. The chemical analysis of the water supplied by all these wells shows these waters fulfill the requirements of the Official Mexican Norm regarding mineral salts, organic substances and microbiological content. All except for the Fluorine content which exceeds this norm (1.5 mg/L) by SIX TIMES the upper limit. Drinking water under these conditions, especially by children, create an illness named chronic fluorosis which consists of a darkening of the teeth, besides some others such as intoxication by fixing Fluorine in liver, kidneys and bones among other human organs. It also could be affecting the IQ and reading and writing abilities in children. Several authors have concluded that children permanently exposed to fluorinated water are less intelligent than those not exposed. Although several warnings have been delivered to the local population through physicians and university specialists, people either do not seem to believe nor take notice of the problem. Many people even think that Fluorine can be eliminated form water by boiling it. It is well known that inverse osmosis is the ideal technique to eliminate Fluorine from water. However this method is too expensive to be applied in poor communities and some alternative methods have to be found. In our laboratory we are actually carrying out studies to find alternative methods to deal with this problem. These methods consist in treating fluorinated water with a mixture of some low cost chemicals with a variety of cactuses, mainly nopal (*Opuntia* spp.) and savila (*Aloe vera*). Detailed technique consisted of mixing ground nopal or savila with powdered aluminum sulfate 1:1 and then added to one litre of water samples containing several concentrations (1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 mg/L) of Sodium Fluoride and further stirring it at RT for one hour. Solids were allowed to sediment for one hour. Water samples were centrifuged at 1,500 RPM and then analysed by IR spectroscopy. All water samples treated showed a dramatic decrease in the content of Fluorine. The results obtained so far have proven the described method to be quite promising in fulfilling the main purpose of this study. The facts presented in this paper will become an advance in the knowledge of the subject since a novel method based upon naturally occurring products to solve the fluorinated water is being used for the first time. It is considered to be a practical and reproducible method by the fact that this cac-



tacea are readily available in the region where fluorinated water is present. The present study has not been finished yet, there are still a number of questions to be answered. A research group including postgraduate students is currently working on it.

# The Hy2U Story

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Keywords: Appropriate Technology, Technology within Poverty, Design Space, Open Source cooperation, Rapidly Applicable

## The need and the reality

(2 pictures: dirty water buckets for school kids hand washing in Ghana, how water is fached from a mud pool)

In Ghana, washing your hands is traditionally a highly valued custom. Kids at school are taught to do so. But there is scarcity of water, that has often to be hauled from far.

In this school, located on an island in the Volta region, only these two bucket with dirty water were available for the class. Sadly a good custom and proper teaching so becomes a way of transportation of bacteria that can cause diarrhea and other intestinal illnesses.

## The innovation and the research

(picture of the first innovative hand washing device) This is a picture of the first prototype for a device for hand washing. A green plastic 20 liter jar was used with the top cut off. In the bottom a hole was punctured, closed by a valve. This valve you just had to push up a bit from under the jar for a little water to stream out onto your hands. Ideal for washing your hands!

(Picture of student with experiments) Two students, Julia and Lisa knew the problem of washing hands and wanted to take the idea to Ghana, that they planned to visit summer 2007. I jumped on the opportunity to get the hand washing device field tested. We started to remove obstacles of cost and complexity of the design, so the girls could easily introduce it. I made a big strong bag from thick plastic sheet material. Transparent, it looked nice!

(Picture of first working prototype based on plastic bag lining) Then Lisa remembered from her year long stay in Ghana the so called “rubber bags”. Such bags were handed out by vendors at the market, soup was also sold in it, showing such bags could hold water without leaking.

I asked the girls to sew a cloth bag same size as the plastic bag as to give it support and protect the plastic against punctures. At the bottom of the cloth bag I fitted a wooden board with the self-closing valve.

## So the Hy2U was born

At that time Julia packed the latest prototype of the Hy2U and traveled to Ghana. She was about to make a big success of her trip!

## Ghana people discover how it works

(Picture showing local people finding out how it works) At arrival she organized that the practical value of Hy2U was tested at the local primary school. Indeed, there was plenty interest, so she showed to people how the trick was done with the self-closing water valve.

## First use in Ghana

(Picture showing how school girls have fun using the Hy2U) Now the school that only had the two buckets of dirty water available for washing hand of its pupils had an alternative. It uses very little water. 100 to 150 kids can wash their hands with a Hy2U bag filled with 5 liters of water. Boys and girls started using it. Though the Hy2U is unlike anything they knew, specially these kids liked it.

## Made in Ghana!

(Picture of young man making the wooden parts for the Hy2U) Julia then invited people to start to make more Hy2U's as there was plenty opportunity for further use.

(Picture of woman making the cloth bag with her hand driven sewing machine) To produce the cloth bag was also done with an easy smile. Nicer looking cloth was used and indeed, people decided to make a bigger size bag, to contain more water.

(Picture of many hands cooperating in assembling of the Hy2U) The fun of cooperation came in welcome when the rather complicated attaching had to be done of the rubber bag to the wooden base with its valve seat. Effectively cooperating hands did the job.

(Picture of women's first use of a locally made Hy2U) The Hy2U with the bigger bag was demonstrated to the public. This lady is clearly aware of the missing spill water basin and something to collect the drip.

Well, Julia is in good contact with these people and we will show them how to make the Hy2U complete to solve this problem.

(Picture of clean child's hands) What counts is that these little hands are now safe hands. Safe for handling food, Save guarded against common diseases to a far larger degree then when easy hand washing was still a problem.

## The fun and the future

(Picture of kids playing music with the construction parts of the Hy2U) As we are in Ghana, and as kids love music and drumming a second use for the valves was soon discovered.

(Picture of Hy2U cloth bag made of nice looking textile) Now I regard it as Demotech's task to make sure the Hy2U becomes really beautiful. The two to three billion people, -about half the world's population- that miss piped water in their homes, deserves a beautiful looking compensation. We will ask users to apply locally woven fabrics, We will propagate the Hy2U to be decorated like so many other objects made looking real nice.

The number of hands that need proper care is huge, is a billion hands a good guess? The World Health Organization seems to think so. Study these links to get convinced:

- [http://www.who.int/patientsafety/events/05/HH\\_en.pdf](http://www.who.int/patientsafety/events/05/HH_en.pdf)
- [http://jama.ama-assn.org/cgi/content/full/291/21/maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&fulltext=hand+wash&searchid=1131644678151\\_4294&stored\\_search=&FIRSTINDEX=0&journalcode=jama](http://jama.ama-assn.org/cgi/content/full/291/21/maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&fulltext=hand+wash&searchid=1131644678151_4294&stored_search=&FIRSTINDEX=0&journalcode=jama)
- [http://www.sciolsp.org/scielo.php?pid=S0042-96862004000800015&script=sci\\_arttext](http://www.sciolsp.org/scielo.php?pid=S0042-96862004000800015&script=sci_arttext)

### **Citing this study**

According to WHO, 1.8 million children die every year from diarrhoeal diseases and 90% of those are aged less than five years, mainly in developing countries. The study's findings suggest that half of those lives could be saved.

So Demotech is in good company when I want Demotech to campaign the promotion of hand washing. Reason to launch as soon as possible the Hy2U-campaign.

# Safe Water at Source and Consumption – A Study from Sub-Saharan Africa

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Keywords: safety, water, source, consumption, africa

In line with the United Nations Millennium Development Goals, drinking water coverage is increasing in Africa ([www.unicef.org](http://www.unicef.org)). Assumptions on water safety are, in public documents most often defined as access to improved water, or water that has undergone any way of treatment. However, the measured treatments are not always sufficient to remove all hazardous components from water (Sobsey, 2002). Besides, access to technically acceptable water sources does not necessarily protect consumers from water borne diseases, as contamination may occur during transport, storage and handling, as concluded in several investigations (Cronin et. al. 2008, Lindskog & Lindskog 1988, Roberts et. al., 2001, Sobsey, 2002).

The disease transmitting agents in water comprise generally viruses, bacteria and protozoa. Tropical temperatures favor all these organisms, and protozoa can extend their survival time by encystations (Dawson, 2005). The organisms typically cause infections by leaving the host in the fecal material, contaminate the water supply, and then enter a new recipient. Serious diseases, comprising Cholera, Typhoid fever, Bacillary Dysenteries, Infectious Hepatitis, Leptospirosis, Yellow Fever, Paratyphoid Fever, Giardiasis and Cryptosporidiosis are known to be spread through the fecal-oral route, in which drinking water may play a major role. (Ashbolt, 2004; Nimri, 2003). Many of these diseases are regarded as mortal to humans, and when transmitted to people with low deficient immune systems, the transmitted diseases can become epidemic. Thus, people in developing countries are especially vulnerable, and most of deaths from diarrhea originated from water occur in developing countries and among children under five.

Estimates of microbiological loads in general, along with fecal indicators like thermotolerant coliforms (TC) and *E.coli* (EC), are recognized as parameters for water quality ([www.who.int](http://www.who.int)). Presence of TC and EC are indicators of fresh fecal contamination from humans and/or warm-blooded animals and should not be detected in 100 ml of water meant for consumption.

The present study aimed primarily to investigate the quality of water sources and further if, and to which extent, potable water quality may decline from source to point-of-use in tropical environments. If contamination post collection was proved, the subsequent aim was to explore the main sources of contamination. The study was conducted in two selected areas in sub-Saharan Africa: peri-urban and rural households surrounding Blantyre, Malawi (Laugen, 2006) and rural villages in Mvomero district in Morogoro, Tanzania (Johnsen, 2007).

In both areas samples of drinking water from source and at point-of-use were collected from 20 small holder dairy farmers. The samples were tested in laboratories for aerobic total count (AC) incubated at 22°C and 37°C, using standards ISO 6222 and thermotolerant coliforms (TC) and *E.coli* (EC), using NS 4792 (Norwegian Standards, 1990). Information about water management and demography was collected at each household using predefined questionnaires.

In water from the source, TC/EC was detected in 75 % of the samples from Malawi and in 100 % of the samples from Tanzania. Thus, the water was far from meeting the WHO guidelines even at the collecting point, in both areas. The most important reason for the difference between the two countries was that 25 % of the households in the Malawi study had access to pretreated, piped water, while the Tanzania study comprised only unprotected wells, protected wells and wells with outdoor taps.

In both countries, significant increase of bacterial count from source to point-of-use was proved with all four parameters. At point-of-use, the TC/EC occurred in 90 % of the Malawi households and 100 %, of the Tanzania households. In Malawi, the household water quality was significantly affected by frequency of water collection, whether separate containers were used for collecting and storing and also by the education level of the head of the household. None of these effects could be detected in the Tanzania study. However, the results indicate many interesting tendencies which are discussed in the paper.

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# Gravity-Feed Household Water Purification Devices Based on Novel, Halogen-Charged Polystyrene Polymer Disinfecting Media

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Keywords: Disinfection, Potable, Household, Storage, Halogens

Hydantoinylated cross-linked polystyrene can be halogenated with either chlorine (Cl) or bromine (Br) so as to create a biocidal polymer medium that functions largely through contact-mediated effects on microbial organisms, both bacterial and viral, in challenge suspensions in water. Halogenated medium (designated HaloPure) in the form of solid spherical beads, was incorporated into disinfecting cartridges in gravity-feed purifier devices in India, aimed at household point-of-use (POU) water treatment, and employing Br as the charging halogen. Cartridges in these devices have finite life spans, usually in the range of 2000-3000 L of 3 Log reduction of *E.coli*, depending on size, and they require periodic replacement. Household studies on efficacy and consumer acceptance (use pattern compliance, sensory evaluation of product water) showed a high level of satisfaction, and there has been rapid uptake in the marketplace (> 100,000 households within months of market offering). In another configuration, devices were evaluated by third party laboratories for compliance with the US EPA Purifier Guide Standards, and passed satisfactorily. In yet other configurations, we have been able to show that the disinfecting medium can be simply and reliably recharged by the consumer by the regular addition of a slow-release formulation of Br, permitting repopulation of halogen binding sites as they become available during the disinfection process. The Br is displayed at these sites in its oxidative (Br<sup>+</sup>) form. This modification offers convenience and an opportunity for ongoing operating cost reductions to the consumer, extending the useful life of the device, potentially for years, depending on the other complementary prefilter components of the end-user product. Bromine-charged medium (HaloPure Br) proved more effective and longer lasting than HaloPure Cl, and the safety profile of HP Br devices was shown to be compatible with all international standards for disinfection byproducts and all other bromine species in the product water. By appropriate manipulation of the polymer chemistry, HaloPure Br beads can be prepared to deliver a Br<sup>+</sup> residual in the product water flow (generally in the 0.1 -0.3 ppm range) which is highly effective in protecting the safety of stored water for 24 hours after collection. Continuing testing of the rechargeable devices has demonstrated consistent biocidal action against challenge suspensions of *Klebsiella terrigena* bacteria (6 log reductions) and polio and rota viruses (4 log reductions), when sustaining Br tablets were introduced on a weekly basis. These tests were conducted with simulated worst case water as the source. When using a parasite-removing prefilter in these devices, 3 log reductions of parasite cysts was accomplished consistently through the test period. Devices based on the disinfecting efficacy of this novel polymer medium can be configured to comply with a variety of regulatory standards, in different jurisdictions, where US EPA standards may be inappropriate, and canisters, pitchers and squeeze-bottle end-products have all been developed to date for potential consumer use. Scale up to larger volumes of water treatment, suitable for multiple households is feasible, and may be usefully applied at the point of issue from faucets receiving water from roof-top tank storage systems. These innovative approaches to low-cost, user-friendly POU treatment of water hold promise for the wide scale introduction of means to generate and store safe water, and may permit eventual adoption by consumers most in need, in the lower segments of the developing world socioeconomic pyramids. Sustainability, in the form of a convenient recharge consumable product, could enable such POU devices to provide safe water at a cost per liter that

approaches those of centralized municipal systems in the developed world. The impact on human health of regular use of HaloPure powered POU devices for prevention of waterborne diseases will be measured in field tests in a variety of geographic regions in future studies.



## Workshop 5: Cost-effectiveness in Pollution Abatement

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# Towards Sustainable Financing in Water Supply and Sanitation – Lessons Learned from Georgia

Author: **Dr. Ashot Baghdasaryan** et al.  
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Keywords: financing strategy, sustainable financing, cost-effectiveness, policy dialogue, MDGs

Today, financing strategies in water supply and sanitation (WSS) are on top of the political agenda in low and middle income countries in Africa, Asia and Europe when it comes to environmental policy making. Since the late 90's more than 25 financing strategies in WSS have been developed and implemented – some at the national level, others at the regional level – and more are to come.

This paper provides in-depth information about the recently developed financing strategy for urban and rural WSS in Georgia, highlighting the most difficult challenges the Government of Georgia are faced with in order to cover operation and management costs and also selected investment costs. Furthermore, it discusses the relevance of lessons learned in Georgia for low income countries in Africa and Asia.

The target group consists of decision makers, researchers and others involved in – or simply interested in – the improvement of the WSS sector in low and middle income countries in Africa, Asia and Europe.

The organisation of the paper is fairly simple. Part 1 provides a definition of a financing strategy in the WSS. In this connection its rationale, objectives and possible use are briefly dealt with. Part 2 deals with the financing strategy for urban and rural WSS in Georgia. Part 3 discusses the relevance of lessons learned in Georgia for low income countries in Africa and Asia, taking a selected country as example.

## Part 1: Definition

What is meant by a financing strategy in the WSS? A possible definition reads as follows:

A time-bound plan for sustainable financing of capital investments and O&M costs in the WSS adopted by a national, regional or local government and embraced by major stakeholders involved in WSS management and operation in the country, region or municipality in question with a view to achieving a set of targets that are SMART and closely linked with the water related MDGs.

“Sustainable financing” implies that expenditures (investment expenditure and operation and maintenance expenditure) are balanced with revenues (from public budgets, user charges and loans/grants from domestic and international sources).

The rationale of a financing strategy in the WSS is twofold: First, there is a need to introduce realism in financial planning regarding the WSS. Second, there is a need to take into account affordability issues – both for households and for public budgets. Consequently, its objectives may be stated as follows:

- To structure a policy dialogue involving all relevant stakeholders about the realistic WSS development targets and how to achieve them.
- To provide a missing link between sector policies and programs and feasibility studies.

- To pave the way for external financing by providing solid and transparent data on financing requirements.

It is widely agreed that financing strategies in the WSS can be used, among others:

- To assess total investment needs of alternative policy targets.
- To bring about practical implementation programmes taking into considerations what the economy and households can afford.
- To identify investment projects and build short- to medium-term project pipelines.
- To identify the policies and measures which are necessary to ensure effective financing of the project pipelines.
- To support claims of environment and other ministries responsible for municipal services on the public budget.
- To support country requests for donor and IFI financing.
- To improve accountability.

## **Part 2: Financing strategy for urban and rural WSS in Georgia**

In 2006, the Government of Georgia in agreement with the OECD/EAP Task Force decided to update its financing strategy for urban WSS in Georgia to include rural WSS.

A baseline scenario based upon a business-as-usual approach was prepared. It covers the planning period 2005-2025 with 2005 as the baseline year. The total estimated expenditure for the planning period is GEL 4.4 billion, an average annual cost of GEL 220 million or an average of GEL 51 per capita per year (EUR 23.3 per capita per year). This estimation was made with the help of FEASIBLE. Urban WSS accounts for GEL 3.985 billion, whereas rural WSS accounts for GEL 426 million. However, the accumulated supply of finance for urban WSS amounts to GEL 1.7 billion, implying a financing gap for urban WSS of GEL 2.285 billion – and the accumulated supply of finance for rural WSS amounts to GEL 305 million, implying a financing gap for rural WSS of GEL 121 million. That is, total financing gap in the planning period amounts to GEL 2.406 billion (EUR 1.099 billion).

How to close this financing gap? This has been the key question in the policy dialogue connected with the development of the financing strategy. Simulations have been carried out with the help of FEASIBLE to access the impacts on the financing gap of changes in various so-called policy variables.

Increasing the collection rate of billed charges for WSS services and also the WSS service payments up to an affordable level reduces the financing gap. But it will not close the financing gap. That is, additional funding will need to come from budget sources of all levels if the sector is to cover at least its operating and maintenance cost. Among others, a doubling of public budget funding for capital investments, specially designed cost reduction programmes and lowering of service levels in certain areas (for instance, from house connections to public standpipes) have been considered.

The paper will provide much further information taking into account final decision made by the Government of Georgia in Q2 2008. The financing strategy in question is currently under development.

## **Part 3: Relevance for developing countries**

This part will be developed in Q2 2008 – on the basis of Part 2 and also findings in an African country.

# Utilization of Renewable River Energies for Cost Effective Pollution Abatement

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Keywords: Hydraulic gradient, Coefficient of Permeability, Concave and Convex side, Dilution Factor, Separation Zone

Growing pollutant load, deterioration of down stream ecological balance and hue and cry of the people residing on the river bank for drinking water can be abated, universally, at minimum cost on sustainable basis by utilizing the renewable river energies. The problem of constantly reducing dilution factor, unscientifically selecting the outfall site, not assessing the spectrum range in stream-line convergence and divergence and not evaluating the critical range of dispersion of pollutants have been over looked till date. The undesigned quantum of pollutants is discharged. This creates large separation zone at the junction point between the drain and the river and pollutant spreads to a large distance down stream affecting the water users. This is of great concern today. Further, the meagre capacity of the treatment plant, insufficient power supply, discharge of partially treated and raw sewage in the down-stream has created great ecological imbalances between sanitation and drinking water. This problem becomes extremely severe at low stage of river (from February/March to June/July). Further, the water extracted for drinking purposes in the city is not sufficiently treated. This is causing the spreading of water born diseases. Thus, the upstream and down-stream problem both exist together in all cities of India situated on river banks. On the other hand a part of the partially treated effluent is supplied for agricultural field. The chemical constituents of it is neither matching with the soil nor with the plants which are grown. This imbalance is causing another set of problem in the form of soil sickness, ground water pollution, diminishing yield and poor quality food grain. Thus, integrally the loss is enormous in terms of money which has been invested and the health problem. This situation can be reduced by understanding discharge-velocity-water quality relationship of river with space and time. Further, three dimensional morphological character of river is to be understood. This knowledge sets the concept of hydraulic gradient capable to work as the effluent transporting agent from concave bank (city bank) side to the trickling filter to be installed on the convex bank flood-plain side. Normally there exists stable huge sand bed. This occurs in upstream, down stream and in front of the cities. The treated effluent from trickling filter will roll down in the sand bed and finally in the river. Under this process filtration, sedimentation, gravity transportation, percolation, aeration, absorption, adsorption, dilution, diffusion, dispersion and digestion will take place. Thus, the difference in coefficient of permeability in between the sand bed of the convex side and that of the soil of the concave side provides an additional energy responsible for the removal of organic matter as well as microbiological pollutants in better way (as compared to the abatement work on concave side). The system will work through out the year except the flood period in which pollution abatement is not required due to high dilution factor. Further, the preponderance of kinetic energy, specially, in the form of strength of secondary cell is more active for quick disposal of the pollutants in the lateral direction over a section. This is that form of energy which is responsible for accumulation of pollutants along the concave bank, city side. The entire play of energy is made sustainable due to turbulent energy responsible for renovation of sand-bed.

Over and above these energies, the solar energy can be utilized to intensify the process of trickling filter and that of the sand bed. It seems that the solar energy is proportionally increasing with the increase

in problem of sanitation. Thus, the sand-bed is more energized at the critical stage of river. Out of these various energies at least a few of them, are always found at every place with all river systems. Hence, it is universally applicable. The application of energy concept for pollution abatement works in the form of utilization of nutrient values of the treated and purified effluent by the aquatic lives and plants, the real stakeholders of sanitation, increase in river discharge, and utilization of waste land for the cultivation of water melon and cucurbits etc..

In the present paper, upstream and downstream status of the Ganga at Varanasi; functioning and impacts of the treatment plants; effects and application of treated effluent for irrigation; the data and application technology of various forms of energies and the design of pollution abatement system for 1.5 million people have been presented. The existing level difference (10m), difference in coefficient of permeability (10<sup>-6</sup> to 10<sup>-3</sup> cm/sec) and the velocity difference (0.6 to 1.2 cm/sec) in between the city and the sand bed sides have been used for designing the system. As the area of land required on the convex side is much less and having no cost (as it is waste land), the system requires nominal non recurring and recurring cost and the power supply cost is almost negligible therefore, the total cost in proposed better system of pollution abatement is much less as compared to the present insufficient pollution management system.

It is concluded that (1) the Nature has designed and energized the convex bank with pollution managing potential thousands of time more than that of the city bank (concave bank side). (2) Application of various forms of energies reduces the cost of the pollution abatement system much less on sustainable basis. (3) The system is applicable for all rivers through out the world.

# Exploiting Abatement Cost Differentials in a Tradable Discharge Program for Nutrient Loads to the Baltic Sea

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Keywords: nonpoint source, eutrophication, water quality trading, abatement costs, nutrient loads

Nobel laureate Ronald Coase (1960) suggests that what is important when dealing with environmental damages is to focus on not only on one individual source of the effect but on the total effect itself. What we would like to find for the sake of economic effectiveness is the lowest cost method to reduce the total damage, the tradeoff between the gain from reducing the harm and the cost of the reduction.

Mobilization and transport of nutrients from terrestrial systems to rivers, lakes and marine environments contribute to deteriorating water quality and eutrophication. Unfortunately, controlling nutrient losses has been more difficult than anticipated (MVB, 2005). A major share of the anthropogenic phosphorus and nitrogen loads coming from the countries around the Baltic Sea originate from farmland. At its meeting in Krakow, Poland, in November 2007 the Ministers of the Environment of the Member States of HELCOM adopted an ambitious overarching action plan to drastically reduce pollution to the Baltic Sea and restore its good ecological status by 2021. Humborg et al (2007) suggest that the only significant potential to reduce the nutrient load to the Baltic Sea is the reduction of nonpoint source emissions from agricultural land. What are needed are policy alternatives that will achieve reductions from these nonpoint sources as economically effectively as possible (Gren and Scharin, 2007).

Pollution reflects social values rather than natural values. As societies we accept anthropogenic impacts on the environment up to a certain threshold, we classify emissions beyond this threshold as pollution. Often the threshold is not defined until it is exceeded or risks being exceeded. The level of emissions under the threshold is what we with current values are willing to accept for the environment as a sink for wastes. Until the threshold is determined, polluters cannot be identified because there is no definition of pollution. One of the criteria used for making this determination is the trade-off between the value of the output which produces the waste and the cost of reducing the waste, the cost of abatement. A general criterion for cost efficiency is that it is not possible to find another alternative to achieve the same effect at a lower cost. In terms of achieving a reduction in nutrient losses to a specific recipient this means that cost efficiency represents the lowest abatement cost for a specific level of reduction, the minimum cost of resources to achieve a targeted level of reduction.

Public intervention in pollution control through market instruments ultimately results in the redistribution of activities which generate pollution.

The permit system for nutrient loads described in this paper is designed to have a direct effect on the distribution of activities which contribute nutrient loads to the Baltic Sea. This paper describes a proposal carried out on behalf of the Swedish government for a permit system for the Baltic Sea based on the composite market model (Collentine, 2005a; 2005b; 2006) that may be applied to both nonpoint and point sources. The paper begins by describing how permit system design can increase economic efficiency without sacrificing environmental targets. A key factor for achieving economic efficiencies is the degree of differences in source abatement costs. The greater the spread in abatement

costs is the greater is the value of economic instruments designed to exploit these differences. The results from three Swedish case studies performed to study spatial differences in abatement costs are used to evaluate the potential economic gains of a tradable discharge permit system. The next section presents the three elements of a permit system design based on the composite market model; the supply of permits, the demand for permits and permit trading. The next section describes the requirements and costs for establishing a tradable permit system. Finally, the dynamics of a permit system based on the tradability of permits are presented. The paper ends with conclusions.

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# Ecological Sanitation in Buffalo City Municipality, South Africa: A Practical Case Study from the Scenery Park Pilot Project

Author: **Ms. Shirley Fergus\*** et al.  
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Keywords: ecological sanitation, urine-diversion, grey-water, housing, energy

The South African Government has determined that everyone should have access to a basic sanitation facility by 2010. Meeting this target is an enormous challenge for the Buffalo City Municipality (BCM), a local municipality in the Eastern Cape Province of South Africa. BCM is characterized by high levels of unemployment (39%) and poverty (60% of people receiving less than \$2 a day in income) and low levels of raw water availability and low access to adequate sanitation (12% with no sanitation and 15% with pit latrines) (BCM, 2006a).

To address these water and sanitation issues, the BCM Council commissioned both a State of Sanitation Report (BCM, 2006a) as well as a Sanitation Policy & Strategy (BCM, 2006b). Prior to the Sanitation Policy & Strategy, waterborne sanitation and Ventilated Improved Pit-latrines (VIPs) were considered the major options for urban & rural sanitation provision respectively in BCM. However the Sanitation Policy & Strategy identified and established the need to consider ecological sanitation with urine diversion (UD) toilets as a viable and cost effective alternative to meet BCM's growing sanitation provision demands (BCM, 2006b). An important advantage of the UD system is that it minimizes the use of water, which means that many more can be supplied without expensive expansion of waste water treatment infrastructure.

To provide practical examples and to gain local experience with ecological sanitation, BCM through funding and support from EcoSanRes, Sida and South Africa's National Department of Science & Technology, commissioned two urine diversion pilot studies. One study, in the Newlands Settlement of BCM, is providing practical experience in a rural setting while the second study in the Scenery Park settlement is piloting UD in a more densely populated urban area.

Newlands is a mixture of 10 peri-urban and rural villages whose households were supplied with Pit Latrines during the 1990's. These are now largely full or dysfunctional. The costs of emptying these ailing pit latrines is overwhelming (BCM, 2006c) and, given the extreme poverty in Newlands, would have to be absorbed largely by the municipality. The BCM rural sanitation master plan (BCM, 2006c) indicates that the low maintenance cost of UD toilets makes it a cost effective solution for the municipality. Furthermore, this system also improves the protection of ground and surface water resources (BCM, 2006c). A pilot project of 30 toilets, 3 toilets in each village, is presently being implemented to assess the social acceptability of UD in Newlands.

Scenery Park is an urban settlement, located on the periphery of East London, the major commercial and industrial centre of BCM. The Scenery Park pilot is testing how alternative sanitation in the form of UD as well as grey-water systems and various energy efficient interventions can be used to provide BCM with more sustainable urban settlements, improving human health, while greatly increasing water and energy efficiency. Six demonstration houses have thus far been built and will be used by the Scenery Park community as a model to determine whether a proposed housing project of 600 houses



in the area can go ahead using UD. This project is currently stalled due to a lack of bulk waterborne sanitation infrastructure and capacity.

The demo houses are presently using a rotational composting system for sanitization of the fecal matter while urine is used as fertilizer on a communal vegetable garden and the surplus is disposed of through a soak-away. Household organic waste is being composted along with the fecal matter thus reducing the burden on solid waste collection. Grey-water treatment is done through a mulch tower, with various filtration layers, and a resorption trench system (Whittington-jones, 2006). Each house has also been provided with a solar water heater, ceiling and improved thermal design.

Thus far the six families residing in the houses have successfully been using the toilets since July 2007. The grey-water systems and the energy efficiency technologies also seem to be functioning successfully, but have not yet been fully tested, as the families are currently getting their water from a standpipe. Piped water is to be supplied directly to the houses during March 2008 after which the sanitation (toilet, composting, urine fertilizing) and greywater systems will be fully evaluated in cooperation between the University of KwaZulu-Natal and EcoSanRes in time to have preliminary results in August 2008.

### **Conclusion**

Early indications for BCM are that the combination of a dry, urine diversion sanitation system and energy efficiency technologies are proving to be a major breakthrough in sustainable housing delivery. Utilizing these alternative technologies allows BCM to increase housing service delivery without placing strain on scarce water resources and energy systems. These systems minimize the need for capital intensive infrastructural systems.

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# Potentials of *Echinochloa Crus-Pavonis* and *Leersia Hexandra* in Constructed Wetlands for Domestic Wastewater Treatment

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Keywords: Potentials, *E. crus-pavonis*, *L. hexandra*, constructed wetlands, wastewater

## Introduction

Very few studies have been carried out in Cameroon on the Subsurface Flow (SF) wetland system. Some preliminary studies have identified and postulated some local aquatic plants growing in natural wetlands as candidates for use in the treatment of domestic wastewater (Fonkou et al., 2005). This work investigated on the potentials of *Echinochloa crus-pavonis* (Kunth.) Schult. and *Leersia hexandra* Swartz in the phytoremediation of domestic wastewaters using constructed wetland systems (Subsurface flow (SF) and Free Water Surface (FWS) wetland systems).

## Material and methods

The study was carried out in a laboratory-scale wetland treatment system constructed in the University of Dschang campus. Three beds were used to evaluate the performances of *Echinochloa crus-pavonis* (Kunth.) Schult. and *Leersia hexandra* Sw. in the treatment of domestic wastewater. These beds initially constructed following the subsurface flow (SF) system were transformed into the free water surface (FWS) system by allowing water to flow into each bed and maintaining the water level at 5-10 cm above the substrate in each bed.

100 seedlings of *L. hexandra* and 50 seedlings of *E. crus-pavonis* were harvested from their natural habitat in the area, washed and transplanted to the beds using the rhizome-bud technique. Wastewater was then allowed to flow from the main reservoir to each of the three experimental beds for a period of 4 months (September to December). This enabled the plants to acclimatize to their new environment and grow with an expected survival rate of 100 %. For the horizontal subsurface flow system, wastewater was fed into each bed in the system continuously at HRL of 0.047 m. d<sup>-1</sup>. The water level in each bed was adjusted at the root-zone level of the plants (below the substrate). The system was transformed to Free Water Surface by allowing water to flow into the beds and raising the outlet levels higher on the support so as to maintain the water level in each bed at 5-10 cm above the substrate. A mean HLR of 0.056 m d<sup>-1</sup> was maintained for this system. Plant density, heights, leaf size, Culm diameter per plant, number of leaves and number of branches were followed on the plants in the system. Physicochemical and microbial parameters were monitored along side mosquito observation throughout the study period in each bed, following standard analysis procedures described by Hach (1998). The % reduction of each parameter by the experimental beds was calculated.

## Results and discussion

For the SF system, the range of efficiencies of the 3 beds were as follows; 42.26 – 80.83 % (control bed), 47.69 – 97.51 % (*L. hexandra* bed) and 49.44 – 98.56 % (*E. crus-pavonis* bed). For the FWS system, the ranges were relatively lower as follows; 7.15 – 83.59 % (control bed), 22.58 – 94.82 % (*L. hexandra* bed) and 25.57 – 95.9 % (*E. crus-pavonis* bed). The planted beds were more efficient than the unplanted controls in both wetland systems and for some parameters these differences were very significant. For the SF system, the differences in the reduction of NH<sub>3</sub>, NO<sub>3</sub><sup>-</sup>, PO<sub>4</sub><sup>3-</sup>, COD

and BOD5 were significant for the *L. hexandra* bed (compared to the control) while differences in parameter reductions between the *E. crus-pavonis* bed and the control bed were significant for NH<sub>3</sub>, NO<sub>3</sub><sup>-</sup>, PO<sub>4</sub><sup>3-</sup> and BOD5 reductions. For the FWS system, turbidity, TSS, NH<sub>3</sub>, NO<sub>3</sub><sup>-</sup>, PO<sub>4</sub><sup>3-</sup> and BOD5 reductions were significant for the *L. hexandra* bed (compared to the control bed) while turbidity, TSS, NH<sub>3</sub>, NO<sub>3</sub><sup>-</sup> and PO<sub>4</sub><sup>3-</sup> reductions were significant for the *E. crus-pavonis* bed. All 3 experimental beds reduced faecal streptococci by more than 96 % and faecal coliforms by more than 99 %.

Mosquito analysis revealed the presence mosquitoes belonging to *Culex* spp. Mosquito developed only in the experimental beds and were absent in the main reservoir because of the hostile conditions which prevailed in this chamber.

### Conclusion

This study clearly shows that, both wetland systems considerably improved water quality. However, the SF system was more efficient than the FWS system in reducing most of the physicochemical parameters. It is probable that, the FWS system was relatively overloaded and this might have contributed to the relatively lower treatment efficiencies registered for this system with respect to the SF system.

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# Aspects of Cost Effective Alternatives to Reduce Pharmaceutical Residues

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In the Millennium Development Goals (MDGs) a target to halve the number of people without access to adequate sanitation by 2015 has been set. When aiming to reach the target collection of excrement need to be done, but what else do we collect and how do we work to reduce the amount of unwanted substances in the sewage and in the excrement?

Residues of pharmaceuticals are being secreted by excrement. Waste Water Treatment Plants (WWTPs) are not designed to degrade pharmaceutical residues or other dangerous compounds and today's waste water treatment plants do not remove all of these substances. Nor are pharmaceuticals or harmful substances designed to degrade in the WWTPs. Over 1,000 different pharmaceutical substances are used in Sweden. The concentrations are reduced between 0 and 100 percent in the waste water treatment plants, depending on the kind of substance.

In laboratory tests it has been shown that concentrations of certain substances close to those found in a number of Swedish recipients affects fish. This is not a question of acute toxic effects, but of uneven gender distribution after long exposure to low concentrations.

In the light of these facts and conclusions, measures need to be taken. The question is what kind of action that are most cost-effective. The following actions are examples of different measures that could be taken individually or jointly.

The flow of various sorts of pharmaceutical residues needs to be mapped in order to assess risks and the possibilities to reduce these risks. Such a mapping is being prepared.

The possibilities of improving the efficiency of treatment in today's waste water treatment plants are limited. There are complementary technical solutions by which the degradation of pharmaceutical residues are effective. These methods can even reduce the presence of other organic molecules than pharmaceutical residues but these solutions are expensive compared to today's technology and more energy consuming.

The pharmaceutical industry should take degradability and environmental impact into consideration in conjunction with the development of new substances. An important task for the society at large, from authorities to manufacturers and individuals, is to continue with up-stream work, i.e. to see to it that environmental contaminants are stopped before they get into the sewage system. The importance of up-stream, closer to source, measures to reduce the amount of harmful substances entering the WWTP has several positive side effects. A lot can be done by information to the public where to turn in not used medicals, by more restrictive promissory note and other measures.

If pharmaceutical residues cannot be stopped at their source and if it is shown that they have serious negative effects on the recipient, a situation may arise which forces waste water treatment plants to incorporate complementary new techniques. But before complementary techniques are developed,

further evaluation of how the treated waste water that is released from today's waste water treatment affects water organisms is necessary. This is needed in order to know which substances are in fact reduced, and thus enable a comparison of the various methods' possibilities to achieve reduction with a reasonable consumption of resources.

This presentation will share some of the outcome from the Swedish Environmental Protection Agency report regarding the WWTPs ability to reduce the residues from pharmaceuticals as well as the experiences and possibilities to work up-stream the system and a discussion regarding aspects of what kind of measures that could most cost-effective.

# Cost of Pollution in Lebanon

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Keywords: Environmental Degradation, Lebanon, Pollution Cost, water resources, Environment management

Lebanon accomplished some actions in environmental management in the last decade. However, challenges from several decades of past and continuing degradation remain. This study using environmental damage cost assessments as an instrument for integrating environmental issues into economic and social development.

The specific objectives are:

- i. Provide an estimate of the cost of environmental degradation in Lebanon using the most recent data available
- ii. Provide an analytical framework that can be applied periodically by professionals in Lebanon to assess the cost of environmental degradation over time.

The study also provides cost estimates of select remedial actions that may be necessary to protect and restore the environment. It also presents a discussion comparing damage and remediation costs, and the potential benefits of remedial action for some environmental issues.

The cost of environmental degradation in Lebanon was estimated at 2.8-4.0 percent of GDP per year, with a mean estimate of close to US\$565 million per year, or 3.4 percent of GDP. In addition the cost to the global environment is estimated at about 0.5 percent of GDP per year. Estimated costs of damage have been organized by environmental and economic categories which indicate that the cost to health and quality of life is about 2.1 percent of GDP, followed by 1.3 percent for natural resources. The most significant negative impacts on health are caused by urban air pollution at an estimated cost of 0.6-1.0 percent of GDP per year, with a mean of about 0.8 percent. Negative impacts on health from indoor air pollution in rural areas from biomass fuel use is estimated at 0.1-0.3 percent of GDP. The cost of diarrheal illness and mortality is estimated at 0.5-0.6 percent of GDP, caused by a lack of access to safe potable water and sanitation, and inadequate domestic, personal and food hygiene. Most of those impacted are children. The lack of safe potable water has an additional cost in terms of avertive expenditure on bottled water, estimated at 0.5 percent of GDP per year. The last category is waste management with potential impacts on health from uncollected and unsafe disposal of municipal and industrial waste, hazardous waste and health sector waste. The cost of natural resource degradation is predominantly from losses in recreational, tourism, ecological and non-use values associated with coastal zone degradation (0.6-0.75 percent of GDP per year), and agricultural soil/terrace degradation (0.4-0.5 percent of GDP). The assessed cost of degradation of the inland natural environment is estimated at 0.1- 0.2 percent of GDP.

The cost of remediation has been estimated for a limited number of actions for each environmental category. While the focus is the cost of remediation, and mainly of investments and programs, a discussion of the policy context is warranted. Reducing degradation and protecting the environment should be viewed in the context of economic and sector policies and development, and in the broader

framework of environmental management. Much can be gained from preventing degradation through analyzing the environmental impacts of policies and development plans. Eliminating price, tax and economic regulatory distortions can also benefit the environment if such distortions favor inefficient use of “dirty” resources or “dirty” industries.

Reducing degradation and protecting the environment also require strict enforcement of environmental legislation, public/private partnerships, environmental awareness raising, and local participation. Sound environmental management also requires that the roles of the public and the private sectors be clarified. It should be said that the remedial actions discussed in this report should not necessarily be undertaken by the public sector. The private sector should bear the cost of remedying the pollution and degradation it causes, and the private sector can provide a significant contribution to the delivery of environmental services.

A comparison of benefits (reductions in damage) and costs (remedial actions) can be useful to point to environmental issues for which benefits of remediation are likely to exceed the cost of remedial actions. We points to some areas for which a comparison of costs and benefits are made. However, in making such comparisons, a note of caution is warranted:

- i. Environmental damage is unlikely to be completely eliminated no matter how stringent and comprehensive the remedial action.
- ii. The remedial action is in most cases insufficient to adequately address the damage.
- iii. Quantification of environmental damage and its monetary valuation can never be completely accurate, and the costs of remedial action are most often only estimates.
- iv. The principle of marginal analysis needs to be applied to obtain remedial action that is likely to provide the greatest benefits per unit of cost.

This study indicates that the cost of environmental degradation in Lebanon is in the range of 2.8-4.0 percent of GDP, with a mean estimate of 3.4 percent. This is substantial and on the order of 1.5 times higher than in high income countries. The main reasons for this are:

- (i) a significant disease burden and avertive expenditures associated with the lack of safe water and sanitation facilities and inadequate hygiene;
- (ii) substantial negative impacts on health from air pollution;
- (iii) environmental degradation and productivity losses associated with soil degradation; and
- (iv) significant coastal zone degradation.

# Unit Abatement Cost as a Tool for Effective Financing of Environmental Projects

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The political changes in the Eastern Europe in the beginning of the 1990s presented the opportunity for an economic build up of neighbouring areas to the Nordic countries. The deteriorated industrial processes, which had caused serious environmental problems, needed a systematic technical modernization. It was simultaneously realized that the environmental problems had no political borders and emissions taking place in the countries neighbouring the Nordic countries also exerted effects on common water areas and air. An important issue was that environmental measures already had largely been taken and additional measures were expensive. With this thought in mind a systematic investment activity started with the aim to obtain as much pollution reduction as possible for least cost. In order to objectively screen such an activity the Unit Abatement Cost (UAC) has been systematically used at the Nordic Environment Finance Corporation for several years.

The method is based on the Sevilla protocol on shadow pricing. UAC is used as a tool to measure cost-efficiency of an investment as compared with if the investment was made in a Nordic country, e.g. the annual investment cost and O & M should be lower than the corresponding Nordic shadow cost to reduce a ton of pollution.

The requirements for the method is that Nordic shadow prices for various sectors are available in addition to the financing costs and operation and maintenance costs of the project. The method is simple and robust and understandable even for the lay man. The method has been used in many projects especially in the water and energy sectors. The results show that the cost-efficiency hitherto for example in the water sector are around ten times more cost effective than the corresponding marginal cost in a Nordic country. Frequently the savings in O & M are larger than the annual investment cost producing a negative UAC.



# Programme for Pollution Abatement and Eutrophication Control in the Shichahai Lakes for Beijing 2008 Olympics Game

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Keywords: Pollution Abatement, Water Sanitation, Reverse Osmosis, Eutrophication, Modelling

Shichahai area, as a bright pearl of Beijing, has a long history and profound culture being one of the most visited area of Beijing. The Central Government has decided to protect this Area as a memory of the ancient culture of China. Abundant cultural relics, parks, lakes and sceneries attract a lot of Chinese and foreign tourists every year.

In the recent years, due to the nutrient enrichment of Shichahai, the oxygen density in the water and the transparency of the water of the lakes within this area decrease, the green and blue algae grow excessively (especially in the summer) destroying the former eco-system of the water. The smell of the dead blue and green algae greatly affected the living environment and quality of the residents living around, and it affected the development of the tourism of Shichahai Natural Scenic Area.

From 1995 to 2000, the Institution responsible for the Shichahai Lake System water quality made and took many measures to control the eutrophication problem. At present, Beijing Municipal Government is making the program for the environmental protection of Shichahai region since the problem has not yet been solved.

In order to restore the eco-environment of Shichahai region, to improve the living environment of the residents around, to protect the historic and cultural heritages and to ensure the realization of 2008 Beijing "Green Olympics", Italian Ministry of Environment Land and Sea (IMELS) within the Sino Italian Cooperation Programme on Environmental Protection provided capital and technical support to Beijing Environmental Protection Bureau to restore the eco-system of Shichahai region and to control the nutrient enrichment of the water bodies.

Within this framework the Project presented in this abstract aims at understanding the causes of water quality deterioration in the Shichahai Lakes which surround the Forbidden city in Beijing and at identifying the costs and the measures to be put in place in order to increase the water quality in view of the 2008 Beijing Olympics games.

The Shichahai lakes system is a part of a bigger water system, anciently know as "the imperial water net-work", which was providing water to the whole city. In the last decades cement enforced banks and ardent urban construction have seriously changed the original ancient water bodies configuration. In addition the reduction of the inflow due mainly to upstream water scarcity, the increase of pollution discharged into water bodies and the partial closure of the outflow of the system have dramatically compromise the equilibrium of the lakes system. An hydraulic model has been constructed to understand the hydrodynamic and chemical state of the system. Water circulation is very low and water

quality is above the standard limits, which if added to the low depth of the lakes clearly explain the water deterioration problems which affect the system.

Through field investigation and water quality model building the consultant has identified the main reasons of lake pollution and has produced different scenarios that will mitigate the problems. Each scenario has been analyzed in terms of costs and benefits in order to provide a valuable decision support tool for the identification of the best solution.

The first phase of the project, concluded that it was necessary to implement 7 small treatment plants (5 l/s capacity each) along the lakes in order to restore the water quality of the system. The construction of fountains was also proposed in order to favor the circulation of water in the currently stagnant lakes as well as adding a positive feature to the landscape.

Following the results of the first phase of the Project IMELS and the Beijing Environmental Protection Bureau (EPB) agreed to proceed with the implementation of the solutions identified and implement a pilot project consisting of the detailed design and construction of a water treatment plant in the Houhai lake. The construction of the works is supported by a monitoring campaign that consents to evaluate the physical and chemical processes in the lakes throughout the year and provide the basis for the optimization of the newly installed treatment works and the evaluation of the costs and benefits of the rehabilitation of the whole lakes system.

The Pilot Treatment Plant has been designed with the purpose to put in place and test different combinations of treatment processes (Reverse osmosis, sand filter, air insufflations). This approach in combination with a treatment plant testing programme and a monitoring campaign will allow to evaluate on field which will be the most suitable treatment process or combination of treatment process for the restoration of the water quality of the lakes with particular attention to their costs.

A more detailed hydrodynamic mathematical model coupled with a water quality and biological models are under construction and will allow to simulate different scenarios where several treatment plants will be placed around the lakes. Those models will take into consideration both all the main chemical pollutants (has been proven that Phosphorus is the limiting factor) and the biological process that influence the algae growth and the hydrodynamic evolution of the lake system. Every scenario produced by the set of models will be then analysed in terms of cost and benefit with the final purpose to identify the investment plan necessary to solve the pollution problem in the Shichahai lakes. Every combination of treatment process entails different investment and operation costs which have to fit with the Environmental Protection Bureau's water quality objectives and investment availability.

At present, January 2008, the second phase of the project is ongoing. The final aim of this phase is to build the Pilot treatment plant in the Shichahai lakes system and test it before the 2008 Olympics Game in order to get some visible results to be then replicated in all the lakes.

# Cost-effectiveness of Composting Domestic Solid Waste in Bangladesh

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Keywords: cost-effectiveness, composting, domestic solid waste, sustainable waste management, Bangladesh

Growing concerns relating to land degradation, threat to eco-systems due to ever increasing domestic wastes and from over and inappropriate use of inorganic fertilizers, atmospheric pollution, and sanitation problems have rekindled global interest in organic recycling practices like composting. Composting is the microbial decomposition of biodegradable solid waste, under aerobic condition, where microorganisms convert waste into a stable end-product called compost. The potential of composting to turn domestic wastes and on-farm waste materials into a farm resource makes it attractive cost-effective pollution abatement proposition particularly for the agro-based country like Bangladesh.

Urban solid waste collection and disposal are the serious problems facing most developing countries in general and Bangladesh in particular. An accelerated unplanned growth of urban centers in Bangladesh with extreme shortage of capital outstrips the capacity of all municipalities to provide most basic services including domestic solid waste collection and final disposal systems. This causes severe environmental degradation.

The domestic solid wastes generated in developing countries contain high percentage of organic matters compared with the solid wastes generated in developed countries. It is evident from this study that domestic solid waste in Bangladesh contains a very high proportion (65% to 90% of the weight of total waste) of biodegradable organic fraction. This organic fraction of domestic solid waste can be composted to reduce the volume of waste and the compost can be used as a soil conditioner. Hence composting diverts the organic fraction of solid waste from municipal collection services as well as from the final disposal sites, and thus, enhances both economic and environmental sustainability of solid waste management system. The use of compost as soil conditioner minimizes the use of chemical fertilizers and has significant environmental benefits. The peak temperatures of experimental composting plants are near 65-66 degree Celsius during summer and during winter season these are in the range of 52-55 degree Celsius. The composting process thus minimizes the spread of diseases because of the destruction of some pathogens and parasites at elevated temperature. Thus the management of this organic fraction of solid waste is becoming a very important strategic option to minimize severe environmental pollution resulting from mismanagement of solid waste in most of the towns and urban centers. The implementation of the composting technology has a great potential for mitigating several problems related to ecological imbalance due to loss of nutrients from the ecosystem, the disposal of organic wastes, which cause water, soil and air pollution and health hazards of the population living mostly in low-income areas and finally minimize cost of solid waste management system by diverting it from solid waste collection system and final disposal site.

This paper summarizes results of two to three years long applied research on different composting plants engaged in composting biodegradable fraction of domestic solid wastes in few towns and urban centers in Bangladesh. This is aimed to bring sustainable solid waste management services with

economic benefits by converting the waste into resource, soil conditioner, so that it is no longer be considered as waste. From the chemical analysis of compost samples produced from domestic solid wastes in Bangladesh, it is found that the nutrient content of the samples are very much comparable to those of compost produced in the international market. This study includes determination of chemical and microbial quality of compost produced of these composting plants for the effective and safe use of compost as soil conditioner to improve the condition of farmland. Then attempt has been made to evaluate the cost-effectiveness of this pollution abatement system presently operating in few towns and urban centers in Bangladesh so that its application can really make a difference in future to evolve an appropriate management option for domestic organic solid waste.

# An Innovative & Cost-Effective Monitoring Network for Water Pollution Control and Water Management

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Keywords: sustainable environmental plan, water pollution control, cost effective system, dynamic optimisation, geo-information technology

Industrial development and pollution, uncontrolled domestic discharges from urban areas, diffuse pollution from agriculture and various alterations in land use or hydro-infrastructure may all contribute to non-sustainable use of water resources. Up to now, water pollution risk is increasing and the environmental degradation is continuing as there is no clear methodology to understand the operational needs that handle inter-related risk and environmental impact due to incompatible information systems that provide easy access to relevant data. Large amount of data (hydrological, geological economic, social economic, demographic, physical, meteorological, etc) is required for the data analysis and water management. There is a need to develop shared information systems for water pollution control and water management which will promote model and systems integration and monitoring. The developed monitoring network will be designed to consider several levels of planning and decision making through the management system of spatially referenced data with advanced computer simulation, graphical visualisation, and dynamic optimization. Therefore, this paper is effectively link into wider strategic aims of bringing together innovative ways of thinking based on knowledge and technology in many scientific disciplines (e.g., dynamic optimisation, geo-information technology, environmental impact assessment, spatial and environmental planning, and water management etc.) to achieve more effective water pollution control. The monitoring network will take into account all relevant aspects of water management, e.g., water pollution control, flood risk management and preventive measures, land-use, urban development at all levels (local, regional, and national), monitoring and forecasting overflows, early warning, simulation and optimisation procedures.

Monitoring of water pollution is a complex task and is carried out using terrestrial based automatic and manual devices. Currently most information comes from fixed-site, terrestrial monitoring stations which provide only a partial picture of the water pollution situation due to the lack of spatial representation of water pollution sources. In addition, forecasting of physical parameters and impact of water pollution are mainly local and often highly variable at short distances. Knowledge of the relative contribution of different sources (agriculture, households, industries, aerial deposits) is often important to verify the effectiveness of control measures. Within the context of dynamic optimisation, the problems in water pollution control involve multiple, conflicting objectives in a highly complex search domain and can be regarded as real-time Multi-objective Optimisation Problems (MOPs). They can be formulated in a design model for the monitoring network as follow:

$$Network_{MOP} = optimize : f(x) = \{f_1(x), f_2(x), \dots, f_n(x)\} \text{ subject to } x = (x_1, x_2, \dots, x_n) \in X$$

where  $f_i(x)$  is the model of monitoring network that consists of  $i$ th monitoring objective functions to be optimised,  $x$  is a set of variables (i.e., decision parameters) and  $X$  is the search domain. The

term “optimise” means finding the ideal network in which each monitoring objective function corresponds to the best possible value by considering the partial fulfilment of each of the objects. More specifically, this monitoring network is optimal in a way such that no other networks in the search domain are superior to it when all objectives are considered. The monitoring network is a system of satellites and ground stations for providing real-time monitoring to detect impact of the pollution sources implicated in water quality changes. This network implements a set of monitoring stations spread over the whole geographic area of the region to provide reliable information on a continuous basis. The design model for the monitoring network requires specific objectives for an efficient and effective monitoring system that will address many operational and management requirements related to water quality and quantity parameters. These monitoring objectives can be consisted of several parameters to optimise: monitoring violations of the water quality standards specified for each watershed, estimating pollution loads from each watershed unit, determining water quality status that help understanding the long and short term trends of temporal variations, identifying the causes and sources affecting water quality changes, supporting utilization of water resources, the use of water quality modelling that support scientific water quality management functions, etc. The use of complex functions to produce further evaluations for the monitoring network requires flexible and power search algorithms that do not need mathematical constraints on the form of the objective functions. Dynamic Metaheuristic Algorithms (DMAs) (which are based on the ideas of Artificial Intelligence (AI)) potentially have these capabilities to produce set of high quality real-time designs that can model more closely and easily the monitoring parameters. Therefore, it is almost impossible even for an experienced and higher-level designer to find an optimal network design by the current used methods which do not provide spatial representation to the whole situation and lack the ability to select ‘interesting’ contingencies for which to optimise. Once such designs are obtained, the technical user will be able to select an acceptable network design by trading the competing monitoring objectives against each other and with further considerations. The final design should be robust (i.e., performs well over a wide range of environment conditions), and flexible (i.e., allows easy adaptation after the environment has changed).

# Identification of Most Suitable Waste Water Emulsion Treating Method: Case Study from Serbia

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Keywords: waste water emulsion, treating method, decision-making, AHP, CP

Water emulsions are waste waters from different industries such as refineries, food and metal industries. Emulsions usually contain large concentration of oils and other complex organic materials. They represent a threat to the environment and must be treated before they are released into the sewage system.

According to some recent monitoring, there are four treating methods used in Serbia: chemical treatment, steaming, separation by the use of the membranes and biological treatment. It is well recognized that all methods have advantages and disadvantages. For example, chemical treatment implies low energy consumption and is based on relatively cheap chemicals, but workers in the process must be specially educated, treatment is not effective when applied on emulsions based on synthetic oils etc. On the other hand, steaming method consumes a lot of energy, there is a risk of fire, steam has a bad smell, but in the same time it is simple, its effectiveness does not depend on the amount of the ions from metals, there is no need for approval for waste water disposal etc.

In past researches it was shown that 7 criteria can be used for confident identification of the most suitable waste water emulsion treating method in metal industry. These are: energy consumption, price of chemicals, effectiveness, simplicity of the process itself, price of used equipment and facilities, ecological impact, and required education and skills of the workers. Some of the criteria are quantitative (e.g., energy consumption and price of chemicals), while others are qualitative (e.g., simplicity of the process, required workers' education and operational skills).

Any selection procedure consisting of assessment and identification of the most suitable emulsion treatment method assumes that different nature of the criteria and their conflicts and contrasts will be respected. The method that has proven applicability in such cases is the Analytic Hierarchy Process (AHP). This method requires well structured problem, represented as a hierarchy. At the top of the hierarchy is the goal; the next two levels usually contain the criteria and sub-criteria, while alternatives lie at the bottom of the hierarchy. AHP determines the preferences among the set of alternatives by employing pair-wise comparisons of the hierarchy elements at all levels, and by following the rule that, at given hierarchy levels, elements are compared with respect to the elements in the higher level by using proper relative (preferential) scale. After all judgments are made and comparison (decision) matrices formed, the local priorities of the criteria, sub-criteria and the alternatives are calculated from comparison matrices by using the principal eigenvector, or any other available mathematical method. The synthesis is performed by multiplying the criterion-specific (or sub-criterion, if any) priority vector of the alternatives with the corresponding criterion (or sub-criterion, if any) weight, and then appraising the results to obtain the final composite priorities of alternatives.

If there are numerous criteria or alternatives, pair-wise comparisons can become tedious for the decision maker, resulting in less consistent decision. Another fact that gives opportunity for other method

to be used is that decision matrix can be filled with real numbers (e.g., price of the chemicals, energy consumption etc.). In such cases, there is no need for decision maker's involvement in the decision process. Ideal-point methods are suitable for calculating local weights in those situations.

A case study from Serbia is used to demonstrate how AHP can be combined with the other multicriteria decision-making tool, namely ideal point-method known as Compromise Programming (CP), to assess commonly employed water emulsion treatment methods and point out the one which will best treat polluted waters at technological outlet in a typical Serbian factory of colored metals.

Hierarchy of the problem is reduced to have three levels: (1) goal – selection of the most suitable treating method; (2) aforementioned 7 criteria, and (3) four alternatives – chemical treatment, steaming, separation by the use of the membranes, and biological treatment. First step in the selection process was to compare criteria regarding the goal, and to calculate their local priority vectors. The AHP application showed that highest weighting coefficient of all criteria has the price of the chemicals, followed by price of the facilities, and energy consumption. This corresponds to the situations when economic factors play most important role in the selection process. The next step was comparison of the alternatives across all criteria in the upper level of the hierarchy and calculating the alternatives' local priority vectors. At that point, multicriteria analysis is diverted from AHP to CP method to come up to the final result, steaming as the most suitable treating method. The result appears as fully logical because steaming method has the highest local weight regarding most important criterion (price of the chemicals), and also high weight regarding the next top ranked criterion (price of the facilities). Local weights of alternatives also show that steaming method is the simplest one, and that it requires lowest educational level and skills of involved workers. If situation is changed and some other criteria are added, for example security, steaming would probably be less desirable method. Obviously, it is up to the decision maker(s) to define hierarchy of the problem that will correspond best to the real decision making situation. Comparison of our results with earlier ones obtained by standard AHP methodology indicated that combined use of AHP and CP provides for better sensitivity analyses and satisfactory overall assessment of alternatives and deriving the final, in multicriteria sense, optimal solution.



# Economic and Environmental Benefit Cost Quantification of Zero Discharge Options for Tannery Effluents along Palar River

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Keywords: cost benefit analysis, membrane technology, Artificial Neural Network tec, pollutant transport models, G.I.S

Development of improved methods for removing pollutants from and renovating already polluted aquifers is dependent on knowledge of the subsurface behaviour of the pollutants. Source control and management option not based on this knowledge are almost certain to result in either under control with gratuitous pollution or over control resulting in under utilisation of the subsurface as a pollutant receptor. Significance of source control need to be addressed with its benefits and economics particularly to the polluter and also to the environment through time tested technological solutions.

## The objectives

The objectives of the study are:

- To develop a three dimensional finite difference ground water flow for the study area and their solution strategies for pollution transport in the ground water.
- To apply the developed three dimensional model to simulate the solute transport in the study area and predict the extend of plume in the aquifer.
- To study the feasibility of the developed model for predicting the pollution concentration levels for various scenario in the future period and exporting the results to Arcview® .
- To study the preferred treatment technology to prevent pollution in the study area and evaluation of the suggested/preferred treatment system using Artificial Neural Network (ANN).
- To study the environmental economics of the preferred treatment system by applying Benefit Cost Analysis for valuation and accounting for environmental and natural resources.

## The methodology

Ground water flow modeling comprises calculation of lot of parameters to be given as inputs. The parameters for an area of study may change from place to place depending on the aquifer characteristics and type of flow modeling. The thematic maps are prepared using GIS softwares.

Empirical studies in these fields routinely employ data for which location attributes are an important source of information. In this study using spatial data, the non-spatial data is given input to the modeling soft ware to obtain map based ground water flow and pollutant transport models.

The pollution control level by the existing treatment system and improvements required are studied with reference to the latest available, time-tested technologies. The most preferred treatment system installed is studied and evaluated applying Artificial Neural Network techniques.

The role of economics through CBA is employed involving environmental effects of the preferred treatment technology on case study basis and hence to ensure the sustainable development.

The study area is Upper Palar basin in Vellore District, a sub basin of Palar river system and one of the 17 major river basins in Tamilnadu. The implication of this study is that mass transport modeling simulation can be effectively used for studying the pollutant movement in a river basin. Thus the role of three dimensional water quality models in the field of groundwater quality and pollutant transport in subsurface studies is fully affirmed. The various scenarios assumed and the development of 3-D model results for such scenarios reveals that the study area needs immediate attention and measures so that the contamination of entire aquifer in the river basin can be prevented. The model developed also reveals that the effect of groundwater recharge is more significant.

The existing treatment systems have failed to contain the salt level that is total dissolved solids in the effluent discharged into the said basin in the study area. Hence, the treatment system needs to be upgraded by installing membrane technologies with suitable rejects management system. This upgradation will facilitate reuse of treated effluents / recovered permeate by the industries and this will ensure the zero discharge of effluents into the river basin. The study on such time tested treatment system provided by the tanneries on the above aspects is very encouraging.

Further in this study an attempt has been made to evaluate the performance of the stated membrane technology based treatment system by Artificial Neural Network (ANN) and results reveals that the ANN could be effectively used as a tool to assess the performance of treatment technologies.

Further, the benefit cost Analysis (BCA (or) CBA) study made on the functioning membrane based tannery effluent treatment system is cheering and a pay back period is also estimated apart from its environmental benefits. This study ascertain that the membrane based effluent treatment system could provide a better solution to prevent the contamination of the river basin in the study area and also predict the remediation measures as well as period through map based mass transport model study. The environmental benefits derived are very much soothing from this holistic approach and also paves a green way for the sustainability of the existing industrial activities in the river basin.

# The Hollistic Remediation Approach can Clean Water Resources and the Environment at a Severely Contaminated Industrial Site in India

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Keywords: Contaminant hydrogeology, Multimadia contamination, Holistic remediation, Remediation strategy, Contaminant groundwater

The Katedan Industrial Development Area (KIDA) in Hyderabad, India include 300 small to medium large industries, dealing with battery manufacturing, metal plating, mini steel mills, plastic products, chemicals, tyre production, vegetable oil processing, textile, paint and pharmaceutical industries and more. KIDA was established for 30 years ago with very limited infrastructure and facilities. As the area has developed over the years there are today residential areas of more than 20.000 habitants, outside as well as inside the industrial area. There are some hundred of similar industrial sites in India and they represent a major part of the export of manufacturing goods.

The Indo-Norwegian Institutional Cooperation Program selected KIDA as an environmental demonstration project for technology transfer, to be executed by National Geophysical Research Institute of Hyderabad, India and Norwegian Geotechnical Institute of Oslo, Norway. The first phase of the project “Soil and groundwater contamination: Sources, Transport, Fate, Risk and Remediation” was finalized in 2005 after 2 years of investigations and studies. In 2007 the planning of the remediation strategy for KIDA was completed.

The gently sloping area is covered with sandy residual soil developed from granite, where most of the 750 mm precipitation infiltrates to the sub-surface. The depth of weathering and decomposed granite of 20 to 40 m and several fracture zones, represents a productive and unconfined aquifer which is depleted and recharged several times yearly. More than 100 wells, 40 to 200 m depth, supply very contaminated water for the industry and domestic use. Potable water is transported to Katedan by trucks. The drainage of the area consists of several shallow reservoirs, interconnected by small streams.

The investigations proved that the surface soil, subsoil, groundwater, surface water and the sediments were extremely contaminated due to all the years with random dumping of hazardous waste and free discharge of industrial effluents. There is also indiscriminate domestic waste dumping and open sewage contaminating the streams and lakes. The surface water and the groundwater transport the contaminants far beyond the industrial area. Risk assessment, based upon Soil Quality Guidelines (Canadian) and Indian drinking water limits, and proved that the surface water, groundwater and the surface soil, containing high concentrations of the trace metals As, Cr, Pb, Ni and Zn, was a serious health risk to humans. According to Eco-Toxicological Guidelines (Norwegian) the concentrations of all the heavy metals in surface water and sediments could be categorized as extremely contaminated. A few organic screening analysis showed that most of the typical organic contaminants were present but in low concentrations.

From the primary contamination sources, the effluents and the solid waste, the order of spreading by infiltration and the flow of surface water create secondary sources such as the sediments and the

subsoil and the groundwater as the tertiary contamination source. The final consumer recipients are the groundwater wells and the surface water. This succession of contaminant partitioning and continuous spreading, creating new contaminant sources, is the basic concept for the holistic remediation approach. The order of contaminant spreading determines also the order of remediation. The correct order of cleaning up starts with the primary sources and continues with the secondary source and finally the tertiary source. To attempt to clean the contaminated groundwater, prior to the removal of the industrial and common effluent, solid waste and the sediments, will be never-ending.

Planning the remediation strategy at KIDA based upon the holistic concept will in short require the following outline and order of working phases:

- Supplementary investigations to determine the extent and degree of contamination.
- Installation of ground water monitoring system for controlling the changes of contamination during the remediation.

Prior to the remediation the following works and actions are necessary:

- Common Effluent Treatment Plant (CETP), to include industrial effluent and/or individual treatment plants
- All random solid waste dumping is terminated
- Municipal garbage collection system is in operation
- Design and construct local landfill for hazardous waste.

The remediation work will involve:

- Removal of waste and materials/chemicals etc on site at the industrial lots
- Removal of contaminated surface soil and solid waste
- Removal of sediments and waste in open drainages, streams and lakes
- In-situ options to remediate contaminated soil by phytoremediation, chemical stabilization,
- Remediation of groundwater according to the monitoring results, by pump and treat, permeable reactive barriers, etc.

The holistic remediation concept is definitely the most effective, optimal and economical solution to clean a multi-contaminated site.

Environmental awareness is nearly lacking in KIDA and a comprehensive program is proposed for all inhabitants including employers and stakeholders to take place prior to the cleaning up.

It is a fact that KIDA has severely polluted a large area including all the water sources, extending far outside the industrial area. Serious health-effects are also known to occur.

The Risk Assessment report contributed to the action by the Andhra Pradesh Pollution Control Board to close the 67 most polluting industries in Katedan and a CETP is on the planning stage.

# Improvement of Cost-Benefit Relation in Sanitation through the Implementation of Ecosan Systems

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Keywords: ecosan, business opportunities, recovering of resources, fertiliser, cost-benefit analysis

The global sanitation crisis has been recognised by the international community with setting a concrete target in the Millennium Development Goals (MDGs) to halve the number of people without access to adequate sanitation by 2015. However, the Joint Monitoring Programme has found that if the current rate of provision does not improve dramatically, the sanitation target will be missed significantly.

While thinking about sanitation, most people still regard it as a cost intensive topic which protects environment and health, but is not affordable for poor communities. Conventional centralised sanitation systems go along with huge investment and high running costs and even for decentralised conventional systems, sustainable sludge management is often neglected because it is too expensive.

With the implementation of ecological sanitation systems however, not only environmental and public health conditions improve, but also the economic cost-benefit balance is changed, as human excreta and water from households are no longer regarded as a waste but as resources that can be recovered, treated where necessary and safely used again. Ideally, ecological sanitation systems enable a complete recovery of water, nutrients and organics in household wastewater and human excreta and their reuse in agriculture. In this way, they help preserve soil fertility and safeguard long-term food security, whilst minimizing the consumption and pollution of water resources. Up to 40% of the worldwide consumption of mineral fertilizers or 50 Mio tons of fertilizer equivalents with a potential market value of about 20 Billion US-\$ could be substituted by recovering nutrients with ecological sanitation systems. In addition, especially in warm climates, the use of anaerobic treatment technologies allows the production of biogas as renewable energy resource. The use of waste heat and wastewater fed irrigation of firewood or other renewable energy plantations are also contributing to the economic viability of ecosan systems and help to protect our climate. Furthermore the implementation of eco-sanitation systems creates a demand for sanitation equipment that can be produced locally and the operation of collection, transport, treatment and marketing of recyclables is generating new business opportunities for small and large scale service providers. In rural areas, the use of the recycled nutrients may improve the access to fertilizers for subsistence farmers, thereby contributing to improve their food production and livelihood.

Recent experience from different countries have shown, that the fact of producing useful secondary resources in addition to providing safe and environmental friendly sanitation is also largely contributing to raise the demand for the implementation of these eco-sanitation systems and make them attractive even for people, who never had been giving priority to sanitation before.

For a further dissemination of productive eco-sanitation systems comprehensive cost-benefit analysis are presently being prepared for a series of existing projects. Within different pilot projects and some large scale implementations a set of innovative sanitation concepts have been developed and tested that apply – adapted to the local circumstances – diverse technical components from low-tech to high-

tech, various logistical concepts, organisation structures and reuse strategies. These projects comprise e.g. eco-sanitation public toilets in India, where urine is collected separately and used for fertilizing attached banana plantations, the faecal matter being digested in a biogas plant, the residual sludge used as a soil conditioner and the biogas being used for cooking. Other examples are constructed wetlands in Syria where the treated water is reused as nutrient rich hygienic safe irrigation water or the construction of individual urine-diverting dehydration toilets. Large scale implementation of ecological sanitation systems is becoming a regular part of Chinese residential house building where different concepts are adopted.

This paper will derive the benefits of ecological sanitation by the help of cost-benefit analysis and will present some best practice examples of ecological and economical sustainable sanitation systems.

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# Development of Methods for Management of Surface Run-Off, Quality in Urban Areas of Kiev, Ukraine: Case Study

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Keywords: management, surface run-off, quality, waste water, urban areas

The water supply in large urban areas and industrial centers is one of the urgent present problems. As a result of the urban population growth and rapid development of industry on the whole, thermal power industry and municipal sector, the necessity to increase high-quality water reserves by means of using groundwater sources has appeared. Slow hydrologic cycle in water-bearing horizons limits opportunities of increase in groundwater collection as aquifer depletion comes quickly. In that situation, increase of the high-quality water stocks is possible only under condition of surface water use.

Ukraine has sufficiently limited water resources. At present, depletion of natural water resources arises mainly from reduction of high-quality water reserves in water reservoirs as a result of industrial and municipal pollution.

Thus, the problem of natural water protection becomes more and more important. The preservation of the Dnipro basin water objects against pollution is especially urgent problem today. On January 1, 2005, Ukraine's total quantity of waste waters amounts to 30 billion m<sup>3</sup>/year, including 3,9 billion m<sup>3</sup>/year (almost 15%) of untreated and not enough treated waste waters. Manufacturing firms and municipal utilities of large Ukrainian cities (Zaporozhye, Dnipropetrovsk, Lvov, Poltava and so on) annually discharge considerable part of sewage.

In spite of the fact that a number of water protection measures against water pollution have been taken, there is continued contamination of water reservoirs in the Dnipro basin. The main ways of water pollution are disposal of drainage and mining waters, disposal of untreated and not enough treated manufacturing waters and sewage, run-off from motorways, urban areas and other sources of anthropogenous contamination, agricultural drainage. Intensity of the Dnipro waters contamination process could be considerably reduced by control of the surface run-off in urban territories. Reduction of the surface runoff speed at the separate sections allows increasing the efficiency of processes of pollutants transformation and neutralization (especially organic matters).

It is known that the most harmful contamination of the Dnipro river is direct dump of untreated industrial and municipal waste water, which quantity grows constantly year by year. At the same time the environmental capacity of the Dnipro and other Ukraine's rivers are practically exhausted. It is proven by such facts, as water mineralization, reduce of the dissolved oxygen and decrease of industrial fish productivity. From year to year, in all Dnipro reservoirs, phenol concentrations are 4-5 times as much as maximum allowable levels, the content of nitrates is 50 to 140 times as much as the emission standard and so on.



Taking into consideration above-mentioned problems, this project provides for working out of methods for development of Dnipro basin surface run-off control that will allow minimizing of contamination processes both of the Dnipro river and groundwater on the whole water collection area of urban territories. Development of such system control is based on mathematical modeling of mixing and self-purification of surface run-off taking into account rate of flows or their quantities and concentrations of pollutants in wastewater. The definition of the basic parameters of the wastewater inflow mode along surface run-off of the Kyiv urban area is accomplished by realization of the sewage dynamics model and qualitative parameters of wastewater (chemical oxygen demand, biological oxygen demand, nitrates, heavy metals and so on) by means of GIS-technologies.

The mathematical model connects the basic entrance and target parameters and characteristics of the simulated network of wastewaters, which are dumped from drainpipes with different predestination and which have an essential influence on forming of the water quality of Dnipro river. Ecological capacity of reservoirs, as is known, is characterized by an opportunity of delute-phase (mixing) of sewage, and also chemical, biological and physico-chemical transformation of contaminants, which get into the reservoir. The mathematical modeling enables to estimate intensity of sewage self-purification in urban territories for any change of entrance and leading parameters, allows to estimate the value of each parameter of the surface run-off management and to give recommendations for optimization of a mode of waste water dumping.

Not all water objects or systems are characterized by the parameters, which enable to control processes of water quality formation. The parameters of water quality management occur in that case, when it is possible to change the different characteristics of process of water quality formation and to reduce intensity of pollution, to change morphometric parameters of reservoirs of self-purification. Speed of untreated and not enough treated sewage inflow to the Dnipro river can be an important parameter of the mode of drainage waters purification in urban territories. Speed of sewage inflow becomes a basic parameter of management, if the drainage network includes some reserve capacities – water reservoirs of self-purification, which enable to reduce the speed of the waste water stream and, thus, to increase time of transformation of contaminants. In such water reservoirs for sewage all main processes of self-purification will take place: mixing, sedimentation, chemical oxidation and biochemical transformation.

The imitating mathematical model (IMM) consists of two types—the model of mixing and transformation of surface run-off (which get into reservoirs of self-purification) and the model of self-purification of them in drainpipes.

# Towards the Sustainable City? Principles and Practice.

Author: **Prof. David Butler** (Invited Speaker)  
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## Introduction

Much has been written about the concepts of sustainable development. Whilst broad agreement seems to have been reached on the overarching principles, there is far less agreement on what sustainable development, let alone a sustainable city, should look like in practice. The aim of this presentation is not to headline gold standard exemplars, but to evaluate the reality of what sustainability means on the ground for large-scale housing projects. It sets out to describe and discuss the attempts of the government of England and Wales to take the principles embedded at policy level and to begin to roll out new 'sustainable' developments in practice, with specific reference to water management.

## Principles

The Code for Sustainable Homes was launched in 2006 as the key national standard for sustainable design and construction of new homes. The Code assesses the sustainability of a new house against nine design categories, rating the 'whole home' as a complete package. The Code uses a star rating system to communicate the overall sustainability performance of a new home and sets out minimum standards for energy and water use at each level. Since April 2007 the developer of any new home in England could choose to be rated against the Code. Since May 2008, this rating has become mandatory although implementation is still voluntary.

Water Cycle Studies are a new concept currently being developed by the Environment Agency. These are a response to the fragmented responsibilities for broad water management in urban areas and cover the complete water cycle: water supply, wastewater disposal, surface water drainage and flood risk management. They provide a framework for assessment and management of the water cycle, with particular reference to new housing areas and are independent advice rather than government policy.

A concept being promoted by government is that of the 'water neutrality' of a new housing development. This has parallels with carbon neutrality in that a water neutral development should demand no greater water supply than the area where it was built. To achieve this, the development will need to be as water efficient as possible and water efficiency measures would need to be fitted to the surrounding urban areas to offset any local increases. A study of the Thames Gateway, showed neutrality is challenging but possible in that location.

The key supporting research in the UK has been the Water Cycle Management for New Developments (WaND) project [[www.wand.uk.net](http://www.wand.uk.net)]. The aim that project was to support the delivery of integrated, sustainable water management for new developments by the provision of tools and guidelines for project design, implementation and management. The project covered aspects around the water cycle. Example sub-projects included development of more accurate water demand prediction techniques, various new decision support tools, the development of an ultra low flush toilet, assessment of the role of rainwater harvesting in water demand reduction and stormwater management, a new protocol for health risk assessment, and studies on the concepts of sustainability itself and its implementation. To make the results of the project more accessible, a good practice guide is being written, to be published by the Construction Industry Research and Information Association (CIRIA) [[www.ciria.org](http://www.ciria.org)], a well-respected provider of industry advice.

## Practice

In July 2002, the Government announced that there was potential to provide 200,000 homes by 2016 in addition to current plans. This plan was essentially to relieve housing pressures in London and the South East England, by providing affordable housing in four Sustainable Communities or 'Growth Areas' (including the Thames Gateway). The principle of using defined areas was to avoid urban sprawl by making the most of brownfield land and building to higher densities. Reference to the initial plan defines a list of twelve key requirements of a sustainable community, all of which are worthy and welcome. Notable by their absence was any mention of minimising environmental burdens or environmental risks. However, more recent definitions do now recognise the importance of environmentally sensitive design, providing places for people to live that are considerate of the environment. There is still a tension over providing so many houses in a water stressed area and the need to build in flood prone areas. Since 2005, 29 New Growth Points have also been designated, which could contribute a further 100,000 dwellings by 2016. All such housing proposals have a requirement to assess their local and strategic impacts on the environment (for example regarding water supply, flooding and sewerage).

A further and recent initiative concerns the so-called eco-towns. These are being promoted as a timely response to climate change, the need for more sustainable living and the need to increase housing supply. Some 15 sites with up to 20,000 homes each have been proposed and up to 10 locations will be chosen by the end of 2008. These will act as set of national demonstrator projects to pilot possible approaches to higher standards of sustainable development, with more radical proposals encouraged. As a minimum all the eco-towns must achieve challenging Code for Sustainable Homes levels. There should also be an aspiration to achieve water neutrality for the wider area. In addition, each town must complete a water cycle study with the expectation that stormwater will be managed on site as far as possible and that all buildings will be in minimal flood risk areas.

## Conclusions

Although the final goal of a sustainable city is an ill-defined one, the key to making development more sustainable is to start the journey! Arguably, the journey is even more important than the final destination. From the above we can see the difficulty in resolving the tensions of national policy that demands and promotes greater housing supply at affordable prices with the tenets of sustainability. So far, the practical outworking has been slow and rather tentative with little radical change. But at least the journey has begun!

# Sanitation of Streets – Discussion on Sanitation Systems and Services for the City of Sao Paulo Streets

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Keywords: Sanitation of streets, City of Sao Paulo, Historical Center, everyday walking travellers, beneficiaries of public spaces

In the Metropolitan Region of Sao Paulo – RMSP, Brazil, (about 19 million people and 38.6 million trips daily) and in the City of Sao Paulo – MSP (about 10.5 million people and 23.4 million trips daily), approximately 35% of the principal mode of daily travels is done on foot (Data: Research Origin-Destination 2002); compared with the previous research, in 1997, these travels grew 31% in the MSP.

These trips occur mostly because of the existence and continuous development of many areas of jobs and services close to homes, spread in the RMSP and MSP. Nevertheless, they also constitute the first and/or the last segment of extensive travels, with daily time of nearly 3 hours, whose destination is mostly the Center the City of Sao Paulo. In this last situation, the travelers belong to the lowest income level and despite of their poverty condition they are integrated the city economic and production structure.

Until the end of the nineteenth century, the Center of the City of Sao Paulo was a small nucleus, well defined and confined to the heights between the Tamanduatei and Anhangabau rivers (around 20,000 m<sup>2</sup>). One century later, it has expanded north and west up to reach the two major rivers of the city in whose banks were built the large expressways “Marginais do Rio Tietê” and “Marginais do Rio Pinheiros”. Furthermore, the urbanization reached, south and east, the rivers Traição, Moóca and Tatuapé, that were channeled and received the avenues Bandeirantes, Anhaia Mello and Salim Maluf (around 100,000,000 m<sup>2</sup>). More recently, tendencies of expansion of the limits of this enlarged center can be already observed even further to the west.

As far as these limits of the Center tend to grow, the Municipal and State Governments align themselves to put in practice actions for the Recovery of the Historical Center, transferring administrative activities to restored historic buildings, installing cultural, leisure and tourist equipments and creating tax incentives to attract private investment and generate employment and income. However, it was the advent of the Transport Single Ticket (possibility of 4 trips – 3 on tires and 1 on rail – in a 2 hours period, implanted in 2005), which allowed accessibility conditions to the Historical Center, that forecasts a stage of great effectiveness for its recovery. Strengthening this public actions towards the Center, the 2006 enforcement to protect urban landscape, known as Clean City Act, became a great success throughout the city, but particularly successful in the Historical Center. Also, dwellers and business people are already involved in transforming the area into a friendly neighborhood by many organized institutions and actions.

In fact, we can observe in the Historical Center of the City of Sao Paulo the dispute for restricted small public space: the streets and sidewalks are disputed not only by everyday walking travellers and the motorized traffic when crossing streets and avenues, but also by the regulated or granted uses of

public space – beneficiaries of public spaces -, such as formal and informal shops, taxi spots, newspapers and magazines “kiosks”, bars and restaurants, parking along the sidewalks, major parking lots under streets and squares etc.

However, this Historical Central Area does not receive the necessary attention to the provision of sanitation services in its streets. Despite the public spaces being cleaned several times a day, everyday walking travelers are not considered as users of the other services of Basic Sanitation (even if they were included in federal laws) such as: drinking water, sewage collection and treatment and rainwater management.

For each of these beneficiaries of public space there are several kinds of responsibility for the restriction of public space to the everyday walking travelers. Then, in order to refund these inconveniences, they should perform additional activities which will be proportional to the scale of their business.

What this study proposes is to identify the wide range of situations of the beneficiaries of public space, to establish their relations with the everyday walking travelers around and to evaluate their responsibilities for the Sanitation of Streets. Each beneficiary of public space will be assigned by both the Transport Regulation Authority and the Sanitation Regulation Authority, a counterpart in the services and public facilities on local street sanitation. At minimum, we can illustrate them: a trash container and the collected garbage to be disposed in a safe place by the beneficiaries of public spaces. At maximum, the underground parking concession should include complete street sanitation services such as drinking water, tap water, bathrooms with or without showers, waste collection and recycling etc. Possibly, the use of these public facilities and services could be paid with a symbolic fee.

# Providing and Maintaining Urban Water and Sanitation Services

Author: **Mr. Hugo Hammar\*** et al.  
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Keywords: urbanisation, infrastructure, sanitation, drinking water, climate change

## Introduction

In the developing countries the pace of migration from the village to the city continues at a pace as the new wealth develops around businesses based in the cities. This continued growth puts a huge strain on the water and sanitation systems which in most cases were planned and developed over one hundred years ago for a much smaller population. With climate change, pollution and population growth the situation will get worse unless we take positive steps to develop new water and wastewater systems in some of the poorest regions of the world.

By contrast in the so called developed countries we have not valued our underground assets that have been installed and in many countries we lose almost half of the water before it reaches the tap. We seem to have forgotten the lessons of the nineteenth century when these great water and sewage systems were installed and at last broke the grip of cholera and other water borne diseases and significantly increased life expectancy.

However, modern materials and trenchless renovation techniques mean that these old systems can be renovated without digging up the street or new systems can be installed using fast and cost effective ploughing or directional drilling. Despite all these developments in the west we face increased water restrictions due to more variable climate conditions and high leakage rates and in the east and south almost 5000 people, mainly children, die each day due to water borne diseases.

In this paper the authors highlight some of the important challenges that we face and show how different groups working together using modern plastics materials can really make a difference to people's lives.

## The challenge of the renewal of water systems inside our old cities

In Western Europe most cities grew rapidly in the early years of the 19th century as industries developed and rural population moved into the city. During this period of expansion the first underground utility systems were installed – gas, which was used initially for street lighting and piped drinking water and domestic sewerage systems. As a result most of the oldest pipes are in the centre of our cities for example over half of the water mains in metropolitan London are over 100 years old and a third over 150 years old.

These water mains made of cast iron were laid in London clay, an aggressive soil and one susceptible to shrinkage and “heave” due to climatic variations. Secondly, the mains were originally in un-surfaced or lightly surfaced roads with relatively light traffic loads from horse drawn vehicles whereas now all roads are of heavy duty construction and suffer from high traffic loadings. Finally, the “lead run” joints used to connect the pipes together have lost much of their original flexibility and integrity. The combination of age, soil conditions and changes in external loadings has resulted in increased breakages and leakage from what is, after all, a brittle material.

To reduce water losses Thames Water has embarked upon a programme to replace 1603 km. of these pipes over the 2005 – 2010 period of investment at a cost of £703 million. The material chosen for the new pipes is PE, a flexible material able to cope with the soil conditions, traffic and vibration loadings.

### **The challenge of reaching the poor living around the cities in the developing countries**

In the developing world many cities are now termed “mega-cities” with populations above 10 million and still more continue to flow into these cities – for the first time in human history the number of people in our cities exceeds 50% of the total population and by 2030, this will reach 60%. In fact every day, over 100,000 people move into cities, many of them into low income, peri-urban settlements or urban slums. These communities often lack safe and affordable water supply and basic sanitation services. At the same time, local service providers lack the capacity to reach these communities due to the technical, social, financial and institutional challenges involved.

Water and Sanitation for the Urban Poor (WSUP) is a cross-sector partnership that is committed to make a difference in these communities. The members of WSUP pool their expertise relevant to water, sanitation and hygiene and work directly with local service providers and with communities to design, develop and implement effective solutions. The organisation was founded in 2005 and has a target to reach 3.5 million people by 2015 with improved water, sanitation and hygiene.

A number of projects are currently reaching the implementation phase and will together reach over 400,000 people.

### **Concluding comments**

Fresh water and sanitation are vital to mankind and clearly pollution, rising population and climate change are putting strains on our systems and our futures at risk. Borouge and Borealis have recognised this as the most vital challenge facing our world and have launched the “Water for the World” programme where by working with other partners we aim to deliver sustainable solutions for fresh water and sanitation. This paper shows that there are solutions to these challenges, in many situations using modern plastics materials but it also requires a will and some dedicated groups of people and organisations such as WSUP to make it happen.

# Sustainability of Local Sanitation and Water Supply in Urban Areas – Examples from Eastern Botswana and Periurban Dhaka

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Keywords: pit latrine, groundwater, geology, pollution, nitrate

Two examples of local sanitation and water supply have been studied, one in Botswana and the other in suburban Dhaka. Pit latrines and local wells is a common way of solving sanitation and water supply problems in fast growing urban areas. In some cases this is not at all a sustainable solution but has to be replaced by water from well-fields outside the habitation and eventually by imported water from surface water sources. Largely this depends on the local geology.

In Eastern Botswana so called “villages” like Ramotswa and Mochudi have populations of 40-50 000 inhabitants. However, the habitations are rather village-like in the sense that the population density is rather low. The villages in Botswana are built on soils formed by weathering of the under-laying hard rocks and the initial solution for water and sanitation was based on pit latrines and drilled wells within the habitation supplying a sizeable number of standpipes. Problems both with bacterial and nitrate pollution have been encountered. The mean value of wells a large number of wells inside urban areas in Eastern Botswana exceeded 50 mg/l which has forced the municipalities to drill new well-fields outside the habitations. This is a common development during urbanisation. The nitrate content in the wells is clearly related to the soil texture. 1-50 % of the nitrogen is lost in deep leaching while 30-80 % is denitrified. Bacterial pollution may in coarser soils travel from a latrine to a well within days. An example of a transit time of 24 hours is observed which caused an epidemic of diarrhoea. A transit time of at least 25 days is needed to eliminate the risk of bacterial pollution.

Suburban Dhaka has fast growing habitations and there is no possibility for the municipality to supply piped water supply and sewage. Instead NGOs have helped in the installation of household wells supplied with handpumps and pit latrines. Two suburban areas have been investigated, Dattapara, north of Central Dhaka and Keraniganj south of the Buriganga river. Especially Dattapara is housing a very dense population and the horizontal distance between latrines and wells may be no more than 10 m. Contrary to the situation in Botswana this seems to function well due to the geological conditions with a thick clay layer covering the sand into which wells are installed. Neither is there any bacterial pollution nor are there elevated nitrate contents in the groundwater. In rare cases where bacterial pollution has been encountered it has been found that the pump installations are not well done allowing leakage of surface water into the well. The habitations are very dense and the nitrogen load on the areas is in the order of 1500 kg/ha, about ten times the application in intensive agriculture. Most of this is denitrified and only about 30 kg/ha are lost in deep leaching resulting in 10 mg/l of nitrate, far below the permissible limit. One effect of the dense habitation is an elevated chloride content exceeding 500 mg/L. This is however a minor problem even though it affects the taste of the water. What may still be a sustainability problem is the accumulation of ammonium in the soils. In the case of prolonged dry-spells this could be nitrified and leached to the groundwater.

The local geology plays an important role for the sustainability of the first hand solution of sanitation and water supply in emerging urban areas in the form of local wells and pit latrines. Ecological



sanitation may improve the sustainability as it leads to less leaching and removes by urine separation a large portion of the nitrogen from deep leaching. In Kerala, which with a very high population density, is more or less continuous village, ecological urine separating latrines protects the very shallow groundwater from pollution. The important suburban agriculture may as well be benefited from the nutrient supply. Ecological sanitation is also growing steadily in West Africa and the use of the collected urine in periurban agriculture has been well accepted in for instance Bamako in Mali and Ouagadougou in Burkina Faso.

# Can Urbanization Solve Inter-Sector Water Conflicts? Insight from a Case Study in Hebei Province, North China Plain

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Keywords: groundwater, North China Plain, urbanization, water balance, water consumption

China, like many countries, is experiencing an unprecedented rate of urbanization. Urbanization is usually thought to intensify inter-sectoral water conflicts. In contrast, this paper considers urbanization as part of a viable solution to a water shortage problem.

By evaluating water consumption, or depletion, in terms of actual evaporation and transpiration, as opposed to the amount withdrawn from water sources, this paper argues that urbanization has a positive role to play in lessening inter-sectoral water competition and in reversing groundwater depletion. We focus particularly on the potential for urbanization to alleviate severe groundwater shortages in the North China Plain, where aquifers supply water for both urban and agricultural uses.

In the North China Plain, water is withdrawn from and returned to a single primary source: the unconfined alluvial aquifer beneath the plain. Reduction in pumping for irrigation triggers a corresponding reduction in groundwater recharge (infiltrated precipitation and excess irrigation water, which percolates through the soil profile, down to the water table) from irrigated cropland. Consequently, despite decades of reducing pumping, the water table has continued to decline at a steady rate, averaging 0.5 meter/year. The declining water table is clear evidence that the water budget is not in balance, as consumption perpetually exceeds replenishment of the hydrologic system.

We examine several management options in terms of their net water consumption, and how that would affect the overall water balance. Interbasin water transfer (Nanshui Beidiao) will provide a critical water supplement to some local areas, but will not by itself abate regional groundwater declines. Crop changes such as substituting vegetable crops for the current wheat/maize rotation is unlikely to generate sufficient water savings, due to the extended growing season of vegetables compared to maize. Reintroduction of annual winter fallowing would alleviate groundwater declines, independent of other land-use changes; however, for social and economic reasons, land fallowing is not likely to be widely accepted. Irrigation-efficiency technologies such as sprinklers and underground pipes, which reduce seepage from the soil profile, do not save water in the North China Plain because seepage provides valuable recharge to the underground water source. In contrast, technologies that reduce the evaporation component of evapotranspiration do reduce outflow from the overall hydrologic system, and therefore can save water. Increasing water prices for the industrial sector also is a viable water-saving strategy. In contrast, increasing agricultural water prices is unlikely to reduce irrigation water consumption unless prices become high enough to take land out of production.

Finally, we considered urbanization. Although withdrawals for urban water use may be large, urban water consumption generally is much less than agricultural water consumption, on a per-area basis. Thus, a key to relieving inter-sector water conflicts in the face of rural-to-urban land-use change is

to capitalize on this paradox by maximizing the reuse and minimizing the consumption of water withdrawn for urban supplies.

Thus, at the regional scale, urbanization can help achieve reverse ground-water declines by replacing some agricultural land use, particularly under two conditions: (1) both the industrial and agricultural sectors adopt water-saving technologies, and (2) urban wastewater and runoff are treated and reused directly in agriculture or indirectly through artificial recharge. Combined, the two conditions must result in a net decrease in water consumption at the regional scale. These points are illustrated with a case study of rural Luancheng County and adjacent industrialized Shijiazhuang City in Hebei Province.

We offer a simple, quantitative water-balance approach for planning a mosaic of future landscapes, which together consume no more water than is naturally replenished to the North China Plain, and therefore can effectively arrest groundwater declines. We demonstrate this approach using various combinations of urban and agricultural land-use practices. Though urbanization alone cannot stabilize declining water supplies, we show how it can be part of an integrated solution.

# Wetlands in Cities: Conflicts or Harmony?

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Keywords: urban wetlands, floods, water pollution, wetland use, management

## Presentation of topic and explanation of how this paper advances knowledge of the theme

The main idea of the presentation: with the growth of urbanization the necessity in new building areas is also increasing; in humid climatic zone wetlands are often occur within urbanized territories; some of them are very difficult to transform into another type of city landscapes and as a result a building up areas are flooded; the ecological value of wetland and their origin for sustainable city development should be consideration during urban landscape planning. In the paper the results of more than 10-years investigation of urban wetland in Belarus are given. The following questions are discussed: peculiarities of urban wetlands, their buffer function and water quality; consequences of building up wetlands; possibilities of wetlands integration into urban landscape (on an example of Minsk city).

According to the land statistics and own investigation there are wetlands practically in every city; they occupy from less than 1 up to 6% of their territory. As a result of urbanization some wetlands have been drained and built up, some of them were flooded or transformed into arable land etc. Preserved wetlands are used spontaneously, because their status is undefined, no special protection measures are being applied to them. These wetlands suffer from intensive anthropogenic influence such as recreation, deformation of wetland banks; dumping garbage either near the wetlands or partially on the territory of wetlands, fires, dumping polluted substances and etc. Nevertheless, many of wetlands have features that are unique for urbanized territory, and which would be highly important to be preserved in their natural state. One of the most important functions for urban environment is considered to be hydrological or water protection function (water accumulation and redistribution of outflow, support of surface and underground water quality).

It was established, that the state of wetlands in cities and in suburbs is significantly different. It depends on wetlands origin and on type of nutrition as well as on wetland location and sources of pollution. For example, the subsoil waters of high bogs are acidic, with low mineral content. The most significant changes were observed at those wetlands, which are located near industrial and residential areas and are partially built-up or used for wastes dumping. Contaminants deal with large amount of discharges from houses and by littering of the banks. Waters contain an increased concentration of almost all components, but especially of chlorides, potassium, ammonium nitrogen and phosphate. Considering urban wetlands pollution and transformation it is necessary to note, that in some cases pollution of wetlands means the prevention of rivers (lakes) pollution as well as underground waters. Barrier functions of peat are illustrated by two wetlands, where the differences in chemical composition of water between outskirts and center (in 2-8 times) were established.

The hazard and consequences of flood are given on an example of Polotsk and Borisov cities, where some microdistricts have been built on the wetlands. It has been established that floods can happen several times a year on such areas: during snowmelt and heavy rains periods. It is no doubt that this type of floods can be studied as one of the cases of land urbanisation and transformation, though

to our minds it requires greater attention because of the peculiarities of its results. This category of floods does not have any statistics; the damages caused by them are not evaluated either. Local people indicate that floods can last up to 2-3 weeks; the roads and the land attached to houses get flooded, and sometimes water level gets even higher than the basement of houses. The groundwater level is very high even during summer. It is shown that conditions of wetlands formation, type and depth of peat as well as behaviors was not taken into account during settling, and the peat has been not extracted. The construction of dwelling houses was started almost at the same time as the drainage procedure of this territory and the ground was actively added up. Today a lot of dwelling houses have basically “sank” into the ground as a result of peat slump and its mineralization. Some of the houses are inappropriate for human habitation due to frequent floods and constant moisture. The matter is that generally in 20-30 years after building, the processes of rewetting and restoration of wetlands occur and dwelling houses become non-suitable for living. Wetland flora (reed, sedge, rush) quickly restores on neglected territories.

Our research has indicated that the majority of preserved wetlands are very harmonically placed among surrounding landscapes (in combination with ponds or forests). Some of them are single sites of wild nature in cities. Keeping in mind the uniqueness of some wetlands, we have proposed to preserve them in their natural condition and give them a special status in the system of land use. Conflicts, or discomfort for citizens is created when houses are built directly on the territory of a wetland.

Practical of applications: Basis for urban wetlands conservation in Minsk and some measures for their integration into urban landscapes were proposed. The results of our investigation were used for designing for the Territorial Complex Scheme on Environment Protection of Minsk and Minsk Region.

# Do Megacities and Metropolitan Areas Pose a Risk to Sustainable Development?

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Keywords: sustainable development, megacities, risk, governance, water resources and services

Between 1950 and the year 2000 world's total population grew from 2.5 billion to more than 6 billion people. The lion's share of this growth took place in cities: While in 1950 750 million people lived in cities, this number had almost quadrupled up to 2.8 billion by the beginning of the new millennium, implying a daily growth of urban population of about 110.000 inhabitants. According to this, the provision of adequate service infrastructures is one of the biggest challenges in urban development. The forecasted further growth of global population (which will amount to an additional 2.1 billion people until 2030) will take place exclusively in cities. Therefore, cities play an extraordinary role for the achievement of sustainable development at a global scale in two respects:

On the one hand, due to the high concentration of people within cities and the related enormous material and energy flows, the high consumption of natural resources from the hinterland and the giant production of waste and sewage, socio-economic inequalities, or substantial governance deficiencies, cities produce high risks for sustainable development. On the other hand, however, this concentration provides the opportunity of facilitating urban service processes in technical and organizational terms, thus contributing to a more sustainable use of natural resources.

According to the basic definition of the Brundtland-Report, sustainable urban development requires the achievement of a two-sided basic goal: to meet the needs of the present population within a city 1) without compromising future generations of urban dwellers and 2) without compromising the present and future generations living outside the city to meet their own needs.

In the project "Risk Habitat Megacity – Sostentibilidad En Riesgo? ([www.risk-habitat-megacity.ufz.de](http://www.risk-habitat-megacity.ufz.de)) the research team aims at developing a strategy for sustainable development in megacities and metropolitan areas in Latin America considering some of the relevant risks mentioned above. In this project, the three crosscutting concepts of "sustainable development", "risk" and "governance" will serve as an analytical framework. These concepts will be applied to a range of critical fields of urban development in Santiago de Chile, the first case study area: social-spatial differentiation, land use management, energy system, transportation, air quality, waste and water.

With respect to urban water services the operational capability of the service infrastructure within the city and the interlinkage of these infrastructures with the catchment area in terms of natural resources and sinks will be analysed. A tool will be developed to analyse these processes appropriately. Core elements of this tool are: a sustainability analysis (1), risk analysis with respect to the functioning of the city as a system (2), policy analysis (3), risk analysis regarding policy options (analysis of obstacles for policy implementation) (4)

Ad 1: Criteria, indicators and target values for sustainable urban development in general and for sustainable usage of water will be developed in close collaboration with local stakeholders. Criteria

and related indicators comprise aspects of ecological, economic and social sustainability and their mutual interlinkages. The suchlike defined targets for urban development then are compared with the status quo and the most urgent sustainability deficits will be derived according to the particular 'distances to target'.

Ad 2: The assessment of sustainability deficits in terms of permanence and spatial extension (i.e. scopes in time and space) as well as (ir)reversibility leads to the identification of the most urgent risks for the operational capability of the city.

Ad 3: Applying the governance concept, within a scenario framework different policy options are elaborated which are estimated according to their suitability to avoid or at least reduce the sustainability deficits and risks for the operational capability identified above.

Ad 4: Here the obstacles – i.e. risks – for the implementation of the policies elaborated in (3) will be identified and analysed. Based on this, proposals for an appropriate management of such risks will be elaborated in addition to step 3.

According to the first findings on Santiago de Chile, the overstraining of water courses (ecological flows) coming from the Andes mountains for water supply and irrigation as well as the falling groundwater tables seem to be the most important sustainability deficits in quantitative terms (i.e. as far as the amount of water resources used is concerned). Heavy metal mining activities upstream the city on the one hand, the incomplete treatment of urban sewage and the effluents from great irrigation areas on the other hand are significant sustainability deficits with regard to water quality. The management of storm water and its usage as green water in the city are very important topics with respect to several types of risk production in the city (e.g. flooding, island-heating-effect) and are therefore on the strategic agenda of water authorities in the city.

The paper presents the methodological design of the investigation and first results of the research.

# Small Towns, Booming Economy – An Approach Towards Integrated Urban Water Management (IUWM) in India

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Keywords: Integrated, Model, India, Towns, Information

What happens when IUWM concepts encounter small town India? Around the answer to that question revolves an entire universe of issues and responses that are vital to the process of translating IUWM from theory to practice in one of the most significant emerging economies of the world. IUWM looks at towns' water scenarios in their totality, spanning the urban water cycle from source to sink, addressing the special needs of the urban poor and factoring in all identifiable externalities related to the social and geographical specificities of regions, the dynamics of demography and growth and existing politico-legal frameworks.

This approach is increasingly being seen the world over as an imperative and the focus is shifting to implementation issues and mechanisms. In keeping with this, our paper takes the broad IUWM concept as a given, extracts its major components, maps them against a representative matrix of the situational diversity of Indian towns and attempts to derive key considerations of potential utility to similar exercises elsewhere in the developing world.

Indian small towns are subjected to the pulls and pressures of a booming economy which often results in a highly distorted environment with extreme wealth and poverty co-existing, emergence of land and water mafias and exploitative situations vis-à-vis the poor. There are 3,784 Class II to Class V towns with populations between 10,000 and 100,000 in India today. With India's fast track urbanization and economic pulls like SEZs (Special Economic Zones), this number will grow rapidly as large villages urbanize: a difficult transition, since it comes without a high literacy base, necessary institutional capacities or experience at the local Government level. Such towns, unlike the metropolitan growth engines, have not been adequately equipped to face the whirlwind of change, but this very neglect makes them ideal candidates for modeling physical and institutional systems from the ground.

Through our detailed examination of five small towns in the state of Karnataka, there is an attempt to arrive at a generic model applicable to any small town embarking on an IUWM effort. The process would begin by the town positioning itself on an IUWM scale through a series of baseline studies. Data from these studies can be categorized into demographic, technical, financial, governance/institutional, social equity, knowledge level and sustainability parameters. Through a participatory visioning exercise, the town stakeholders would collectively determine and prioritize IUWM activities necessary for their town as indicated through the baseline data. Implementation would follow an extensive planning and design effort, in a collaborative manner.

What emerged from our preliminary study was a broad profiling of town needs based on key focus areas that together spanned a wide range of IUWM components.

1. In Tiptur (popn: 53,104, Census 2001) the high proportion and growth rate of the slum population made services for the urban poor stand out as the overwhelming need, with current reliance on



informal sources being very high. Related issues of rights, land tenure and the need for participation platforms also figured prominently.

2. In Doddaballapur (popn: 72,000), environmental sustainability issues were a pressing need with industrial pollution, drying up of surface sources, rapid depletion of ground water and the town's imminent expansion as a link between Karnataka's capital Bangalore and the latter's proposed new airport. The strong NGO/SHG presence allows IUWM efforts to address another key IUWM component, namely demand management. Rainwater harvesting and ecosan initiatives are already in operation and can be scaled up effectively in this location.

3. Mulbagal (popn: 53,000) in the Kolar district brought out basic issues of system efficiency, with poor urban planning, only 40% of the town covered by stormwater drains, 70% of sewage being sent to these SWDs, 30% of the town using septic tanks and only 40% of the slums having toilets. Here the need is for rigorous asset inventories, technical analysis, leak management, optimal water treatment inputs and a remodeling of the WS and sanitation network.

4. Harihar (popn: 75,000) illustrates the scope for effective governance. The town is well endowed with water resources, with the perennial Tungbhadra flowing through it. Its water supply system has a 100% coverage, it has a fully-laid sewerage system and under-exploited groundwater resources as well. Yet it also has excess fluoride and nitrates, a dysfunctional sewerage system, a lack of metering, poor revenue collection and under-utilization in several schemes.

Underpinning the entire programme is an Urban Water Management Platform to collect, organize and analyse structured data from all phases of the programme – from baseline surveys to asset inventories, needs analysis, project monitoring and performance measurement. By having an MIS system with structured data tagged to every phase and module of the system, several of the challenges described earlier can be directly addressed. Using such a module for the WS&S system for instance, through parameters like the total input into the system, unaccounted for water, leakages, amount at tap, etc., one could derive a standard tool for decision making and performance evaluation of an IUWM intervention. For less easily quantifiable elements like community empowerment too, our preliminary efforts suggest that a carefully chosen mix of hard data and heuristic parameters would help narrow choices down to those that most closely approximate the best fit for a given situation. Our ongoing documentation of Indian and international best practices would play a supporting role in this. This is the direction in which our model is proceeding.

# Towards Cleaner Environment for the Poor in Ranchi Slums: A Case from India

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Keywords: Urban Poor, Slum Development, Solid Waste Management, Sanitation for the Poor, Pub-  
pvt community partnership

Geeta, a young mother of two, lives in Mission Lane slum of Ranchi. Till recently, she and her family used to go to the nearby fields to answer nature's call. However, slowly, the open space in her surrounding started shrinking due to new houses being constructed around the area and so it was increasingly becoming difficult for Geeta and her family to defecate in the open. They did not had a household latrine nor anyone else in her locality. So, why did Geeta's family not build the toilet then? Geeta and her husband always believed that constructing a toilet will cost a lot and as a daily wage labourer, her husband earned just to feed the family. A toilet was considered as a luxury. With this earning, Geeta could not build a proper house, leave apart having a toilet of her own. "Due to open defecation in the area, the locality was dirty and used to stink a lot" says Geeta. Apart from this, there was no proper place to throw garbage and all the families in her area used to dump it in a common place nearby. "We were used to flies and mosquitoes in our area and never thought that we would start living in a much cleaner environment", said Rony, her neighbour in the slum. "It was the intervention of Nav Bharat Gagruti Kendra (NBJK) that made all the difference" she informs.

NBJK started in 1971 by socially sensitive individuals who were moved by the condition of poverty stricken families in undivided Bihar. NBJK was formed with the vision of establishing a progressive, peaceful and just society that has values of equality, fraternity and mutual help. In Ranchi, NBJK is working in 19 wards out of 37, where several activities have been undertaken. They range from waste management and cleanliness including door to door waste collection, street sweeping and cleaning of drains to development and maintenance of civic infrastructure, cleaning of drains and sewerage and planning for social and economic development such as employment generation and poverty alleviation programmes for the people living in slums. Apart from these, water supply and public health programmes have also been an integral part of NBJK's slum development programmes. "We started with the need assessment survey in slums of Ranchi and found out that some of the slums have problem in water, sanitation and hygiene" informs Rajesh Kumar Das, Branch Head of NBJK. After identification of the slums, the strategy was to inform the community through awareness programmes, to create demand for safe sanitation and hygiene. The process involved organising the inhabitants of the slum through development of slum development committee (SDC). The committee is made with representation from all the quarters of the slums. SDC of Mission lane has around 10-12 members. Under the SDC, a watsan committee was made with the mandate of looking into water and sanitation issues.

After formation of SDC, NBJK started capacity building programmes for Mission Lane SDC with number of community mobilization trainings and exposure visits to areas where successful committees are implementing water and sanitation programmes. Intensive leadership training given to these leaders helped in creating a cadre of community members who in turned mobilized households to build toilets. An important aspect of this was demystifying toilet technology that was understood as

expensive by the households living in slums. NBJK promoted the construction of toilet with people's contribution of Rs 1000 while Rs 500 came from the support from WaterAid, the funding organization that is supporting the project for water and sanitation. Once the households were convinced that toilet construction can be done at an affordable price, it was easy for NBJK to convert Mission Lane to an open defecation free slum of Ranchi. An important part of slum development programme was to link it with the provision of access to safe water. For this, identification of water points was done and hand-pumps were installed leveraging from the budget of Ranchi Municipal Corporation (RMC). Apart from this, soak pits were also constructed to check the waste water flows. Other programmes included the promotion of kitchen garden and vermi-composting.

Apart from providing water and sanitation access to the poorest in Ranchi, NBJK is involved in door to door collection of household waste in 19 wards of Ranchi Municipal Corporation. Feeding to the point to point collection (as against household collection) of daily waste by the RMC, NBJK launched the door to door collection of household waste and other solid waste management activities in the year 2002 through a project called 'Clean Jharkhand'. Based on a business model, the solid waste management programme covers 37,875 households in Ranchi through a cadre of workers called Safai Mitra. 300 Safai Mitras collect garbage from households (from rich, middle and poor localities) and feed the municipal garbage collection trucks that carries waste from point locations. NBJK also manages the dumping yard which is around 13.5 kilometers away from Ranchi town where the organic waste is used for making manure. The project has given livelihood to over 300 Safai Mitras and 500 rag pickers and is considered a successful GO-NGO-Community partnership project in eastern India. Initially supported by India Canada Environmental Facility (ICEF) grants, the project is financially sustainable with a monthly collection of more than Rs 6.94 lakhs as user fees. Apart from this, the RMC provides a grant of Rs. 40,000 per month for collecting household garbage from three wards where slums are located and Rs. 45,000 per month for managing the dumping yard.

The case shows the classic case of partnership with the municipality and the communities to bridge the critical link between the government and the people. The results are clearly visible – a cleaner environment for Geeta and Rony and her children of Mission Lane says it all.

# Sustainability in Infrastructure Development for Industrial City Zones

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Keywords: Sustainability, Infrastructure Development, Eco friendly architecture, Industrial developments, water use efficiency

Industrial zones & belts within a city are usually an epitome of pollution, resource overusage, degraded groundwaters, air and land quality and an unsightly aesthetic. The above description, apt since the industrial revolution, still remains the abiding image of our times. Industrial centres with cities did give rise to compact cities, but technology and behavior soon created a humungous environmental footprint. This issue has now assumed extreme proportions with the conflicting needs for fast development and the resultant aspects of climate change which face developing countries like India. The need of a fast growing economy and the need to keep up with economic competition has forced large-scale development of industrial areas in new city sites, underdeveloped regions, with a large no. of them in ecologically fragile zones. Tax breaks in these city zones have attracted a variety of manufacturers, with their needs to keep costs low, many times at the expense of mis-utilizing local resources of water land and air with a detrimental effect on health, hygiene and the environment. Economically backward but ecologically rich areas in most cases do not mind the tradeoff.

It is in this scenario that a need has been felt of a sustainable developmental paradigm specifically targeted to these zones within the overall city development approach. This paper presents the case of certain projects under development and proposed in such industrial areas which help create an alternate exemplar. In the resource rich state of Uttar Pradesh & Uttaranchal in India, these developments are proposed to kick-start the paradigm shift towards sustainability in infrastructure development.

The paper presents case studies of Sugar & cosmetic factory complexes, which planned additional new infrastructure. For.e.g, When the idea to develop a educational facility for the factory workers emerged, this was proposed to be located adjacent to the main production facility, rather than outside, as originally proposed. The facility was conceptualized with resource efficiency as a base, whether in terms of water, daylight, building materials, land etc and which could act as a experimental base for the parent complex.

These storied facilities were conceptualized from a eco-logic perspective as follows:

- As the location had a extremely variable weather with dusty winds and very high-very low temperatures, the building was planned looking intrinsically into closed courtyards, which provided not just natural light and cross ventilation, but also a shaded space for school activities.
- The courtyards are proportioned to be shaded and are also cooled using the principles of evpourative cooling with water. The building's footprint is minimized over the originally green patch to promote natural percolation of stormwater and a cooler enviorn.
- Usage of Local Building materials including bricks and stone provide a contextual aesthetic and provide a readymade palate of materials providing embodied energy efficiency, besides ease of construction. These also prevent contamination of the vertical and horizontal surface water runoffs due to other possible modern building materials

- Water usage is being optimized in all manners in the following ways:.....
- Stormwater is utilized as an all important resource, with the roof stormwater runoff being utilized for the complex's floorwashing requirements & is reutilized for toilet flushing requirements. This reduces the overall load on conventional water drainage systems, besides providing water efficiency. Low flush toilets automatically optimize this usage.
- Excess Stormwater & ground surface stormwater is stored in tank for usage in horticulture and floor washing. This can be accessed by zero power traditional system i.e. handpumps, thus also promoting the value of water in the younger generation.
- Soilwater (toilet water) is also proposed to be cleansed using a simple DEWATS plant filtering system and reutilized for the extensive requirement of horticulture. This is to be yet accepted by the community and the industrial promoters and is currently under consideration.
- An eco-based concept is promoted in the educational program with recycling of all components of the waste.

Building design has allowed a 100% daylighting usage with no requirement of artificial light. For Cloudy days, energy efficient fluorescent lamps are installed at the optimum light level, which is backed up with a mini- solar photovoltaic system.

This project has led to a complementary philanthropic project among the surrounding community for another rural school with the same principles of resource efficiency in mind. The third project, a industrial facility utilizes all these principles, and also reutilizes wastewater from water cleansing operations like Reverse Osmosis plants. The initial projects has also galvanized other renewable energy operations including the usage of bagasse for co-generation plants, which are now powering the whole facility and the new infrastructure. These developments and their dissemination has also created a ready resource of learning for spillover into the surrounding industrial zones.

The infrastructure sector already (dis) credited with creating more than 50 % of all carbon emissions, and is a major contributor to climate change and resource absorption. This paper shows these initiatives as aimed at creating the water efficiency, resource efficiency and environmental precedence in all infrastructure related decision making within these industrial locations.

# Assessment and Mapping of Water and Sanitation Facilities in Slum Areas of Chennai Metropolitan City, India: A GIS Approach

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Keywords: GIS, Slum mapping, environmental sensitive areas, Vulnerability, Sanitation

Roughly sixty percent of the population in Asia is lack of access to adequate sanitation. Poor drinking water, sanitation and waste result in a smelly, foul, turgid river that despoils a city and its environs. Improved water supply, sanitation and water management boost the economic growth and contribute to poverty eradication and attract the business investment of the country.

One of the major obstacles for efficient planning in urban India is a lack of up-to-date, comprehensive attribute and spatial information about urban systems. This lack of information is a major reason behind the failure of metropolitan cities to include Slums in citywide planning and urban development. Like other major cities in India, Chennai has large slum population with poor sanitation and water facilities. The city suffers from inadequate infrastructure provision, which has not kept up with the rapid urban growth. The pattern of inadequate provision is reflected in the slums in the city, where inadequate basic amenities result in poor living environments.

In this present study an attempt has been made to analyse Water and Sanitation Facilities in Slum areas of Chennai, which is the fourth largest metropolitan city in India. For this study, detailed information on slum areas and sanitation facilities have been collected and digital database have been created. GIS based mapping techniques have been used to map the slums, and environmental sensitive areas. Based on slum mapping, risk and vulnerability mapping have been generated for better planning of Water and Sanitation facilities in the slum system of Chennai. Socioeconomic survey has been conducted to analyse the sanitation conditions of the slum areas to understand the exiting facilities.

The slum population in the Chennai is 10,79,414. The proportion of the Slum Population to the total population is 26 percent. 67 percent of the households in slums live in one-room tenements. Only two percent of the households in slums have more than 3 rooms. Only 26 percent of the Slum population has access to drinking water within their premises. Main source of drinking water in slums is hand pumps and tap water (42 and 31 percent).

The incidence of malaria has been attributed in a large measure to storage of fresh water in containers within the houses. The incidence of gastrointestinal diseases can also be traced to inadequate chlorination, contamination due to improper storage and contamination of drinking water sources on account of garbage accumulation, open defecation, inundation and pollution. More than a third of the households in slums have no latrines. This results in open defecation and consequently the spread of a host of diseases.

30 percent of the households in slums do not have any drainage facility. Of the rest, 14% have open drainage facilities. Thus, 44 percent of the slum population was exposed to grave risk of several diseases.

It is found that more than tenth of the total slum population in Chennai live on riverbanks. There were 33,313 families live along the Adyar, Cooum and Buckingham river banks. Water borne diseases are highly prevalent among these families, and carriers like mosquitoes could bring more ones like malaria into the lives of any of these 1,00,000 plus dwellers. The slums like Mullaikuppam and Dobikana where there are no public sanitation facilities at all. Other slums represent a fair mixture of private and public sanitary facilities, which bring the total slum population to sanitary requirements ratio to 1:0.65.

- It is observed that the water and sanitation facilities such as toilets, septic tanks, pit latrines, and sewerage systems are poor in slums. The slum population along the banks of the rivers and canals requires special attention from the health point of view.
- It is suggested that disposal of garbage and animal waste and maintaining cleanliness along water channels should be given equal importance.
- Unless solid and liquid waste management are taken care of in the city, environmental sanitation conditions cannot be improved.
- Individuals and organizations should help in sanitation management in the respective geographical areas.

The GIS based mapping techniques provides spatial and non spatial information and spatial solutions for slums, water, sanitation and other infrastructural facilities for sustainable management of the city.

# From Sustainable Urban Water to Restorative Developments: Applying a Framework for Water Management when Renewing our Cities

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Keywords: sustainable urban water, urban renewal, stormwater harvesting, sanitation, restorative targets

Internationally, increased pressures on urban areas due to population growth, climate change and resource constraints are driving the need to plan and design more innovative and sustainable water management within our cities. This paper focuses on the implications of these new drivers in the planning and design of three large scale urban renewal developments in Sydney, Australia. It also considers how these new approaches can be rolled-out and become models for sustainable water management in highly urbanised areas around the world.

In Sydney, long term water shortages have resulted in increased public and institutional support for initiatives in sustainable water management, including household rainwater tanks and greywater reuse systems. To date however, regulations and costs to developers have meant that larger scale recycling schemes have been limited to greenfield housing developments where the government-owner utility has provided the infrastructure.

The recent introduction of the Water Industry Competition Act has changed the regulatory landscape in the Greater Sydney region, promising developers significant access to water and wastewater infrastructure. Private companies will now be able to own and operate sewer or stormwater mining infrastructure and sell the recycled water they produce. The opportunities provided by this legislation combined with an awareness of the business case for sustainability are driving a number of landmark urban renewal developments across Sydney to consider innovative servicing options for both water and sanitation.

The case studies addressed in the paper are three iconic precinct scale developments that include residential, commercial and retail sectors, located within 3km of the city centre. In each case, the developer has investigated what it would take to move beyond best-practice and create restorative developments that have net positive impacts for the environment and society. There has also been a significant focus on adopting a holistic and integrated approach that considers water consumption, waste, stormwater quantity and quality and downstream impacts within the same analytical framework. Linkages to the assessment of energy systems alternatives have also been made, particularly in relation to cooling loads and potential co-generation on the sites.

Across the three case studies, the new framework has been applied in order to set clear and site-specific water and sanitation management targets for the developments. This has occurred at three tiers, firstly with a 'Base Case', that meets with already strict government regulations, then a 'Sustainable' case that seeks to have no net impact on the environment and finally a 'Restorative' case that aims to have a net positive impact on the environment. The site specific targets and actions have been defined in terms of catchment (stormwater) management, water use efficiency, potable water substitution and resource recovery.



Each site has a range of opportunities and constraints based upon existing infrastructure and placement within a catchment / urban environment. The first site is located directly on Sydney Harbour and due to its waterfront location, stormwater runoff from this site must be of a very high quality. The second development located near to Sydney's Central Station sits at the bottom of a catchment, with several large stormwater and sewer mains passing beneath the site; this makes stormwater or sewer mining easily accessible. The last example is an old railyard which sits in a low lying, flat area and is constrained by existing drainage capacity and local flooding. At this site, the reuse of rainwater and stormwater provides the added benefit of flood attenuation.

Together, these case studies demonstrate how emerging drivers for sustainability and a changing regulatory landscape have impacted upon the planning and design of water and sanitation infrastructure (at the precinct scale) in Sydney city. The three developments are at the forefront of an emerging trend in Sydney where innovative combinations of decentralised water and sanitation management options are now being seriously explored by developers.

The results from modelling the impacts of water efficiency, the use of alternative supply sources and stormwater pollution reduction will be shown in this paper. These case studies demonstrate how the new framework of target setting and costing for these developments can be applied to assess the potential of these innovations. In light of increasing demands on cities worldwide, these approaches have significant potential to be applied in a range of urban environments.

# Planning for Sustainable Environmental Sanitation Infrastructure and Services in Cities

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Good sanitation and hygiene, together with safe drinking water are essential to keeping people healthy and for success in the fight against poverty, hunger, child deaths and gender inequality. They are also central to the human rights and personal dignity of every woman, man and child on earth. Therefore, reliable water supply and environmental sanitation services are one of the important requirements for a sustainable city.

At the United Nations Millennium Summit in September 2000, all 189 heads-of-state adopted the Millennium Development Goals (MDGs), which set clear, numerical, time-bound targets for making real progress, by 2015, in tackling the most pressing issues developing countries face. Among those targets is the Millennium Development Target 10 (as expanded by the 2002 World Summit on Sustainable Development): to cut in half, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation. Yet today, 2.6 billion people do not have access to basic sanitation, whereby many of these people live in urban areas of Asia, Latin America and Africa. Inadequate sanitation have not only huge consequences on human health, the impacts on the environment, education and economic activities are also enormous. Due to the special challenges, increased focus will have to be given to the urban and peri-urban population. According to the most recent estimates, over 900 million people can be classified as slum dwellers – that is, lacking one or more of the following conditions: access to improved water, access to improved sanitation facilities, sufficient living space, dwellings of sufficient durability and structural quality, security of tenure. In today's world, almost one out of three urban dwellers already lives in a slum. It is such urban poor, living in "slums" that suffer most from deficient environmental sanitation infrastructure and services.

This unacceptable situation and recent experiences provide strong evidence that conventional approaches to planning and implementation of environmental sanitation services in urban areas are unable to make a significant dent in the service backlog which still exists. The typical conventional approach addressing the problems related to urban environmental sanitation has been one in which planners and engineers define the needs of the population, including the poor, and then decide what type of infrastructure and service will be provided. In most cases sector professionals then translate hypothetical demand into project designs based on sewerage and treatment technologies commonly used in industrial cities of Europe and the United States. Such top-down and supply-driven approaches have seldom been appropriate in the developing country context as many examples illustrate.

The main objective of a sanitation system is to protect and promote human health by providing a clean environment and breaking the cycle of disease. In order to be sustainable a sanitation system has to be not only economically viable, socially acceptable, and technically and institutionally appropriate, it should also protect the environment and the natural resources. When improving an existing and/or designing a new sanitation system, sustainability criteria should be considered related to all of the following aspects: (a) health and hygiene, (b) environment and natural resources, (c) technology and operation, (d) financial and economic issues and (e) socio-cultural and institutional aspects.

Most of these sustainability criteria can only be taken into full consideration if the planning for environmental sanitation services is based on a model which involves all stakeholders from the beginning of the planning process. The “Household-Centred Environmental Sanitation” (HCES) approach is such a model where decisions are reached through consultation with all stakeholders affected by the decision, according to their spatial attribution. The HCES approach places the household at the core of the planning process and, therefore, responds directly to the needs and demand of the user, nevertheless retaining coordination with the local authority. Individual households determine what sanitation facility they want and can afford; together with other households, they decide on the piped water system they want for their community; together with other communities, they determine how the city might treat and dispose of its waste. On the other hand sanitation policies and regulations, critical for an enabling environment are determined by central government, but their implementation is delegated to the appropriate levels, as close to the household as possible and reasonable.

A further component of the HCES approach is that problems should be solved as close to their source as possible with an emphasis on recovery of waste as a resource. Only if the affected zone is unable to solve the problem, should the problem be “exported”, that is, referred to the next spatial or administrative level.

The successful application and implementation of the HCES planning approach requires an enabling environment including (a) the necessary support by the central and local government, (b) a flexible legal framework, (c) arrangements for small credits, (d) appropriate institutional arrangements, and (e) required skills.

# Sustainable Water Management in a Megacity – Macro-Modelling for Lima

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Keywords: Lima, megacity, macro-modelling, participation, resource fluxes

Planning, design and management of water infrastructure always has been a challenging task. Facing the pressing demands of today, such as aiming to achieve the Millennium Development Goals, and also taking into account sustainability with its various facets, including preparedness for climate change, this task appears to be unsurmountable. This holds true in particular for megacities (urban growth centres) with their large number of population often suffering from insufficient water supply and sanitation services.

Despite all these challenges, the needs of the population are to be addressed today and in the very near future.

Traditional approaches to tackle the challenges often are focusing on the various subsystems, such as solutions for subsystems (e.g. improvement of water supply in a single city district) or in isolated (often demonstrational) solutions. However, the need to consider the urban water supply and sanitation system as a whole is often neglected. This is of particular relevance since the megacity is often interacting with its surroundings (e.g. sources of water supply, discharges of wastewater, migration of population and urban planning issues).

This paper advocates the need for considering the megacity water system as an entirety. In order to be able to consider the system, with the complexity of its processes and the interactions involved, the setup and application of macromodelling tools is suggested. It is obvious that, due to the sheer complexity of the system, modelling approaches have to be conceptual, not modelling every single pipe.

Taking water and wastewater management of the urban growth centre Lima Metropolitana as an example (with its particular characteristics: annual rainfall of 9 mm; high dependency on water supply by the Andean rivers; particular vulnerability to climate change and ENSO effects; high fraction of non-accounted-for waters; space limitations due to topography; significant population growth), this paper presents a computer modelling approach, which takes the water system of the city as a whole into account: In close cooperation with the water company of Lima, a simulation model is being developed which allows to represent groundwater abstraction, water supply by rivers, water treatment, water supply network, consumption, wastewater discharge and treatment to be represented and modelled in a unified way.

Representing the major fluxes of water, pollution, resources and costs and describing the transformation processes in a conceptual way serves as a tool for evaluation of scenarios and operational variants. Model setup, simulation and analysis of results is carried out in close cooperation with the relevant stakeholders (e.g. water company and NGO sector) and also supports participatory approaches by facilitating informed discussions and decisions. Furthermore, the simulation system assists, by allowing population growth and climate change scenarios to be modelled, also in long-term planning.

The simulator uses building blocks for the main elements of the megacity water system (including, for example, groundwater wells, water abstraction and purification plants, distribution network, city districts, sewer network, wastewater treatment systems and outfalls. The elements are interacting through links of water, resource, pollution, energy and cost fluxes, all of which can be represented and modelled within the simulator. The underlying modelling principle of resource flux modelling is enhanced by dynamic components and also allows interfaces to other simulation models to be set up. Processing of time series information enables future scenarios to be simulated conveniently. Integration of geographical information (Google Earth interface) and representation of resource fluxes facilitate user communication. Setting up potential solution variants (e.g. addition of treatment systems of different technologies) is supported by the integration of the appropriate design formulas in the modelling system.

The present paper analyses, for a subsystem of Lima, various scenarios of population growth and availability of water resources, and illustrates use of modelling as a means to analyse the effects of reduction of water losses, future water-demand scenarios as well as their effects on wastewater treatment efficiency. Furthermore, the impacts of the provision of additional water purification and wastewater treatment facilities on the entire water system are analysed.

Furthermore, the paper summarises some of the experiences made in the application context and gives recommendation for future work and applications.

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# Social Issues in the Provision & Pricing of Water Services – Maharashtra, India

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Keywords: Access, Equity, Affordability, Economic Regulation, Sustainability

Water scarcity is an ever-growing global problem. Increased population pressures, improved living standards, & growing demand for environmental quality have all prompted governments to find better ways to manage their available water resources. In declaration at the Bonn 2001 International Fresh Water Conference & again at the 2002 World Summit on Sustainable Development (WSSD) in Johannesburg, ministries expressed concern at the 1.1 billion people in the world who, at the beginning of 21st Century, live without access to safe drinking water, & 2.4 billion without access to proper sanitation. The Millennium Development Goals expressed in the UN General Assembly's Millennium Declaration, call for halving the population of people without access to safe drinking water by 2015.

Maharashtra State, which is 3rd largest state in India. However, the water sector has been affected badly by various problems viz. conflict within various categories of users & unsatisfactory levels of water use efficiency & cost recovery. There was thus a pressing need to tackle the situation from consideration of productivity, equity & sustainability.

A holistic approach has there, been adopted by the state involving policy reforms, legal enactment, capacity building & stakeholder participation. Subsequent to framing of a State Water Policy in 1993, an important legal measure was taken in 2005 by enacting the Water Resources Regulatory Authority Act.

Maharashtra among the first state in India to have framed water policy keeping in view the problems in the water sector & the challenges to be faced in 21st century because of the growing population & increasing demand from various categories of users & to lay down the road map comprises strategies & approaches to face the challenges.

A social issue in the provision of water services has to be considered from the perspective of impact of policies on different income & consumer groups. Water pricing policies can contribute to environmental & economic goals but may face social resistance. However social concepts in water service provision include access & affordability. "Affordability" is social aspect of water service provision that is most clearly & closely linked to pricing policies. Affordability of water services may not be distributed equally across income groups or neighborhoods – a lower income household will inevitably pay a higher proportion of their income for water services than a higher income household does.

Charging water pricing structures to better reflect environmental externalities & resource cost will always entail social acceptability issues. Social water pricing can often contribute simultaneously to economic efficiency, resources conservation, & equity goals. Improving access to water services & filling water infrastructure investment gaps have cost implication, & the distribution of these costs is important for policy implementation. Institutional frameworks for water governance also deter-

mine how (and by whom) water pricing is set and regulated, as well as how environmental & social concerns are dealt with.

Appropriate water pricing is an important incentive for water conservation & a disincentive for water pollution. Also, optimal levels of service in water supply & sanitation have both human health & environmental implications. Lack of access to good water is a key element of poverty, but pricing water in a way that reflects environmental & efficiency concerns can sometimes be controversial due to social consideration (especially affordability for low – income households).

The question is often framed as one of efficiency versus equity. However, these two approaches do not necessarily have to result in conflicting policy options. Under certain conditions, water pricing systems can promote efficiency while addressing equity goals. One such approach would define the basic needs part of water demand, access to which should be guaranteed for all (especially low–income) households, & beyond which the prices for water services should reflect economic & environmental policy objectives.

With above background, household water charging system has to be designed, keeping in view,

- economic efficiency
- equity & affordability among the various consumers for essential needs
- generation of revenue sufficient to meet service providers O & M / Financial requirement
- environmental effectiveness to ensure sustainable use of water resource

To establish water charging system with above objectives in mind, there is a need for regulation in water sector as a whole in protecting against abuse of monopoly power. Economic regulation in particular seeks to address conditions of supply, access & prices. Customer service, water quality, investment, profit & return on capital are also subject to regulation.

Maharashtra has already established Regulatory Authority in water sector aiming to ensure efficient performance, adherence to standards & fair, affordable user charge with sustainable development of water sector. Authority in the initial year is making tariff regulation for deciding tariff structure. Authority will come with it's 1st tariff order in June 2009.

The policy & the legal measures were introduced in Maharashtra by following full consultative process with civil societies / NGOs / stake holders & expert in the field.

# Lessons Learnt of a National Community Based Sanitation Program Facilitated in over 100 Cities in Indonesia

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Keywords: Community based sanitation, multi-stakeholder approach, Quality management, Health impact assessment, ABC analysis

The few centralized sewerage systems in Indonesia generally do not cover poor residential areas, many of which lack even the most basic sanitary infrastructure. Due to large investment costs, even if a few more centralized sewerage systems are to be constructed, large-scale sewerage programs are unlikely to improve sanitation significantly for the urban low-income areas.

This paper provides recommendations, based on the lessons learnt of a CBS mass-dissemination program of over 250 CBS systems in low-income communities in over 100 cities in Indonesia. Included are a number of “Best Practices” for sustainable program implementation such as the Multi-stakeholder framework between communities governmental and private sector organizations who coordinate and facilitate CBS, Quality Management to safeguard the effectiveness of the technical sanitation infrastructure options including wastewater treatment efficiency and effluent standards, Activity Based Cost Analysis to monitor the cost efficient implementation in a transparent manner and Health Impact Assessments (HIA) to objectively document achievements related to improved public health and livelihoods within disadvantaged communities.

## About SANIMAS

SANIMAS, or Sanitation by Communities, is a national dissemination project that is funded and coordinated by the National Indonesian Planning Agency (BAPPENAS) the Ministry of Public Works (PU) demonstration project and Local District Governments (PEMDA). The aim of the project is to mainstream CBS as the leading option for providing improved sanitation.

A typical CBS project consists of a low-cost simple sewerage system consisting of household sanitation facilities linked by a network of small-bore feeder sewers to a local wastewater treatment plant which follows the DEWATS Quality standard. In areas where low-income people resided in rented settlements, public community sanitation centers (MCKs) were constructed, consisting of toilets and bathrooms connected to a wastewater treatment facility. Each of the developed CBS systems serves from 50 to 150 urban households, depending on the size of RTs and RWs (the two smallest administrative units in the Indonesian government).

The execution of 90% of the Indonesian SANIMAS program is currently facilitated by a network of non-for profit organizations including BORDA, LPTP, BEST and BALI FOKUS.

Since the adapting a Quality management system in 2004 the network of facilitation agencies have facilitated more than 250 community sanitation projects in more than 100 cities within 17 provinces of Indonesia. Basic and improved sanitation facilities have been provided for over 100.000 people, decentralized sewage treatment facilities provide efficient daily wastewater treatment for over 9000 cbm of domestic wastewater making SANIMAS one of the largest and most successful community sanitation programs in the developing world.



Per capita transaction costs for improved sanitation was reduced from EUR 160 eqv. in the demonstration phase to EUR 70 during the dissemination phase.

The results of a Health Impact Assessment revealed that open defecation was reduced by 100% , sanitation related diseases decreased by 60% in the intervention areas.

## **Best Practices**

### **A. Multi-Stakeholder Framework**

- A "buy-in" of all main stakeholders in community sanitation projects is necessary to ensure active participation during different phases of the implementation
- Responsibilities of stakeholders must be regulated and should reflect their mandate, competence and experience
- Multi-source financing schemes must be made transparent to all participating parties
- Open lines of communication need to be established between stakeholders to anticipate bottlenecks during implementation

### **B. Quality Management**

- Best Practices and processes related to planning, infrastructure construction, operation & maintenance must be standardized at an early stage to provide solid tools for uniform capacity building in a "high-growth" program environment
- Standardized control mechanisms and criteria for technical sanitation options and infrastructure must be developed for a set of implementations options to ensure quality and performance of community
- Benchmarks for professionals involved in the implementation of community sanitation projects (e.g. community facilitators, supervisors, civil engineers) must be in place to ensure a uniform high quality facilitation.
- A database for key performance indicators needs to be established and maintained on the executing stakeholder level to allow for efficient monitoring and evaluation.

### **C. Activity Based Cost Analysis**

- Multi-source financing requires detailed costing and, financial controlling of development activities as funds are allocated for a pre-determined number of sanitation interventions and regulated by contract agreements that govern the utilization of funds.
- Financial administration of sanitation projects should allow for analysis of expenditures on the basis of activities and individual sub-projects. In that way, cost of procurement of materials and efficiency of facilitating staff can be measured, compared and checked transparently.

### **D. Health Impact Assessment**

- Standardized health impact assessments (HIA) that can be facilitated in a participative, time-efficient manner must be an integrated part of community sanitation programs to prove their desired outcome – improved public and environmental health as well as livelihoods of residents and communities
- In order to compare the impacts of a great number of sanitation community projects within a national dissemination program, structured interviews should be followed by pre-determined composition of gender and age groups, a set of questions that query the 4 levels of impact related to health & hygiene, infrastructure, community environment and general impact on the livelihood

# On Possibility of Serving a Normal Sanitary Condition of Tashkent City and Convenience of Habitation in it

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Keywords: Sanitary control, Epidemiological control, Surface water courses, Waste water, City waste

At present it is doubtless that sickness rate and health condition of population of any state connected directly with grade of environmental pollution and general hygiene and sanitary conditions. The Republic of Uzbekistan can not stand out of the problem as well, since ecological and sanitary-epidemiologic situation is rather unfavorable what is reflected on health condition and sickness rate of the population in a lot of its regions.

The capital of the Republic of Uzbekistan is a large industrial center, where aircraft construction, mechanical engineering, building, textile and food industry enterprises are concentrated. After economic recession in the 90th of past century last of 5-7 years output and transport expansion is observed in Tashkent. At present in Tashkent contribution of auto-transport in total atmosphere air pollution amounts more than 60%. It is supposed that part of auto-transport contribution in atmosphere pollution will rise in the future as growth rate of traffic is more than that of industrial production.

Distribution of pollutants owing to auto-transport takes on special significance, worsen dispersal conditions, in comparison with emissions from stationary sources and creates heightened pollution level at the local areas of the territory. Results of study of atmosphere air in Tashkent city for last years testify to high rate of discrepancy to maximum permissible concentration (MPC). All of that lead to negative impact on environmental objects and general hygiene and sanitary conditions of the city territory. At present in Tashkent a lot of national economy objects are unqualified ones polluting environment: content of polluting substances in emissions to the atmosphere and discharged water exceeds of hygiene codes. Moreover a number of inappropriate public utilities is considerable and amounts of 57-58%.

Physic-geographic and climatic conditions of Uzbekistan and Tashkent city in particular, aridity of the territory, predominance of readily disintegrating soils, abundance of sunny days and high intensity of solar radiation create favourable conditions for forming secondary harmful substances which are more toxic than initial emission products. Therefore tighter control is necessary for the sanitary condition of the city territory. It is necessary to give especial consideration to water objects situated at the city territory. Their usage for recreation and drinking water supply issues challenges for the sanitary-epidemiologic service. Presence garbage and trash at some city channel banks, non-observance of leanness at sanitary-protected zones at the channel banks, execution of non-registered dumping public and industrial water – all of those lead to increasing of surface water pollution, and deterioration of sanitary condition of the city watercourses.

Cafes, restaurants, private houses building is carrying out especially intensively contrary to Nature Protection Law, right at the banks of numerous city water courses and all construction and public waste discharged to the water courses. Reclamation and recycling of industrial and public wastes is a nagging problem in Tashkent city. Available polygons for storage of city wastes are objects harming sanitary conditions of the city considerably at present as well.

In the Republic of Uzbekistan and Tashkent city the certain steps are taking for improving of ecology-hygienic condition of the territory however it is necessary more intensive activities in the direction. The important aspects should be done:

1. Load reducing on water and air from man-caused factors through assuming more serious administrative and economic measures to enterprises executing emissions;
2. Further improving of regulatory and normative base in the area of risk assessment for population health, connected with unfavorable factors of environment;
3. Creation of up-to-date material and technical basis for sanitary-epidemiologic service;
4. Further integration of environmental protection and health sectors into addressing of ecology and population health issues.
5. Organization of activities for separate waste collection from population and creation of specialized plants for its recycling, utilization with further usage of obtained compost in agriculture.

# Evaluation of Sustainable Water Use

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Keywords: sustainable, water use, evaluation, intergrated criteria, water governance

A crucial, albeit finite, resource, water is vital to a country's economic and social development and the cornerstone of sustainable development. Yet, water-related problems are growing more complex and acute worldwide, and habitats are facing critical challenges: lack of water supply and sanitation, aging infrastructure, growing competition for the use of freshwater and deteriorated environments. These and other troubles point to the fact that today's water problem is largely one of governance.

The sound evaluation of water use efficiency, based on the principles of sustainable development, must be carried out on multiple levels, including relevant environmental, economic and social aspects. In fact, different approaches to criteria generation and their use for evaluation have been developed in a number of water-use sustainability studies; most are specific and locally oriented. As a country with a transition economy, Ukraine is in an excellent position to benefit from a new system of evaluation of sustainability for natural resources consumption.

The aim of our research is to develop a methodological approach based on an integrated criterion for sustainability evaluation of water use in Ukraine, which considers economic (GDP), environmental (water use, wastewater treatment) and social indicators (population, water consumption).

The following methods have been applied for problems solving, which were put by the research: theoretical approaches into development of integrated environmental and economic indexes, standard methods of mathematical and economic analysis.

It is proposed to evaluate economic efficiency of water management starting from the amount of water, necessary for forming a unit of GDP of a region. Economic development can cause degradation of natural environment, as it results in the growth of energy and resources consumption. Therefore, the less a region needs in water resources for forming GDP unit, the more efficient in economic sense is water management there.

Environmental and social efficiency of water use are also essential parts of evaluation of water use sustainability.

It is appropriate to define environmental efficiency of water use, as a return of treated water into natural environment. In that way, the environmental indicator of water use sustainability can be calculated as a part of treated water in total amount of consumed water in the region.

Social efficiency of water use is the most sophisticated indicator in both substantial and calculation senses. Conceptually, the social efficiency of water use is a minimization of water consumption level for the satisfactions of needs in a society. In such way, level of water consumption is closely related

with water demand. It is defined, that biological need of water is about 2-5 liters of drinking water for a person per day. Consumption of water in cities is approximately 300-600 liters per capita per day, what is higher, then in rural areas, where consumption of water is approximately 100-120 liters per capita per day. It is confirmed, that inhabitant of a big city can spend not more then 150 liters fresh water per day for full satisfaction of her/his needs. The same level of water consumption can be more or less efficient in social sense with different levels of water needs. The last depends on cultural differences, environmental and climatic conditions, structure of economy, policies of a government, law and so on. It is impossible to obtain quantitative data about water needs on regional and national levels without special researches. Furthermore this data can't have high level of reliability because of the subjectivity of the term "need".

This integrated criterion helps to analyze the current situation of water use and wastewater treatment in all regions of Ukraine and determine the critical directions of water use and water treatment policies for different regions.

The analysis has insofar yielded a breakdown of Ukraine into three groups of regions: low sustainability of water use (Odessa, Khersonska, Crimea Republic), medium sustainability of water use (Dnipropetrovska, Donetska, Zaporizka, Kievska), satisfied sustainability of water use (other regions). For every region of Ukraine, factor analysis has been applied to estimate the influences of environmental, economic and social indexes on water use sustainability.

The results of our research will play a crucial role in the analysis of water and wastewater management at national and regional levels, and in the development of regional recommendations for improving water use sustainability and reforming the tariff system. The proposed method helps to make decision-making and policy formulation more accountable and increase the effectiveness of water use in Ukraine.



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# Integrated Hygiene Behavior Change Programme – Where CLTS Stands

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Keywords: Hygiene behavior change, Total Sanitation, CLTS, MDG, Impact

Water and environmental sanitation (WES) in Indonesia is an important programme component in UNICEF current country programme (2006-2010). After keeping a low profile for water and sanitation since 1999, in 2005 UNICEF revived its WES activities initially as a response to the tsunami of December 2004 and from 2006 also in other areas of Indonesia. One of the key reasons behind this increased attention for WES was the huge number of people in Indonesia still without access to adequate water and sanitation facilities (about 50 million and 100 million people respectively; WHO-UNICEF Joint Monitoring Programme 2006) with the well-known negative consequences for health and well-being, especially among children and women. Through its WES programme, UNICEF will support the government, NGOs and communities to accelerate improvements in the WES sector, aiming at achieving the tenth MDG target: Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation, and, Ensure that, by 2015, all schools have adequate child-friendly water and sanitation facilities, and hygiene education programmes, (target set in the UNICEF WES Strategy).

Indonesia still has very low rates of sustainable access to basic sanitation. The target of halving the number of households without sustainable access by 2015 is ambitious. Major challenges to reach the MDG sanitation target poses a big challenge as majority of the population without access to water and basic sanitation lives in relatively hard-to- reach remote areas. Other challenges like lack of community involvement, inadequate safe water, and low quality of materials and inappropriate choice of technology jeopardized the sustainability of the sanitation facilities in the past.

Over the last 4/5 years, several approaches for sanitation promotion have been tried out in Indonesia by different development partners, NGOs and government. Methodology on Participatory Actions (MPA), Participatory Hygiene and Sanitation Transformation (PHAST) Community Led Total Sanitation (CLTS), Dusun Resik (Hygiene Village) etc. are the most prominent ones. Among these approaches, the Community Led Total Sanitation (CLTS) approach is gaining more and more acceptance as an important approach to improve sanitation by the government and other development partners including UNICEF. The approach is now becoming the magic word to many donors and development partners for funding and many agencies are now trying to implement the CLTS in the name of Total Sanitation without knowing the applicability and effectiveness of the approach.

The government of Indonesia set the domain of the “Total Sanitation” in the National Operational Strategy for Rural Sanitation and Hygiene Improvement in Indonesia, 2007, where stopping open defecation, use of latrine, hand washing with soap, use of safe drinking water, food handling practices, domestic solid and liquid waste management are the important components of the Total Sanitation. Now the time has come to see the impact of CLTS in the overall hygiene behavior change programme framework – “Total Sanitation”.



During the community planning and assessment process of CLTS, other aspects of hygiene behavior change are identified. However, in the CLTS process, the total community becomes mobilized with the single goal of making the areas defecations free. As the CLTS approach created some ignition effect among the people, they were in effect motivated to use their resources and energy to personally arrange for latrines. The down side is that the other aspects of hygiene practice such as hand washing with soap, safe water use were not given the same level of attention by the community.

Replicability is the major challenge of the CLTS programme. As in most cases it takes lot of interpersonal communication and continuous guidance from the district level government or NGOs support, there is also a difficulty to transfer the same enthusiasm and devotion for the next steps or new areas. As a result in many cases, after achieving the target at the sub-village level it becomes static and needs some push from the higher level.

The CLTS approach is mainly dependent on some individual's entire devotion and commitment for achieving the single target, as a result, in many cases absence of a proper project management system involving people at different levels with an effective monitoring and follow-up system is quite apparent.

Now the question is whether the CLTS can be used as the entry point to more comprehensive hygiene behavior change programme. The answer is no. From the experience in Indonesia and other countries (Bangladesh, Pakistan etc.), it is found that the community's energy becomes exhausted after implementation of the CLTS programme and then it becomes almost impossible to incorporate other hygiene aspects in the programme. Also incorporation of other hygiene practices becomes often, an ad-hock addition.

Another constraint of using CLTS as an entry point is that it may not necessarily be applicable considering the limitations on availability of clean water and space and therefore it can be deduced that CLTS would not be the main component of hygiene behavior change in Indonesia. The temporary nature and mobility of urban slum inhabitants also reduces the effectiveness of the CLTS approach in this setting due to the lack of enthusiasm in latrine construction participation.

There is a need to develop a model for the integrated hygiene behavior change programme which will be applied in different situations in general and should have enough flexibility in the process and issues in rural and urban context in developing countries. This paper is recommending a step-by-step guideline and conceptual framework on the integrated hygiene behavior change programme which we have developed for the Eastern Indonesia WES programme funded by Netherlands and Swedish Governments.

# Sanitation Services in the West Bank and Gaza Strip: Facts, Figures, Realities and a Call for Immediate Actions

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Keywords: Occupied Palestinian Territory, Sanitation Services, MDGs, Septic tanks or Cesspits, Wastewater

The Water and Sanitation Hygiene (WaSH) situation has been deteriorating very rapidly in the Occupied Palestinian Territories (OPT) since the start of the current Intifada in September 2000. During the past year, the situation has deteriorated further as a result of the political climate and the subsequent economic embargo. Donor funding for WaSH related projects has declined and in many cases previous commitments have been put on hold indefinitely until there is a political solution to end the stand off. This has caused and created an escalating humanitarian crisis in the WaSH sector whereby the urgency for it to be resolved is growing on daily basis especially and more rigorously in the Gaza Strip.

The effects of Israeli Occupation on the WaSH sector in the West Bank and Gaza Strip were severe, especially during the past over seven years of the Intifada. Israeli Occupation Forces have systematically destroyed water infrastructure and confiscated Palestinian water sources. Wastewater collection and treatment in the rural areas is virtually non-existent. Almost 56% of the Palestinians are not connected to a wastewater network. According to the results of survey conducted by the WaSH Monitoring Program, in the West Bank, households spend on average 7.4% of their income on water, while spending 3.0% on sanitation services. On average, a household in the Gaza Strip spends 11.4% of their income on water, while spending 5.1% of their income on sanitation services. These percentages are considered high compared to the international standards. On the other hand, an accumulation of solid waste in communities continues unabated as tankers transporting this waste are turned back at checkpoints. Water quality continues to deteriorate as Israeli settlers discharge untreated wastewater into valleys and open spaces resulting in environmental pollution and the spread of water borne diseases. It is no coincidence that 85% of Palestinians infected by such diseases originate from communities without a wastewater network. The collection, treatment and reuse of wastewater in the OPT are rather limited. The existence of a water supply network in a city does not necessarily guarantee that a wastewater network will be in place. Development of these two basic services has not gone hand in hand for all urban centers. None the less, there is a functioning wastewater network in most of the large urban centers within the West Bank and Gaza Strip. Most communities that are not connected to a sanitation network are typically serviced by either septic tanks or cesspits. A septic tank is an underground receptacle for household sewage whereby the solids decay and the liquid is drained off and released into a leaching bed. A cesspit on the other hand is a pit, conservancy tank, or covered cistern which collects raw effluent and has to be emptied when full. Septic tanks are therefore self-serviced whereas cesspits require evacuation, transportation and a final disposal service. Additionally, there are some rural areas where there is no disposal service, these areas are referred to as open, i.e. open defecation locality. It is important to stress that in areas which have a wastewater network and or a regular cesspit evacuation service the only guarantee that exists is that the waste will be collected and transferred from one location to the next. However this does not mean that the waste will be treated. There are only a few wastewater treatment facilities in the West Bank and Gaza Strip and

of them many do not function properly. This ultimately means that the potential for groundwater contamination originating from wastewater is high and that a vital additional source of water from wastewater, namely reuse is not being utilized. In order to assess the adequacy of wastewater coverage in the OPT, it is important to understand the type of access that each community has in terms of their ability to dispose of their wastewater.

This paper focuses on presenting the analysis from data collected during the 2006/2007 monitoring period in order to verify the status of the sanitation situation in the OPT. In turn the paper builds on this analysis to help examine whether progress is being made towards achieving the UN Millennium Development Goals (MDGs) related to sanitation and hygiene. Furthermore, the analysis is used to help identify the main constraints facing the realization of this goal, and in addressing water issues and crisis afflicted on Palestinian communities throughout the OPT. The information presented in this paper is meant to increase the potential for donor funding to meet the needs of the most vulnerable and marginalized communities, as well as aid efforts for advocacy and actions that not only demand an end to the Occupation, but strive for the implementation of sanitation as a fundamental human right for all.

# Sustainable Policies for Sanitation and Health Programs: Lessons Learned from the Case Study of a Sanitation Project in Nepal Hill Area

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Keywords: improved health, sanitation, health education, sustainability, multi-pronged approach

**Background:** Contamination of drinking water accounts for 80% of ill health in Nepal. Open defecation, the norm in many South Asian countries including Nepal, is a major cause of drinking water contamination compounded by lack of sound hygiene practices. Sanitation programs that are augmented by health and hygiene education components can reduce contamination of drinking water. Nepal Water for Health's (NEWAH) programs provides technical and financial support in water, health and sanitation. NEWAH also works to develop capacity of the individual institutions involved in sanitation for management of water, health and sanitation programs. However, the sustainability of many sanitation programs is not assured especially in the absence of 'buy in' of all the stakeholders and the lack of supportive policies at the local and the central level.

In the village of Hatiya Sunargaun, Deurali, Gorkha District, Nepal, the NEWAH project focused on building latrines and health education.

**Methods:** In order to collect data for the case study of Hatiya Sunargaun the author visited the village. The author, a member of the internal evaluation group, participated in questionnaire enumeration; observation of hygiene practices, focus group discussions and community meetings. The focus group discussions focused on 'latrine building and its challenges', 'health' and 'NEWAH's program'. The results from post-program completion survey that was done at the end of the program period was compared to the baseline data that had been collected during a feasibility study prior to program implementation. A questionnaire survey supplemented with observation of practices was used for data collection. Information gathered from focus group discussions was also used for evaluation of the program. The data was analyzed using the SPSS package. The author did a descriptive analysis of the results from the questionnaire and the focus group discussions.

**Results:** Hatiya Sunargaun is a predominantly Dalit (repressed caste) population where more than 64% of the population live on less than \$ 2.00 a day. The village is composed of 127 households and has a population of 670. The program was successful in building latrines for 96% of the households at the program site. This has led to an improvement in health status due to reduced diarrhea and other water borne illnesses especially for children. There has been a great improvement in personal hygiene behaviors with an improvement from 25% to 100% of the population using either soap or ash when washing hands. Storage of drinking water and food also has seen considerable improvement as more people are covering food and water and keeping the containers clean. A shift can be seen in the reported primary disease burden from predominantly acute diseases like diarrhea and headache chronic diseases like asthma, rheumatism, osteoporosis and toothache. Along with an increased awareness about disease and the importance of proper treatment the survey showed a shift from use of traditional healers and home remedies to use of hospital, nursing home or health posts for treatment of illnesses. The focus group discussions on topics of latrine building, health and the program itself

yielded very good information about community appreciation for the program though one of the most emphasized points was the lack of money on part of the villagers who were unable to build latrines even with the heavy subsidies provided by NEWAH. Focus groups discussions also highlighted the lack of cooperation and coordination between various agencies involved in water issues. While the changes in personal hygiene behavior, raised awareness about disease and treatment and the building of latrines, were beneficial to health and village environment, it has increased the economic burden of the community members. This has been due to increase in expenses for health, sanitation articles like latrine building materials and soap etc. Thus, a comprehensive program that will help the community members to improve their economic status as well is called for.

**Lessons Learned and Directions for Change:** The most important lessons learned are that there are barriers associated with total community participation, which are of a monetary nature. There is danger of creating ‘dependency syndrome’ within a community when so many subsidies are provided, as it can be a barrier to a ‘feeling of ownership’ by the community members. This can pose a problem for sustainability of the program. Building of latrines supplemented with health education and the need for proper disease management has a positive impact on the environmental and personal health of a community. Some recommendations for the improvement for the program would be to use a multi-pronged approach that focuses on health education, infrastructure maintenance, general education, income generation and community building. Along with a more holistic sanitation intervention effort there is a need for close interaction and cooperation and coordination between all the stakeholders like the community members, the village development committee, NEWAH, the local government, the local water governing body, the office of the Chief district officer and the government offices operating at that level.

# Urban and Rural Sanitation Problem in India

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Keywords: Problems, Sanitation, India, Safety, Disaster

Despite all their efforts, the majority of urban and rural areas in India have been unsuccessful in meeting the sanitation needs of the poor. Today, one of the main challenges they face in this sector is to develop innovative approaches, alternative to the centralized provision of sanitation services. Despite the universal understanding that the availability of adequate and reliable sanitation services is essential to improve the quality of life of the urban poor, Indian villages and cities have been largely unsuccessful to respond to this basic need.

Despite the universal understanding that the availability of adequate and reliable sanitation services is essential to improve the quality of life of the poor, Indian cities and villages have been largely unsuccessful to respond to this basic need. Amongst the most recurrent and well known reasons for this is the fact that public programs often focus on the direct provision of public toilet blocks using a supply-driven approach. In cities and villages where a large percentage of the population live in informality, single-handedly build public toilets for all the dwellers easily turns in to a never-ending task, draining large shares of the budget. Even when (and if) funds are made available for construction, the problem remains of coping with heavy recurrent expenditures for operation and maintenance.

Unplanned slum and squatter settlements have numerous problems associated with water and sanitation provision and unsafe hygiene. Families often have no choice but to live in small, makeshift huts crowded together in vast, unplanned areas. Without toilets, drainage systems or rubbish collection services refuse and human waste fill the areas. Without safe water on tap people are forced to collect what they can find. Water and sanitation-related diseases are rife – exacerbated by the overcrowded conditions and poor hygiene. In many cities in developing countries you will see raw sewage flowing into rivers while only feet away children swim and adults wash themselves and their clothes. Often the settlements are unofficial and so, without legal tenure, the people living in them are not entitled to connections to basic facilities like water and sanitation. These settlements are also vulnerable to demolition as governments reclaim the land for other uses.

The main cause of all problems is formation of slums and could be eliminated by placing stringent ceiling on population/area in each city. But usually the developing countries will alter green belt if present and extent unconditionally. Close look at the statistics of slums reveal that most of the slums do come in capital cities of state/countries due to huge opportunity for employment, access to resources, entertainment, health, and education. More than 5% of the population in these capitals forms government employees and their dependents. Due to political support the capital city will easily get good infrastructure compared to other cities. Industries will be established due to access to good infrastructure and market. The next tier of population, who are service providers to government and industrial employees include slum dwellers. Shifting of capital city once the city reaches certain limit with respect to area or population would itself is a major remedy for associated problems with slums and urbanization.

Unique the problem with rural India is about investment. Each sanitation facility will cost about price of a cow (or four sheep or ten piglets) which is attractive for a village dweller due to associated cost recovery by investing in animal husbandry or seeds/manure for next sowing season. Many rural dwellers sacrifice education for their children for sake of other priorities. Sanitation was usually not on the top of their shopping list. Subsidized facility from government may not motivate the village dwellers for associated paper work and corruption. Further sanitation was never a priority from the day of ancestors. The climate in majority of India also encourages them for open defecation rather than attending the need in sanitation facility.

This paper describes the problem with respect to finance, space, water, culture, awareness, maintenance, safety, privacy, children, lighting, and disaster preparedness.

# MDG and Improved Sanitation: Bangladesh Perspective

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Keywords: Sanitation, Hardware, Community-led, Gender-driven, Capacity building

**MDG and Sanitation:** To achieve the Millennium Development Goal's (MDG) targets the Bangladesh government has emphasized improvement of sanitation as a national priority. As a reflection of this priority, the government has set a national goal of achieving 100 percent sanitation by 2010. This challenging target is much earlier than that of the MDG. This goal has to be realized through the "people-centered, community-led, gender-sensitive and demand-driven" paradigm. The government conducted a national Baseline Survey in October 2003 to assess the extent of sanitation coverage. Out of a total number of 21,394,093 families in the country, only 7,108,362 families (33.23 percent) were using hygienic latrines at that time.

Over the years the situation has improved and recent household latrine user estimation by the National Sanitation Secretariat, sanitation coverage in rural areas is 84.47 percent, 87.59% in municipal areas and 84.38% in City Corporations. The government estimate is based on the household latrine coverage and distribution of sanitation subsidies. However, the definitions of sanitation as well as reliability of the coverage are issues that are now being addressed by the government through an independent committee set up recently.

**The Approach:** The government sanitation program is hardware focused, and functions in a top-down and supply-driven manner. Traditional/government approaches to improve sanitation have focused on technocratic and financial patronage, rather than empowering people to understand the problem and benefit from sanitation. The majority of people in Bangladesh have a poor understanding of the link between poor hygiene and disease. However, for sustainability of the sanitation program, behavioral change is very important. Community-Led Total Sanitation (CLTS) approach introduced in 2001 was based on the principle of triggering collective behavior change.

In this approach, communities are facilitated to take collective action to adopt safe and hygienic sanitation behavior and ensure that all households have access to safe sanitation facilities. This approach helps communities to understand and realize the negative effects of poor sanitation and empowers them to collectively find solutions to their sanitation situation. In the process, the community is sensitized of the consequences of poor sanitary practices, commits itself to finding own solutions, and finally is liberated from open defecation. This helps in creating a receptive environment for the adoption of improved practices in personal hygiene, safe handling of food and water as well as safe confinement and disposal of excreta and waste in many aspects.

**Women's Sanitation:** Throughout the sanitary campaigns Gender division of labor and women's specific sanitation-related needs are unrecognized. Due to a culture of silence and ignorance, the issues related to menstrual hygiene and management is absent in most water sanitation and hygiene promotion programs. A vast majority of women and girls use rags torn from old saris, known as "nekra," instead



of sanitary towels/napkin. This practice is responsible for a significant proportion of illnesses and infections associated with female reproductive health.

Sanitation for urban Poor: Squatters and the urban poor living in slums suffer much hardship in accessing drinking water and sanitary latrines. Most of the urban poor live in slums and squatter settlements, with the largest concentration being in the capital Dhaka. Presently, there is no policy for public agencies to deliver water and sanitation services to the poor who live in informal settlements, mainly slums. Land tenure issues and the absence of a legal and regulatory environment create barriers.

Gap between policy and practice: Bangladesh adopted the National Water Supply and Sanitation Policy 1998, Pro-poor Strategy 2004, and National Sanitation Strategy 2005. The policies maintain a progressive outlook on institutional reforms, people-centered development, community involvement and cost recovery. However, one needs to understand that translation of these policies into practice is altogether another challenge for the days ahead.

Ineffective local government and decentralization: Decentralization of local governments and their active participation for the implementation of integrated water, sanitation, and hygiene projects is one of the key concerns. Local governments are very weak, particularly in rural areas; they have very limited human and financial resources, little revenue raising authority, and limited influence on how central government resources are used.

Lack of capacity at different levels in different sectors: Public, local government, NGOs, UN, donors and the private sector, all suffer from lack of capacity at all levels -- national, intermediate and community. Hence, the need for capacity development at all levels -- human resource, and organizational and institutional development -- is enormous.

Difficulty in identifying and reaching the hardcore poor: Poverty and disadvantage are sociologically complex and difficult to address. Most of the development actors consider poor communities as homogeneous entities, and that “broad brush” implementation approach is applied, rather than tailoring of inputs to the specific needs and capabilities of the poorest and most vulnerable.

Conclusion: Last year’s World Toilet Day was observed just before the International Year of Sanitation, the objective of which is to put the global community on track to achieve the sanitation related MDG. Sanitation is the foundation of health, dignity, and development. Increased sanitation access, especially for poor people, is fundamental for reaching all the Millennium Development Goals.

# The Revolving Fund: A Tool for Addressing the Challenge of Sustainable Rural Sanitation

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Keywords: rural sanitation, sustainability, community based approach, revolving fund, community based organizations

Rural sanitation programs normally incorporate relatively simple implementation approaches and technologies and hence intuitively could be expected to have fewer problems than more technically complex urban systems. Yet, such programs seem to face more predicaments during implementation and with ensuing sustainability. Common approaches adopted to counter this situation include: adoption of community based implementation practices; use of appropriate technologies; and integration of hygiene promotion. Nevertheless the problem of poor sustainability of rural sanitation has persisted.

The World Bank-funded 1st Community Water Supply and Sanitation Project (CWSSP) (93-98) introduced a community based approach. Selected communities set up Community Based Organizations (CBOs) to undertake project implementation in their respective villages. The CBO identified needy households which were then provided financial assistance by way of a grant to cover the capital cost of latrine construction. Labor and local materials were to be provided by the recipient. Each selected household was provided with a grant, subject to a maximum of 50 latrines per village. The grant was released in three installments by the CBO based on construction progress.

This approach was instrumental in providing over 64,000 latrines, far exceeding the target of 45,000. However, being limited to 50 households, this approach did not address the total sanitation requirement of selected villages. As the country's sanitation coverage was 76 % as at 2004, this subsidy approach was clearly inappropriate to achieve the National target of 100 % sanitation coverage by year 2025.

In 2003, Sri Lanka, and other participating countries of the 1st South Asian Conference on Sanitation, endorsed the Dhaka Declaration. This emphasized the need to pursue strategies under a common definition of "sanitation" to accelerate progress of good sanitation in the South Asian Region. One principle of the Declaration is to provide hardware subsidies only to the poorest of the poor, while recognizing the importance of community subsidies for promotion, awareness, capacity building and creation of fund mechanisms for scaling up sanitation and hygiene programs.

The 2nd CWSSP (2003-2009) adopted these principles by introducing an innovative Sanitation Revolving Fund (SRF) instrument designed to achieve universal sanitation coverage in 800 rural villages. Under this approach, funds are provided to the CBOs, sufficient to cover the costs of installing latrines in 50% of the village need. These grants form the seed capital for the village SRF. CBOs then lend money from the SRF to project households sufficient to cover the costs of materials not locally available for the latrine substructure. Labor, local materials and the full cost of the superstructure have to be supplied by the borrower. The terms of the loan, including repayment period, are decided by the CBO. The concept of a revolving fund is not only to assure better latrine coverage, but to encourage those who can afford it and have ready cash to build it themselves, and also give

an opportunity to have hands-on experience in managing the fund. CBOs are encouraged to release funds on a grant basis to the poorest of the poor, after the completion of sanitation facilities among the rest of households.

The strategy to achieve 100% household latrine coverage is to: (i) increase awareness of the health benefits of latrine use and to thereby motivate households to demand, build and use latrines; (ii) provide seed money to the CBOs to establish SRFs and (iii) support CBOs in managing their SRFs. After implementation in 360 villages, this new approach is showing encouraging results. Social and technical audit conducted by independent consultants in 2006 suggested that the SRF mechanism can help address a number of the rural sanitation problems previously encountered in Sri Lanka. The assessment noted that the CBOs had used the SRF for the purpose intended and had developed the capacity to effectively manage their SRF.

By October 2007, more than 25,500 latrines have been constructed using the seed money which would have been sufficient for only about 15,290 latrines if subsidies had been provided. Loan recovery is in the range of 60–100 %, with an average of 78%. The demonstration effect of this exercise is significant as 1,180 of households have constructed latrines using their own funding, in parallel with the project. A significant achievement of this approach is the credit discipline developed in rural societies. The revolving funds retained by the CBOs after achieving 100% sanitation coverage have been used not only to cater for future village sanitation needs, but to provide credit facilities to its members for income generating activities.

Main challenges that surfaced when this approach was introduced are relatively longer period (24 months or more) to achieve total sanitation coverage; delays in repayment due to seasonal income pattern (eg. waiting for harvesting period) and the tendency by CBOs to release the first round of loans to relatively high income earners to ensure loan recovery.

Developing CBO capacities and delegating to them the authorities are vital elements for successful revolving fund management. This innovative program has shown that the revolving fund mechanism can be successfully adapted to address the challenge of achieving sanitation targets. It places full financial and sustainability responsibility in the hands of individual households and enhances the capacity of rural communities in credit management. Furthermore the knowledge and experience gained from running a SRF is reckoned to be a strong tool in addressing rural poverty. Most importantly, this approach helps to diminish the hand-out mentality that has engendered a culture of dependency which for so long has held back rural advancement in many developing communities.

# Sanitation Revolving Fund – National Initiative for Sustainable Sanitation Solution

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Keywords: Sanitation Revolving Fund, Community Managed, Program Ownership, Sustainability, Community Demand

Sanitation improvements, especially latrine constructions, in rural villages have clear and demonstrated benefits for the people's social and economic well being. The Government of Sri Lanka has acknowledged the importance of the health and well being of its people and has set a goal of providing access to basic sanitation facilities for all citizens by year 2025. This is reflected in the internationally adopted Millennium Development Goals, which aim to reduce by half the proportion of people without access to adequate sanitation by 2015.

Poor sanitation and lack of good hygiene practices constitute a fundamental risk to community health. In the recent past government and non-government agencies in Sri Lanka have implemented many large and small sanitation projects, all designed to address these issues. However, these programs faded away once "project funding" terminates, with communities seemingly not being prepared, or able, to sustain the earlier motivation and momentum. Hence, assessment of the outcome of various approaches adopted, particularly the achievement of the health and sustainability objectives is prerequisite to devise new approaches and formulate appropriate policies.

With the lessons learned, the Community Water Supply & Sanitation Project (CWSSP) has taken an initiative to formulate a sustainable sanitation program with an appropriate financial mechanism which is called Sanitation Revolving Fund (SRF). The main objective of this initiative is to provide seed funds to villages to sustainably cover sanitation needs, with minimum project intervention.

A significant feature is that the SRF is established at the inception of project with seed funds from the project and contribution from the beneficiaries. Potential participating families were requested to submit their sanitation need with an initial contribution of Rs.50 to their respective Community Based Organization (CBO). This payment by families is viewed as a symbolic agreement to accept this concept and repay any loan provided through the SRF.

When a CBO submits a community sanitation proposal, based on individuals needs, the project provides seed funds equivalent to 50% of the cost requirement of latrines construction in a village on the basis of Rs.3,000 per latrine. The CBO decides the loan amount to be given to individual families according to need. During the last four years, over 22,866 latrines were constructed in 436 villages and the recovery rate of the SRF exceeds 80%. Sanitation coverage in these villages is 100% although the project provided seed funds only for 50% of the requirement. The target is to construct 50,000 latrines within 6 years in 799 villages.

The main principles of the sanitation program are focused on creating community demand on sanitation and transferring the program ownership to the respective communities. Thus, sanitation programs commence with an extensive social mobilization process aiming to transform the program from being supply driven to demand driven. Emphasis lies on sanitation being a community responsibility rather than an outsider's. Making better environmental sanitation at households including latrine construction was somebody's responsibility in the past and individual families were merely being silent receivers of subsidies. This has been changed under the CWSSP and the Government responsibility in sanitation has been transformed from implementer to a facilitator.

CBOs in the project villages became managers of the sanitation development in their villages. Communities are free to decide whether they need sanitation facilities or not, the need is expressed by the submission of sanitation proposal. Appropriate environment has been created for CBOs to own and manage the sanitation program along with the beneficiary participation in decision-making, which directly influenced by the sense of ownership. Hence, the strategy adopted has provided maximum opportunities for CBOs in total management, including the selection of beneficiaries and co-ordination of financial and technical inputs required for sanitation program implementation. Except monitoring, project has no control over their decisions. The SRF mechanism reduces the management cost of sanitation program drastically, which was very high in the past. Under the SRF mechanism the management cost is negligible, which may Rs.100/- per unit or less.

The CBOs have realised that the sustainability of their SRFs is laying on recovery of loans, especially at the initial stages. In order to avoid any risks of collapsing the SRFs due to non-payment of loans, low-income families are provided with loans at later stages. Often, women headed and families in absolute poverty are provided with grants to construct their latrines.

The externalities of sanitation program and their influence to sustainability and the success of the SRF mechanism managed by communities should be reviewed regularly. In future only CBOs should be provided with seed funds to improve the sanitation in their villages instead of providing subsidies directly to individual families.

Establishment of SRF is a significant event as it targets the multifaceted activities such as development of social capital to sustain the water and sanitation facilities and livelihood activities. Once the latrine constructions are completed, the SRFs are transformed into Community Development Funds.

The sustainability of sanitation programs at local levels will only be realized with an established suitable financial mechanism. So far, more than 400 villages have achieved 100% sanitation coverage through SRF and the most exciting impact is that nearly 1,720 latrines have been constructed by families on their own, which is the demonstrated effect of the program. This whole process insinuates that "subsidy culture" will not solve the issue of access to sanitation for all as it provides only a short-term solution.

# Community Participation in Small-scale Waste Water Disposal System in Low-Income Densely Populated Areas

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Keywords: Sewer network, Sewage disposal tariff, Waste water, Densely populated areas, Community participation

Kandy city is the largest provincial town in Sri Lanka. Apart from a resident population of about 110,000, the city attracts a daily commuter population of about 75,000 who visits the city for various purposes. According to official estimates the population densities within the city vary from 36p/p/h to 239p/p/h depending on the area. In 6 congested neighbourhoods where accommodate urban poor, population density is ranged from 88 to 1,700p/p/h.

The rapid urbanization and population growth in Kandy City have produced a corresponding increase in the volume of sewage. It is estimated that an average daily production of sewage in the city is 6,000m<sup>3</sup> and volume of waste produced in the densely populated communities is only 2203p/d, which is negligible compared to the total volume produced. The densely populated areas do not have adequate sewage and sludge disposal facilities and it has seriously deteriorated the quality of ground water and surface water. In general the sewage and effluent from septic tanks and households are discharged to the urban drains, which flow into Kandy Lake and the Mahaweli River without sufficient treatment.

The lack of sewage treatment facilities increases the potential for water borne diseases because the Mahaweli River is the city's primary drinking water source. Safeguarding the water environment and public health, as well as providing sanitary living conditions for the residents is essential for improving living conditions of urban residents and facilitating economic and social development of this city and surrounding areas. This can only be achieved with the development of a proper sewage collection and treatment system.

In general, sewer projects may only serve the better off residents in towns, leaving aside densely populated areas due to complexity in sewer related infrastructure developments and O&M cost recovery. Tariff setting under major sewerage projects serving densely populated areas is difficult as substantial percentage of families in these settlements uses common facilities.

The Kandy City Wastewater Disposal Project (KCWDP) has addressed this vital issue. Innovative approach and strategies were adopted to bring residents in densely populated areas within the ambit of the KCWDP. When designing the KCWDP, appropriate and separate sanitation solutions (small-scaled sewerage systems including small sewerage networks, communal septic tanks and pumping facilities) for the densely populated communities were included with the provision of connecting these independent sewer networks into the KCWDP in future.

Approach adopted for the implementation of these sanitation solutions was purely a participatory and communities were provided with opportunities to participate in decision making at all stages of project implementation namely design, construction and O&M.

Communities in all settlements, where the common facilities are being used, were mobilised to participate. They have expressed their willingness to participate if following basic demands were met (i) provide adequate number of latrine units in order to reduce overcrowding and queuing at latrines during peak hours (ii) improve the conditions of superstructure with tiled floors, doors and proper ventilation (iii) provide water supply facilities inside the latrine units, and (iv) construct latrines blocks in several locations in the settlements to ensue the easy access to facilities especially for women and children even at night.

During design stage, adequate information and data including area maps were presented to the respective communities to make decision on sewer network routes, areas where people are provided with improved common latrines and lands to be acquired to build common latrines etc.

Although the community are supposed to undertake the construction of the improved community sewage disposal systems, due to the complexity of constructions and the need for maintaining high quality and standards, construction of sewer networks, communal septic tanks, pump houses and treatment plants will be outsourced. Community construct superstructures of common latrines and water supply and provide total labour requirement for the construction activities on voluntary basis.

The maintenance responsibility of these community sewer systems are shared, the MC will maintain sewer networks, communal septic tanks and treatment plants and community will maintain superstructures of common latrines. Tariff structures of their sewerage system were extensively discussed at the community meetings. It was agreed that the sewerage disposal tariff should be affordable to all and vary on the service levels of individuals. It has been decided that the tariff of households with individual latrines is higher than the household who use common latrines, the Municipal Council will introduce appropriate tariff structures for these small-scaled wastewater systems on this basis.

Provision of subsidy to households on sewage disposal tariff in densely populated areas was agreed and it is proposed that certain percentage of tariff to be subsidized in order to make it affordable to all.

The notion of difficulties in inclusion of poor live in densely populated settlement into sewerage projects in cities has probably been rendered invalid with the success of the integrated small-scaled sewerage systems implemented in these areas under the KCWDP.

While good quality private latrines are the preferred goal of most people, in the absence of houses or residential land big enough to construct or accommodate private latrines, especially poorer segment of the population, are willing to accept improved public latrines. Provision of small subsidy in the tariff will certainly motivates people in densely populated communities to join the major waste water projects.

# Uttarakhand: Progressing Towards Total Sanitation – A Case Study

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Keywords: Total Sanitation Campaign, IEC, VISION 2012, MDGs, Sector Wide Approach(SWAp)

The state of Uttarakhand is primarily a mountainous and hilly region situated in the Central Himalayan zone of the Indian subcontinent. Uttarakhand faces acute drinking water and sanitation problem, characterised by low sanitation coverage and poor access to sanitation facilities. The twin issues of low sanitation coverage with little or no emphasis on behavioural change for improved hygiene practices has given rise to numerous health related problems for the local community. Water-borne diseases like diarrhoea and dysentery are common in the rural hilly areas, especially affecting children. The issue of sanitation and hygiene in Uttarakhand is interlinked with the demographic and socio-economic factors, which influence the sector immensely.

## Sanitation Scenario in Uttarakhand

Prior to 1996, before the Swajal I Project, the sanitation coverage of the state was abysmally low as 10%. The major programs were government owned with huge individual subsidies and no users participation.

## Lessons Learnt from Swajal – I

The overall sanitation coverage in 857 villages increased from nearly 10% to approximately 60%. By the end of 2003, when the Swajal I project closed, the overall state sanitation coverage as per the then Rajiv Gandhi Survey of Habitations was 21%.

Although the Swajal project demonstrated the success of demand responsive approaches to water supply and sanitation through a focus on community participation, the following major lessons learnt find importance: 1. The approach towards sanitation promotion focussed largely on individual behaviour change, in preference to a form of collective action. 2. Differential household incentive patterns, based on poverty levels. 3. Promotion of a single technology option- the twin pit pour flush type. 4. Intensive IEC campaign only in the target villages.

## Total Sanitation Campaign (TSC)

The Government of India funded Total Sanitation Campaign (TSC), launched state-wide in 2003 is community based sanitation project emphasizing on IEC, HRD, and capacity-building activities to increase awareness and generate demand for sanitary facilities.

## Paradigm Shift in Sanitation Strategies to Scale up Sanitation Coverage

The sanitation and hygiene promotion strategy builds on the lessons learnt from Swajal I and also draws upon the existing Total Sanitation Campaign guidelines to frame a strategy in line with the Sector Wide Approach adopted by Government of Uttarakhand.

The key principles being implemented for a state strategy for sanitation are as follows:

- Focus on sanitary outcomes – stopping open defecation rather than constructing latrines: This



approach has focussed on the outcomes and impact of the programme rather than only the inputs and outputs. IEC efforts clearly highlight that gains from individual behavioural change is closely linked to community behaviour change.

- Adopt a total concept of sanitation, which includes solid waste management, drainage, excreta disposal, hygiene and safe handling of water and focus on highest health risk first; understanding of the linkages between health and hygiene, to gain the commensurate health benefits.
- Focus on demand creation at community level to internalise the public externality of individual sanitation behaviour.
- Strategic Approach to IEC: IEC efforts aim at bringing about positive behavioural change towards total sanitation and thus focus not only on enhancing knowledge but also on converting knowledge into practice.
- Sustainability is higher if fiscal incentives are directed to rewarding community based outcomes rather than subsidising outputs at the individual level: Rewards/incentives at the habitation, village, block, district and the state level are in place to support the process and motivate the communities and agencies for achieving the public good outcomes.
- Promotion of a variety of technology options, that is responsive to the socio-economic and geographic conditions of households and communities.
- Greater involvement of Gram Pradhan for implementation and monitoring: Even the incentive money for the beneficiaries is routed through the Gram Panchayat.
- Support Organizations to motivate the community and the Gram Panchayats for adopting the total sanitation concept and also provide the necessary technical support for project implementation.
- Formation of District Water and Sanitation Mission (DWSM): DWSM is the overall coordinating body at the district level, responsible for contracting Support Organizations and be responsible for release of their payments. It solicits feedbacks and suggestions by user groups and field functionaries on a regular basis.
- Formation of State Water and Sanitation Mission (SWSM): To provide overall guidance, implementation support and conduct regular monitoring.
- Dovetailing and coordination with health department and education department at state, district, GP and village level have been ensured with the departments and organisations for successful implementation of the program particularly for IEC activities. The DWSM ensures coordination with the agencies at the district level.

### **Key Outcomes of the Revised Sanitation Strategies**

As a result of the implementation of the above strategies, Uttarakhand has integrated the Total Sanitation Campaign in its Sector Wide Program. All the sector institutions are working in tandem to achieve the Target 2012 set up by the Government of India which is in sync with the VISION 2012 of the state government and the Millennium Development Goals. The overall sanitation coverage is nearing the half way mark with about 3500 habitations declared Open Defecation Free. The key point is that the constructed sanitation facilities are being used and maintained by the beneficiaries.

### **The Challenge**

Surely, Uttarakhand is on the right sanitation path and with the revised strategies shaping up, the dream of a Total Clean Uttarakhand will come true.

# Supply, Demand and Collaboration: Some Lessons from South Africa and Uganda's Basic Sanitation Programmes

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Keywords: South Africa, Sanitation targets, Sector collaboration, Pit emptying, Delivery models

This paper reflects on key themes from South Africa and Uganda's basic sanitation programmes to offer lessons for other countries pursuing MDG sanitation goals.

Good sanitation programmes in developing countries focus on good hygiene practices and motivating people to invest in improving their own sanitation facilities. Uganda, for example, is building district-level water and sanitation co-ordinating structures to support local government's increasing involvement in sanitation improvement, and buttressing this at national and regional level with communications and marketing campaigns which are adding 21st century innovations to existing sanitation toolkits. A sector-wide approach is in the process of implementation, aimed at helping Ugandans leverage their limited resources through building household demand for sanitation improvement on the ground.

But if the government of a developing country has sufficient resources to provide the infrastructure itself, how does this alter the character of the national sanitation programme? Is 'household demand' for sanitation improvement still relevant when basic sanitation infrastructure can be funded fully? And how best can local government drive lasting sanitation improvement?

South Africa's commitment to improving sanitation over the past decade has been an inspiration and a stimulus to many programmes elsewhere. The impacts of a strong rights-based policy approach, high-level political support and substantial funding – equivalent to more than a billion US dollars and rising – are evident in the provision of fully-funded toilets to over three million households since the mid-1990s, and an improvement in sanitation coverage from 48% to 71%, despite significant population growth.

Notwithstanding these extraordinary achievements, South Africa's programme has become increasingly infrastructure-focussed and supply-driven. A sector-wide strategy has focused on building capacity nationally to implement sanitation improvement projects, but as pressure has mounted to meet output-driven targets, the approach has become increasingly rigid and inflexible. A growing number of VIP toilet pits are filling up and becoming unusable, and there is growing concern that the benefits of this massive investment will be lost unless there is a massive correction soon.

National sanitation policy was drafted soon after liberation in 1994, and emphasized a health- and household-focused demand-responsive approach to improving basic sanitation. But demand responsive approaches were perceived as slow, and have steadily been replaced by toilet construction programmes in which people and their health are often secondary. Sanitation policy and strategy, moreover, has not kept pace with developments in other sectors. Responsibility for water supply and sanitation has been decentralized to local government; for rural water, this has meant that the plan-

ning, management, operation and maintenance functions of rural water committees have been taken over by municipalities; for dry sanitation, the implications are less clear. Critically, government has not clarified or communicated the roles and responsibilities of users and municipalities around VIP maintenance. Most municipalities do not know how to respond to full pits, and users don't see this as their responsibility; many users are now reverting to unimproved toilets or open defecation, with little net gain in health and hygiene behaviour. What is clear, though, is that the VIP toilets being built are grossly inappropriate for municipal servicing: many pits are small and sealed, the top-structures are not movable, and few facilitate access for pit desludging. Worse, pit desludging opens up a range of risks and disease pathways, and is a horrible job.

Massive pressure to meet South Africa's ambitious and unattainable 2010 backlog eradication target is constraining scope for correction and innovation. Each additional VIP toilet built without roles being clarified adds to a second generation backlog that will be even more challenging than the first, because it will take more than a new building programme to set South Africa on the right path again. Sanitation improvement has become something that government delivers; and the notion of people as the primary agents of their own development is getting lost. Most worrying of all is that the health benefits of improved sanitation are being compromised by a narrow focus on toilet provision with limited prospects for lasting usability. In a context of widespread AIDS, this is tragic.

The paper concludes that Uganda and South Africa are each making a profound contribution to sector learning. Demand creation without clear national policy and firm government commitment is not enough to effect sanitation transformation on the scale required. But even clear national policy, huge government commitment and massive funding will deliver limited benefits if households themselves are not engaged, and if toilet provision is emphasized over hygiene improvement. Lasting sanitation improvement needs demand creation, hygiene awareness, behavior change – and toilets. Toilets, though necessary, are not enough.

# Lessons from the 'Great Stink': A New Sanitary Revolution in the 21st Century

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Keywords: History of sanitation, Sanitation – lessons from the, Urban sanitation, Institutions in sanitation, Behaviour change in sanitation

The nineteenth century sanitary revolution that occurred in Britain and the industrializing world, following the 'Great Stink' in London precisely 150 years ago, resulted in widespread sewerage of towns and cities in Europe and North America. By the early twentieth century this had finally achieved significant reductions in mortality. This historic revolution has several valuable lessons for the similar effort that is now needed to enable 40% or more of the world's population to access improved sanitary facilities and services and so to greatly improve the lives of huge numbers of women, men and above all children.

These lessons include:

- Time is needed to bring about significant changes in understanding and behaviour, and to build the necessary material and human infrastructure, and hence to generate the resulting health and social improvements. Claims that the sanitation MDG can be achieved in years rather than decades seem unduly optimistic; even when the goal has been reached, more than a billion of the poorest and most vulnerable global citizens will still be without essential facilities and services. Long-term, visionary planning and commitments, beyond the brief horizons of elected politicians, are needed.
- Both the private and public sectors have important roles to play, as does an amalgam of individual, household and collective action. Sanitation does make an important contribution to public health, but only if the government, both national and local, plays its essential roles in stimulating, regulating, enabling and, in some cases, financing action, alongside the other players. The role of small independent service providers is already significant in the sanitation sector, but needs recognition and support. Above all, household demand must be stimulated and met.
- The motivation behind a change in behaviour, connected with the use of new sanitation and hygiene facilities, needs to be well understood. Further resources of both funding and skilled staff need to be put into strengthening this important aspect of work in sanitation development.
- Emphasis needs to be given to the excreta-related nature of much disease that is commonly termed 'water-related'. Conventionally-trained public health engineers too easily ignore the important but difficult subject of excreta management – a new emphasis is needed in education, training, management and practice. The multi-disciplinary nature of work in this sector, including engineers, social scientists, economists and politicians, needs further emphasis.
- Consideration should be given to a range of affordable solutions, from dry technologies to sewers, each being appropriate in the right socio-economic circumstances. While the waterborne sewer

came to dominate the nineteenth century sanitary revolution, dry toilets were being promoted by many proponents. Today's ecological sanitation movement has many parallels with its earlier counterpart. In most parts of the poor, water-scarce cities, towns and villages of today's developing world a water-borne solution is unaffordable and impractical; other solutions are available, appropriate and well understood by the specialists, but need promotion with politicians, engineers and local communities alike. The impetus given by the 'Great Stink', through the miasma theory of disease that was accepted at the time, was enormous. Any technology that is proposed needs to take the issue of the smell of excreta into account in order to achieve acceptability with users.

- Whilst the majority of those unserved by sanitary facilities live in rural areas, the need is greatest in the rapidly growing, crowded slums of the towns and cities of Africa, Asia and Latin America. The transmission of disease and the indignity suffered by residents are both appalling in such circumstances. The numbers game which we all play may not prioritise these unseen and often illegal settlements, and they may not be a high political priority, but the human need is enormous and growing, and must be met.

Above all, a new group of sanitary heroes, comparable to Edwin Chadwick and Joseph Bazalgette in the British nineteenth century, is needed to give impetus to a twenty-first century revolution, and to overcome the taboo – the 'Great Distaste' – under which this important subject has languished for much too long.

# Rethinking Sanitation through Community Led Total Sanitation Campaign: A Success Story in Bhiwani District in India

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Keywords: Sanitation, Bhiwani, India, Subsidy-less, Campaign

It does seem obvious that adoption of clean, hygienic practices should be the preferred choice for all individuals. This does not happen. It leads us to deliberate on the lingering failure of sanitation, a salient theme in the workshop at world water week and the central concern addressed to by this paper. The canvas for this sanitation experiment has been provided by Bhiwani district in Haryana (One of the states of Indian Union). This paper begins by discussing the repeated failure of conventional top-down approaches to sanitation. Implementing programmes by offering subsidy did not excite users enough to change their hygiene practices. Targets were fixed for construction of toilets and money was given to those below poverty line to construct these. Despite ample provision in state-aided programmes to provide for construction of toilets, there were few takers. Open defecation was rampant in Bhiwani villages which were neither remote nor economically backward. Neither economics nor technology could explain this apathy to sanitation. An innovative approach of Community Led Total Sanitation Campaign undertaken by district administration changed the scenario. Based on the premise that demand for toilets and hygiene practices should arise from people themselves rather than imposed from above, this strategy of mobilization of tools of social intervention had several components. Firstly, awareness about perceived advantages of sanitation was disseminated. Demonstrative effect was induced by quoting examples of other success stories. Most importantly, a direct link with the life of beneficiaries was established. They were told that there would be reduced suffering, evident in less incidence of water borne diseases. Children would no longer be sick on a frequent basis. Consequently expenditure on medicines and visits to hospitals would drastically reduce as it had happened in those places characterized by cleaner practices of sanitation. Secondly, the constituency of women was specially roped in to enable deep rooted absorption of hygiene as a way of life. Involving women as agents of change ensured the stability and effectiveness of the initiative launched. Thirdly, the motivators were carefully chosen after a thorough scrutiny, trained and rewarded for their efforts. Fourthly, all available tools of communication and advertisement were deployed to drive home the importance of sanitation. What is also noteworthy about the entire exercise is that the social landscape was not a harmonious idyllic village community but one deeply ridden by unequal caste equations (unique to Indian set up), class disparities, factionalism and bickerings of local politics. To establish a foothold among such an amorphous mass, the mobilisers had to devise ingenious ways and means to eliminate all opposition and ensure total social acceptance of the need for a cleaner lifestyle. The most astonishing and unique outcome of this entire exercise was the widespread social acceptance of sanitation practices and total rejection of open defecation and that too, without state subsidy. This behavioural-attitudinal change was also apparent even among the most deprived who embraced this without any monetary incentives. The sanitation programme which started in 22 villages of Bhiwani has now not only been a success in 120 villages in Bhiwani but has been replicated across 1600 villages in Haryana. Besides this enormous success has been the drastic reduction in health costs, improved environment for living and gradual acceptance of cleanliness and hygiene as a way of life. Not to

overlook the much desired awareness and social awakening engineered by the motivators, animators and other stakeholders in the programme. This is not just a surmise but is supported by field data collected from surveys in villages of Bhiwani district. The success of COMMUNITY LED TOTAL SANITATION CAMPAIGN has marked a watershed in the history of sanitation in the state of Haryana. Results achieved have been unprecedented in terms of magnitude and scope. Implementation of this approach across all districts in the state is the accepted norm now while hitherto adopted top- down programmes have been shown the door. Lingering failure of sanitation is reduced to an academic discussion.

# Achieving 100% Sanitation in Developing Countries in the Light of Experiences Gained in Pakistan

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Keywords: sanitation, community participation, hygiene, disease, developing countries

Despite enormous expenditures for drinking water and sanitation in Pakistan, access to safe drinking water remains a challenge. Institutional challenges in rural and urban drinking water and sanitation remain a major stumbling block. These include addressing leakages in official spending, monitoring of progress and creating linkages between different agencies. The failure of increased coverage and access may be a combined result of ineffective programmes and policies as well as worsening livelihoods of the poorest communities on the one hand and the elite capturing resources and capital on the other. Failure in addressing resource sustainability and in achieving the desired behavioural change goals, needs to be reassessed from this point of view instead of relying upon a one-sided target driven approach.

The majority of people in Cholistan, Pakistan have poor understanding of the link between poor hygiene and disease. People tend to want to have latrines for reasons of convenience, privacy and status, rather than sanitation and health. Traditional approaches to improving sanitation have focused on technocratic and financial patronage, rather than health and hygiene education. Water supply coverage is relatively high, but safe water alone leads to only minor health improvements and does not prevent serious diseases like cholera and dysentery. In 2005, the Government of Pakistan conducted an extensive survey, the results of this survey show that only 38% of households use sanitary latrines, 25% use unhygienic latrines and 37% use no latrines.

The various case studies, discussed in this paper, pursued by the Cholistan Development Authority (CDA) are as follows:

1. Abbas Nagar Total Sanitation Project (ANTSP)
2. Sheikh Wahan Total Sanitation Project (SWTSP)
3. Basti Maluk Total Sanitation Project (BMTSP)
4. Liaquat Pur Total Sanitation Project (LPTSP)

A number of constraints have been identified to achieving total sanitation in Cholistan e.g.,

- The Government is centralized and functions in a top-down and supply-driven manner
- Fixed latrine models are too expensive for the poorest people and in many geophysical areas prove non-user friendly
- Lack of tenure rights, particularly for slum dwellers, mean poor people have no right to build latrines where they live
- Women's specific sanitation-related needs are unrecognized by the community

The CDA has identified three key areas where short term initiatives can significantly contribute to immediate service improvements and a sustainable long term reform program:



- Improving communication and responsiveness to customer needs from senior management.
- Improving revenue collection performance by strengthening the billing and credit control process, providing incentives for payment and reducing unauthorized connections.
- Improving capital expenditure project planning and management practices, and expanding communications with citizens related to these projects.

On the basis of abovementioned case studies, The CDA has developed an integrated, empowering approach in collaboration with community people living in rural areas. The key aspects of the approach are:

- People's skills, abilities and knowledge are appreciated
- 0% subsidy for latrine construction
- 'Whole community' approach
- Use of participatory research tools to analyze the problems
- Formation of Village Development Committees – local engineering groups

The approach has proven successful in establishing safe water supplies, environmental sanitation and promoting good hygiene practices. The process involves the community in all aspects of the project. This introduces ownership of the programme, as well as ensuring sustainability for the future. As part of the wider community, local Government bodies, GOs, NGOs, community based organizations and other stakeholders have successfully been brought into the process. The approach demonstrates success as other villages are adopting the 100% Sanitation Approach, seeking guidance and help from community leaders. In the light of the experiences gained, some guidelines to improve sanitation in the developing countries have been proposed

# CREPA's Ecological Sanitation Program in Ten West African Countries – Dissemination Strategy and Lessons Learnt from Six Years of Experience

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Keywords: ecological sanitation, regional network, West-Africa, lessons learnt, dissemination strategy

The CREPA network has been doing research, training and project implementation in the field of ECOSAN (ecological sanitation) in francophone West Africa since 2002. The national CREPA offices in Benin, Burkina Faso, Congo Brazzaville, Côte d'Ivoire, Guinea, Guinea Bissau, Mali, Niger, Senegal and Togo are participating in the Sida financed dissemination phase 2006-2010, aiming to reach more than 1 million people with the ECOSAN concept. This paper describes CREPA's strategy of dissemination of ECOSAN in the region and also discusses the lessons learnt after six years of ECOSAN research and project implementation.

## Dissemination methodology and approach

During the research phase 2002-2005, technical, sociological, hygiene/risk and agronomical aspects of ecological sanitation were studied. This research phase was important to adapt the ECOSAN concept to the local context and generate the scientific results that today serve as a solid foundation in the dissemination that is under way.

CREPA's choice of project sites in the dissemination phase is based on the demand and engagement from the local authorities, and participative methods (SARAR/PHAST) are used to involve the population. School interventions are guided by the HESAWA approach and the HCES approach is emphasized in urban contexts.

Micro credit schemes are set up to lower the subsidies. The private sector is mobilized and trained in toilet construction and also in the collection, sanitization and transport of human excreta in the urban context.

Reuse of sanitized excreta is central to the ECOSAN-projects. A demonstration field in the community is used for training, awareness raising and demand creation. CREPA's ECOSAN research during this phase is mainly focused on reuse issues, with one PhD student and two master's students granted by the ECOSAN program.

A variety of capacity building activities on all levels are needed to raise ECOSAN awareness and competence on local, national and regional level. For up-scaling, ecological sanitation should also be included in the legal and strategic framework. This needs lobbying and good relations to the governments.

Close follow-up of the national offices and good communication and knowledge exchange between national CREPA offices and CREPA HQ are of importance to reach the program goals. A data-base is created to monitor and compare the advancement in the 10 countries involved.

## Lessons learnt

### Community involvement/changing behavior

- + Introducing UD dry toilets in the school and then using the derived fertilizer in the school garden can be very successful. (Côte d'Ivoire, Senegal, Benin, Guinea).
- + Rapid start of implementation by installing simple urinals at each household in a village in order to meet a need (access to urinal, especially at night) and immediately collecting plenty of urine for field demonstrations. (Côte d'Ivoire).
- + Television spots featuring the advantages of ECOSAN create interest and demand (Mali and Congo).
- + Gaining credibility by "walking the walk" and not only by "talking the talk". There are now eight UD-dry toilets at CREPA HQ, (five are inside the office buildings). More than 15 of the people involved in the ECOSAN program have built a UD toilet at home.
- The behavior change on household level requires a persistent follow up that has not always been assured.
- Hand washing devices have not been persistently associated to the household toilets.

### Financing and construction of toilets

- + Some countries have developed toilet models using 100% local materials to lower costs (Mali & Burkina)
- + Stimulating other organizations to engage in ECOSAN by financing and providing training for the first ten toilets to each new organization wanting to "try" ECOSAN (Mali).
- + Agro-business industry financing toilets in workers' villages (Côte d'Ivoire).
- The local building knowledge is still largely untapped, which will be a decisive factor in order to get costs down to a level where auto-replication can start.
- Difficulties in setting up micro credit schemes.

### Reuse

- + Finding local attractive words for sanitized urine and faeces has helped to overcome mental barriers (Burkina)
- + Agronomic studies on the fertilizing effect of sanitized excreta on a variety of local crops have been compiled into guides on application mode, dose and interval.

### Capacity building

- + Regional and national general ECOSAN training courses are carried out annually
- + ECOSAN integrated into the curriculum of professional schools (Senegal and Guinea Bissau).
- + ECOSAN workshops targeting strategic professional groups are important in the dissemination phase. 2007 a regional ECOSAN workshop for architects was organized in Ouagadougou, and in 2008 a corresponding workshop will be organized for agronomists.
- The follow up of the training course participants is often lacking. A network with the alumni students should be created.

### **Institutional arrangements/influencing policies and legal framework**

- + Setting up piloting committees with members from different institutions to follow the projects (all countries)
- + The UD toilet has now been included as a technological option in the national strategic plan (Burkina Faso)
- + National ECOSAN consortia are being created (Mali)
- + Project management:
- + Setting up a yahoo-group has facilitated knowledge sharing
- + Regular supervision mission to the national offices by CREPA HQ and members from the Regional Technical Committee
- Lack of benchmarking system between countries, database delayed

### **Conclusion**

The potential of ecological sanitation is getting into the minds of more and more actors in the region. Important partnerships have been made between CREPA and municipalities, research institutes, other NGO's and donors. The impact on the MDG's is however still far from evident. The demand due to the reuse potential has still not reached the level where auto replication will take off, and numbers really rise.

# Strategic Sanitation Planning Approach in Burkina Faso: Lessons Learnt after 10 years of Implementation and Promising Improvements

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Keywords: sanitation, strategic planning, demand-based, stakeholder-based, sustainability

The spatial development and rapid population growth of cities in West Africa must be accompanied by supply and people's access to basic services of health, education, drinking water, and sanitation. Unfortunately, the countries rarely have the means to make these investments contributing to the improvement of living and health of city dwellers. The question of sanitation, for a long time obscured by the problems of drinking water in semi urban cities, is no less worthy of interest and attention. In this sector, the implementation of programmes has often been confronted with many difficulties because the questions "what technology, at what cost, and what financing for any user?" have not always found adequate solutions. Since the late 1990's, the sustainability of interventions is the major concern of policy makers, professionals and stakeholders in the urban sanitation. Based on the shortcomings observed during the international decade for water and sanitation, several approaches have been developed and tested for improving the sanitation services. In the case of Burkina Faso, the national water and sanitation agency (ONEA) adopted the strategic planning process developed by the World Bank. The strategic sanitation planning approach is based on a demand and incentive principle; its operationalization requires the involvement of stakeholders, and the challenge for governments and agencies is to motivate and build capacity of stakeholders to participate appropriately and productively. The demand is accessed by a willingness-to-pay survey based on different technologies of latrines and the contingent valuation method. The private operators are asked to develop the service to meet this demand. They are also in charge of promoting the programme and building the latrines. In the case of the city of Ouagadougou, the implementation of the plan has helped to increase the sanitation coverage by equipping thousands of household with latrines. Households contribute for 70% of the cost, and the 30% is covered by a subsidy from ONEA. The ventilated improved pit (VIP) latrines, technological option preferred by ONEA were mostly built in schools, and were not the 1st choice of the households. After 10 years of implementing this approach in Ouagadougou, the results achieved in improving sanitation coverage led to ONEA to extend it to other small/middle municipalities (30.000-100.000 inhabitants).

Despite these results, this approach by principle and due to the manner of its implementation by ONEA present shortcomings: high cost of the proposed technologies (150-500 euros), limited access to the service by the poorest households (because of the high cost, limited access to information), limitation or the technological inadequacy, lack of strategy for improved faecal sludge management. Correcting these deficiencies is today a new challenge that requires a shift in the demand-based approach. In addition, the decentralization context requires repositioning of the ONEA towards municipalities that assume now the mission of organising water and sanitation services.

In this article we describe and analyze how CREPA (Research Centre for water and sanitation at low cost) as part of its research-development programme has supported some decentralized communities to develop an approach based on stakeholders, and integrating the benefits while minimizing the

drawbacks of the demand-based approach. The continuous advocacy conducted by CREPA among communities and local partners allowed the incorporation of “no mixed” toilets in the range of technologies, as well as management of faecal sludge. To promote access to sanitation services by the poorest, the micro credit system in place for drinking water is being expanded to include latrines and bins for solid waste. In the city of Ouahigouya (65.000 inhabitants), by focusing on local practices, perceptions and individual behavior, our study revealed that financial viability – often reduced to willingness-to-pay – is not the only factor to consider when planning improvement of sanitation practices. Willingness-to-improve is highly dependant on psycho-sociological factors such as attitude towards and beliefs in an improved neighbourhood environment, social pressure on the households by the neighbourhood as well as the subjective costs and benefits expected from improved hygiene. These factors therefore present levers allowing planners and decision-makers to encourage, increase and develop the demand for improved latrine emptying services, e.g. through social marketing. To lead the planning process, local authorities need strengthening and technical support. The key to the success of the planning process is to ensure that the stakeholders are involved in an appropriate manner, and that their interests, capabilities and responsibilities are taken into account. This can be obtained by analysing stakeholder importance and influence, and choosing the subsequent the stakeholder involvement techniques.

# Periurban Sanitation: What's the Problem?

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Keywords: periurban sanitation systems, condominal sewerage, community toilet blocks, training trainers, design code revisions

To meet the WHO/UNICEF target of 'Water & Sanitation for All by 2025' some 4.4 billion people will have to be provided with improved sanitation during 2001–2025, and around half of these are/will be in 'urban' areas – but in reality we are talking about periurban areas. Given that most population growth over the next few decades will occur in 'urban' (again, really periurban) areas of developing countries, periurban sanitation will have to become much more important than it already is. Our current focus is on achieving the sanitation target of the Millennium Development Goals, but these efforts will have to be doubled if we are to meet the WHO/UNICEF 2025 sanitation target in periurban areas, and then maintained for the next quarter century as we seek to meet the sanitation needs of the additional two billion or so people expected in periurban areas by 2050.

So the Big Question is: How can we provide affordable sanitation to these very large numbers of poor people in periurban areas in developing countries? The answer to this question depends in part on the population density: at low population densities on-site sanitation systems are normally feasible, but (and as we have known since the early 1980s), even if there is sufficient space for them, they may not necessarily be the cheapest option (and, because we are attempting to serve poor and very poor people, we have to consider cost); and, of course, at high population densities on-site systems become infeasible as there is no space for them. In addition to being affordable, the chosen sanitation system has to be both socially acceptable and institutionally feasible.

Consider the typical periurban situation: a high population density, one too high to permit on-site sanitation systems. What are the 'best' solutions for sanitation? If affordable, the system of choice would normally be simplified sewerage (also known as 'condominal' sewerage). With this sanitation system we should remember that in Natal in northeast Brazil, where it was developed in the early 1980s, it became cheaper than on-site sanitation at the relatively low population density of ~160 persons per ha, there were no connection charges and the monthly charge for the service was only USD 1.50; and that in Chisty Nagar in Orangi, Karachi, Pakistan, where Brazilian-style simplified sewerage was first installed in Asia in the mid-1980s, the residents obtained their water (only ~27 litres per person per day) from public standpipes, thus demonstrating that a plentiful on-plot water supply is not a *sine qua non* for the system. Simplified/condominal sewerage is one of the components of the very successful 'Slum networking' programme in India, and it has also been used in small villages in northeast Brazil. It is socioculturally very acceptable as it appears to its users to be similar to conventional sewerage, so their sanitation system is the 'same' as that enjoyed by the rich. It is also institutionally acceptable simply because it is a sewerage system and, as such, it can be readily understood and appreciated even by very conservative sewerage design engineers, especially when they realise that its hydraulic design is actually more rigorous than that used for conventional sewerage.

At this point it would be informative to consider what we would do if – just if – conventional sewerage were sufficiently low-cost for its widespread application in periurban areas. Well, for a start, there would be no discussion: the choice would be made – we would simply install conventional sewerage.

However, we would also interact with the beneficiary communities (and this would be the extent of ‘community participation’) to explain pertinent aspects of the system – for example, to inform them what was going to happen, how much the monthly water bill would increase, and offer low-cost loans (to be repaid through the monthly water bill) to install household pour-flush toilets – and, of course, no connection fees. Why should simplified/condominial sewerage be any different?

The next question is also very important: What is an appropriate sanitation solution in very poor high-density periurban areas where simplified/condominial sewerage is unaffordable? The only answer, given that the high density precludes individual household-level on-site systems, is ‘SPARC’-style community-owned, community-managed and community-funded sanitation blocks [SPARC, the Society for the Promotion of Area Resource Centres, is an Indian NGO]. They are reserved exclusively for community members – they are not in any sense ‘public’ facilities.

Both simplified/condominial sewerage and community-managed sanitation blocks are well proven sanitation systems and both equally suitable for large-scale replication, so why is periurban sanitation still ‘lingering’ in developing countries? The paper provides several answers to this question which lead to the conclusions that, in order to accelerate periurban sanitation coverage, we need to (i) train and disseminate much more effectively and in a much more focussed way (train local trainers in applicable sanitation systems so they can train others in their own language); (ii) facilitate changes to national sewerage codes and sanitation regulations; and (iii) ensure that decision-makers in global and regional development banks, as well as those in multilateral and bilateral aid agencies, understand the ‘real world’ practicalities of periurban sanitation so that they fund only realistic pro-poor sanitation programmes and projects. If we really want to meet the MDG sanitation target, then we need to start doing all this very soon as 31 December 2015 is only 88 months away.



# Innovative Options for Increased Investment in Sanitation in Developing Economies: A Kenyan Case Study

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Keywords: Sanitation, Millenium Development Goals, Investment, Economy, Financing

Sub Saharan Africa is lagging behind the rest of the world with respect to achieving the Millennium Development Goals (MDGs) on water supply and sanitation, which aim to halve the proportion of people without access to safe drinking water and basic sanitation by 2015.

Worldwide, over 2.6 billion individuals live without sanitation. Another 2.8 billion individuals have access to some type of sanitation, mostly pit latrines, of which many are unhygienic and contaminate the human and natural environments. About 1.1 billion individuals have waterborne sewerage of which 30% are connected to an advanced sewage treatment facility and the remaining 70% are sources of downstream contamination.

Whereas Kenya appears to be on the right track to achieve the water MDG, the sanitation sector is lagging far behind target. In both areas, great attention needs to be paid to resource allocation and equity. In 2002, 62 percent of Kenya's 32 million people had access to water supply, and 48 percent had access to sanitation. To achieve the MDGs, 15.8 million more people need to obtain access to water and 16.5 million more to access sanitation. This would require an increase in current capacity of about 1.2 times for water supply and 2.2 times for sanitation. Even if targets are met, an additional 8.5 million people will remain without access to safe water, and 12.2 million will lack sanitation. The government is ambitiously striving to exceed the sanitation MDG and achieve a 90 percent access rate by 2015. In achieving the water and sanitation goals, there are indeed identifiable financial constraints. Furthermore traditionally this sector has received insufficient financing to meet intended targets. To exacerbate the situation and in the light of insufficient current financing there are questions of efficiencies in spending the available resources.

It has also been difficult for Non State actors working in the development sector to advocate for increased financing for the sector due to financing data not being readily available. There are also gaps between planning models and actual demand and needs on the ground which has resulted in inaccurate projections for future investment.

This paper will therefore seek to answer the following questions: why has the sanitation sub sector traditionally received insufficient financing and investment; What finance models have been used in the past; what financing options are available to meet financing gaps; what lessons can be learned from micro level community sanitation projects and what options for institutional mechanisms are available to enhance efficiencies, accountability and impact.

In looking to answer these questions the paper will be seeking to increase the body of knowledge around innovative investment models and their increased impact on improved sanitation delivery

and outcomes. Secondly in postulating options for finance models, the paper will challenge countries facing similar challenges in delivering sanitation services to contextualize the options and innovate within their resource limitations for better outcomes. Furthermore the paper will also seek to profile small scale investment models In Kenya seeking to draw relevant lessons for possible replication at the macro level. In profiling these micro models the paper will also aid in capturing community perspectives and knowledge in delivery of sanitation programmes.

This information as captured in this paper will provide a solid evidence base to argue for increased investment in the sanitation sector by identifying the structural weaknesses in the traditional financing models while challenging the myths about the economic non- viability of investing in sanitation systems and programmes. The context of the research being in a developing economy should aid in changing the trends in other like economies that account for the vast number of countries that are not on track to meet the Millennium Development Goals on sanitation.

This paper will be packaged not only to meet scientific requirements in terms of empirical data but also pose untried arguments that will hopefully spur more study and innovations in the future in the sanitation sector for better outcomes especially in developing economies.

# Many Decades of Sanitation Promotion, but no Change – Where Have We Gone Wrong?

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Keywords: Sanitation, Sanitation Demand, Sanitation Supply, Sanitation Marketing, Sanitation Approaches

The WHO/UNICEF Joint Monitoring Program Report (2004) glaringly states: “Without a sharp acceleration in the rate of progress, the world will miss the sanitation target by half a billion people”.

Sanitation is a very broad term. For purposes of this presentation therefore, sanitation will be narrowed down and interchangeably used to imply a toilet/latrine.

An integrated and holistic sanitation and hygiene promotion program has been proven, at least in many developing countries, to be a cost-effective means of reducing poverty, disease and ignorance particularly among rural households. This justifies the inclusion of sanitation and hygiene into the Poverty Reduction Strategy Papers (PRSPs) of most developing countries.

Indeed, there have been and still are quite many major action-oriented milestones for sanitation at global level including the UN Millennium Development Goal (MDG) on Water and Sanitation and the most recent resolution of the General Assembly of the United Nations (resolution A/C. 2/61/L.16/Rev.1 dated 4 December 2006) to declare 2008 as an International year of Sanitation (IYS).

However, the question remains: why is sanitation failing despite the efforts and the many decades of sanitation promotion? The reasons for the failure of sanitation are as many as there are action-oriented milestones! This Paper therefore endeavors to analyze past experiences with promotion, the results of such actions, where things could have gone wrong and recommendations for the future.

The international targets are very meaningful in so far as that they focus attention on the appalling state of sanitation. The targets have also enabled national governments in many countries have commitments to achieve these targets and this has influenced national planning.

For decades sanitation projects have used the same worn-out approach – heavily subsidized government or donor-sponsored latrine construction, coupled with health education. Such latrine building programs have set construction targets but have not taken into account users views and needs. There has been ambitious master-planning of infrastructure (e.g. sewerage) that is too expensive to implement, operate and maintain and resulting into little action.

For many national governments, sanitation has been a neglected area in terms of performance data collection, analysis and interpretation over the years. There is no real consensus on coverage rates and indicators. When coverage rates are quoted, it is likely that actual usage rates are much lower. Quite often these figures mask the unserved – e.g. “the invisible poor” – that live in urban poor areas/informal settlements characterized by high population densities. There are problems too with affordable technology that works.

Many countries have put in place sanitation policies and there are many pilot projects but nobody knows how to plan and program to upscale these pilots – which is also a “missing link”. Consequently, there is little impact on the scale of the problem – hence low coverage figures.

Many latrines have been built but are not used simply because norms and standards have been inappropriate and unaffordable allowing only a standard latrine type. Since promotion programs are based on subsidy, there is not enough to go round. Unfortunately it is the poor who miss out. Different levels of government have different programs with different rules e.g. about subsidy, which causes confusion.

We can conclude that large-scale interventions for latrine construction have largely been disappointing, although there are a few notable exceptions. For example reduced donor investment in sanitation facilities, which is of concern because the single most important intervention for environmental health is probably the latrine.

The future, therefore, lies in the new and innovative approaches to be used by Professionals to promote sanitation; approaches to stimulate demand for sanitation. Large scale latrine coverage can only be achieved if large scale demand can be created. How does one stimulate demand for sanitation, considering such demand is much less expressed than the demand for water? Development of capacity and skills base among sanitation professionals on sanitation marketing approaches is the way to go.

There is also need to understand the supply side of sanitation; to supply a range of toilets at a range of prices, which requires a flexible and responsive supply system, and support for the market to fulfill this need through identification and supporting key players in the supply chain i.e. the local toilet builders.

The fragmentation of sanitation between different institutions calls for adequate coordination of actors as well as programs to avoid conflicting approaches. Coordination can best be achieved through facilitating Multi-stakeholder/multi-sectoral Platforms (at all levels) to dialogue on sanitation and share best approaches and practices. This will also ensure that the Local Governments that have quite often been ignored are involved. Consumers (sometimes referred to as beneficiaries) should be at centre of decision making.

In conclusion therefore, sanitation has no one solution. A well planned sanitation program requires a “cocktail of drugs” – a multi-faceted approach of innovative approaches as well as coordination of the work of Engineers, Public Health Specialists, Social Scientists, Private Sector, Government Institutions as well as the Non-Governmental organizations.

# Mobilising Political Will and Institutional Action: Lessons from the Southern Nations Region of Ethiopia on Successful Sanitation Policy-Making

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Keywords: Politically attractive policy, Movement for basic health, 'Ignition' documents, Institutionalising policy, Extension and outreach

Initially brought to international attention as a success story by a WSP Field Note (WSP, 2007), the post-2003 sanitation and hygiene policy of the government of the Southern Nations region (SNNPR) in Ethiopia has now been studied by a DFID-funded research and learning project, the 'RiPPLE' Programme (see below), to look at how success was achieved (and how far).

Despite low levels of sanitation services and poor hygiene in Africa, it has proved difficult to place sanitation and hygiene appropriately on political agendas in many countries. The following question lingers: why is it that sanitation & hygiene policies which are backed by sound epidemiological evidence, and supported by good socio-economic arguments for increasing investment in sanitation and hygiene, are nevertheless not adopted by many governments?

Studies (ODI 2006, Tearfund 2007) have identified factors which help – and hinder – development and implementation of strong sanitation and hygiene (S&H) policies. This research in Ethiopia has looked more closely at the policy-making process. The experience in the SNNPR region provides a case study of how hindrances to launching S&H strategies may be overcome.

An innovative methodology for investigating the processes of formulation, promotion and implementation of policy was applied by the RiPPLE Programme, to identify strengths and weakness of the approach of the SNNPR regional Bureau of Health (BoH). The researchers studied the policy content, context and process, including institutions and other actors, and inter-actions between them. The objective was to understand how political momentum for S&H was created, policy messages communicated and policy objectives institutionalised – with outreach to rural communities.

'RiPPLE' refers to 'Research-inspired Policy and Practice Learning in Ethiopia and the Nile Region'. This RiPPLE-supported study was initiated in collaboration with the BoH, led by the Overseas Development Institute-ODI and the IRC International Water and Sanitation Centre and carried out by researchers from Addis Ababa, Hawassa and Jimma Universities.

Alongside the policy component of the study, latrine construction and use, hand-washing and water storage/handling by households were surveyed by the researchers, in sample households in six localities ('kebeles') in two districts ('woreda'), employing a questionnaire, focus group discussions, key informants' interviews and observations (relatively rapidly applied). The results show a substantial increase in the number of household latrines, in a few years, from 16% to 94% coverage in one district (Mirab Abaya) and 10% to 69% in the other (Alaba).

Some questions arise as to the sustainability of this wave of latrine construction (e.g. need for techni-

cal improvements) and the field observation suggests that hand washing and water storage/handling practices are still poor. The BoH and RiPPLE, and other stakeholders in the recently formed ‘Technical Research Group’ – part of a regional ‘Learning and Practice Alliance’, are discussing opportunities for further, collaborative research into behavioural aspects, and applying results.

The study has, meanwhile, yielded the following clear insights into how the BoH promoted the S&H policy:

- the initiative was regionally-inspired, not donor-driven;
- S&H was made part of a basic community health package;
- the key elements of the S&H component, as described by the BoH, were as follows: “broad based”, “household-centered”, “low cost” (hardware subsidy-free, promoting use of local materials) – for “high impact”;
- those elements were designed to be politically attractive, as well as financially and administratively feasible;
- they were approved by the regional cabinet, as part of a ‘movement’ to bring improved services to rural communities, promoted at election time;
- ‘ignition’ documents were written to motivate local politicians as well as civil servants;
- following those communication-oriented documents, more conventional technical ones were written;
- implementation tools piloted by donors in the region (e.g. Health Education Programme) were opportunistically applied by the BoH, and donor funds leveraged (for software aspects);
- a cadre of health extension workers and community health promoters was developed and intensively involved;
- the political campaign was accompanied by measures to institutionalise the policy;
- five years later the BoH maintains this policy and its ingredients are being applied and adapted at federal level for further application.

The above activities were successful in launching and ‘rolling-out’ the S&H policy which (as noted above) resulted in substantial increase in latrine construction.

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# Sustainable Urban Sanitation: Rhetoric or Reality? Insights from Kathmandu Valley, Nepal

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Keywords: Kathmandu Valley, Bagamti River, Sanitation, Culture, Corruption

## **Brief Description of the Workshop theme to be addressed**

The paper aims to contribute to the workshop theme on The Lingering Failure of Sanitation – Why? The sanitation sector calls for solutions that are cost efficient, culturally appropriate and sustainable. There is lot of efforts and funding gone in to addressing the issues in urban sanitation sector in Nepal. However, the results are far behind compared to the policy goals. There is a need for robust governance structures that can address the corrupt practices and increase access to information and decision making for the residents of the poor neighborhoods in the Kathmandu Valley.

## **Presentation of the topic and Analysis of the Issue**

A century ago evidence suggests that toilet waste was collected in major European cities. Today, they have achieved a higher level of sanitation infrastructure. Compared to these cities, billions of resource poor people in urban, semi urban areas in the Asia region have no access to proper sanitation even in the 21st Century.

The paper focuses on the state of affairs of sanitation services in the Kathmandu Valley, Nepal. In the last ten years the city, in addition to the urban population growth has witnessed a large volume of in migration due to the Moist led internal conflict in the Country. At the same time due to the weak state mechanisms, corruption in the sector, sanitation as a public service provided by the state has been a failure, leading to inadequate sanitation and hygiene. Corruption undermines water and sanitation services. It is those without a voice, the poor, who are systematically deprived by corrupt systems. Using resources honestly and effectively, rather than using more resources is arguably an answer to achieving the Millennium Development Goals (MDGs) for sustained water and sanitation services that reach the poor.

One of the main principles of ecological sanitation is recycling and resource efficiency. This means a system approach to a technical design. The success of the design is based on factors like appropriateness, access to information and cost. The research shows that the neighborhoods in the valley, that lack access to proper (ecological) sanitation facilities are polluting Bagamati River system and hence prone to disease. In this cycle, the worst sufferers are the children especially from weaker sections and migrant families.

The paper discusses the governance issues in the sanitation sector, practices and coping mechanisms of families that lack proper sanitation facilities in the urban and peri urban settlements within the Kathmandu valley. It also critically examines the government strategies/policies in providing sanitation and hygiene to the city residents especially to the low income families. In addition, the paper documents the current best practices in sanitation sector.

## **Results/Finding**

The study findings suggest that much of the sanitation infrastructure and practices are either open defecation, based in hiding human excreta in deep pits (drop-and-store) or flushing them away and diluting them in various water bodies (flush-and-discharge). In most cases the sanitation infrastructure is neither appropriate nor affordable to many families. Different cultures also promoting either faeco-philia or phobia. The study shows the evidence that the urban government policies are not able to meet the sanitation needs of the growing population. The sanitation practices at the household level are directly proportional to the level of education and cultural practices.

## **Conclusion and Recommendation**

Achieving sustainable urban sanitation becomes rhetoric in the absence of robust governance mechanisms. Introducing technological alternatives to the conventional sanitation is crucial. By providing better access to knowledge and decision making, community members can create the conditions to improve the water and sanitation facilities in their neighborhoods. The paper highlights the importance of sharing knowledge and innovations in the sanitation sector and argues for improved access to appropriate urban sanitation systems and models for Kathmandu Valley.



# Moving Sanitation Forward – People Driven Systems; Integration at the Top, Involvement at the Bottom

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Keywords: Integration, involvement, systems, sanitation, people

The UNICEF Water, Sanitation and Hygiene (WASH) program supports specific focus communities in selected focal Local Government Areas (LGAs) in all the 36 states of Nigeria as well as national government with cash, material and technical assistance to government and non governmental partners for capacity building, policy development and WASH service provision. UNICEF also provides support to communities and local governments outside these focus communities as a response to identified gaps in the sector. E.g. the Girls Education Project (GEP) intervened in 720 GEP school communities in 36 GEP LGAs in 6 of the 36 states of Nigeria between 2004 -2007. In 2007, UNICEF Nigeria expended \$15,260,901.58 on the WASH programme and hygiene and \$26 million dollars on the GEP project (2004 -2007).

Though there is some improvement, Nigeria is still not on track to meet the MDG target for sanitation in its rural communities. In the fifteen years from the MDG baseline year of 1990, rural sanitation coverage rates have risen just 3%, from 33% in 1990 to 36% in 2004 (WHO/UNICEF JMP, 2006).

The challenges to sanitation include but are not limited to the following:

- Poor institutional framework – non compliance with policies and guidelines, low capacity within government agencies for sanitation and hygiene programming.
- Low commitment to sanitation by governments – WASH programs financed by governments are often water centric, as sanitation is not seen as politically lucrative and rural sanitation programming is almost exclusively executed through other external supported projects, which are all limited in scale.
- Low sanitation demand in some communities due to poor sanitation marketing, and non inclusion of minorities and special groups like women in purdah in program design , target setting and technology choice.

## Scope

The evaluations will draw from selected rural sanitation projects supported by the UNICEF C Field regional office which provides support to eight states and the Federal Capital Territory of Nigeria.

## Methodology

The paper aims to share best practices for moving sanitation forward by reviewing evaluations and methodologies of UNICEF supported household and institutional rural sanitation programs.

## Results

The sanitation programme in Kadadaba a predominantly rural community in Zamfara state, Northern

Nigeria adopted a community-based integrated sanitation and hygiene approach with emphasis on community involvement in target setting. Despite its socio-economic challenges, poverty and low involvement of women due to the purdah system, Kadadaba community in three months moved from a 48% sanitary pit latrine status to a 100% sanitation coverage and 100% borehole functionality which has been maintained. Maru LGA supported the community with development of community action plans and targets. This has resulted in amongst other things, the improvement in sanitation related status and demand in Kadadaba and environs, .The State Ministry of Planning has begun replicating this approach in ten other communities of the state.

The GEP DFID funded/UNICEF managed project (2004 -2007) covers 720 school communities in 36 LGAs in six Northern states of Nigeria. Prior to GEP, many schools in Northern Nigeria had no access to safe water or sanitation. The national pupil to toilet ratio was 292:1 and nearly 3000:1 in some states (UNESCO/FME 2002). In addition to the general sanitation challenges, these communities are predominantly muslim and more girl children than boys are out of school. The project approach integrated inter-sectoral collaboration, child and community involvement, tri sector partnerships, to provide WASH facilities as part of a child friendly environment. This contributed to increased enrolment, attendance/retention of pupils, especially girls in the schools. According to the DFID Output to Purpose Report (OPR) 2007, the enrolment of girls in 360 GEP focus schools in 'C' Field office increased from 5,556 in 2006 to 9,662 in 2007. This has led to reduction in gender gaps in the GEP focus schools in the states from 42.7% in Sokoto, 25.8% in Niger and 26.8% in Katsina to 25.1%, 19.7% and 20.9% respectively. Comparing non GEP and GEP indices, Sokoto state wide gender gap reduced from 39.4% in 2005/2006 to 30.7% in 2006/2007 whilst in GEP schools to 25.1%.

In Niger state, the gender gap reduced by 8.5% average in the 120 GEP schools, and 2% average state-wide from 2005-2007 ( FGN/UNICEF 2007 Annual report). The approaches are being replicated by the state governments in non GEP LGAs.

Technology which is not suited to terrain or special needs is one of the challenges that results in low sanitation demand and usage, in realization of this, UNICEF and its Kwara state partner provided terrain specific technical assistance to a focus community resulting in 100% household sanitation coverage for the first time in the history of the community and the state. A pilot has also been carried out in Zamfara state to amend school sanitation facilities to suit the special needs of the physically challenged and girls of menstrual age.

## Conclusion

An evaluation of the FGN/UNICEF Program of Cooperation ( 2002 -2007) in the focus LGA/community areas in the UNICEF C Field office indicated that the WASH, health and education interventions has had a positive impact on the sampled focus communities e.g. sanitary means of faecal disposal at household level had increased from 33.16% to 66.18%.

The school of thought that sanitation coverage is slow because of low community demand must change. Establishing People driven systems is key to moving sanitation forward. 1. Integrating at the top to build sound institutional framework and securing high level government financial commitment by providing evidence based advocacy of pilots that work and 2. Involvement at the bottom; community involvement in most program aspects including target setting.

# Faecal Sludge Management in Freetown, Sierra Leone: A Missing Component of the Millennium Development Goals

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Keywords: On-site sanitation, Faecal sludge, Desludging trucks, Private sector, Treatment options

The urban sanitation situation in Freetown is largely undeveloped and much of the system remains unimproved or non-existent. A small area in the Central Business District is served by sewerage; but by far the majority of the city's inhabitants utilise various types of on-site sanitation. These include pit latrines and septic tanks of various descriptions. In addition to poor design and construction, the lack of servicing of on-site sanitation results in serious environmental health problems and contamination of water supplies.

The City Council only has a couple of desludging vehicles and there are only a handful of private companies in operation. One of the problems facing the operators is that the equipment breaks down regularly and spare parts need to be imported. In this case, vehicles are out of action for extended periods of time and the demand for desludging cannot be met. In addition, many pits are of basic construction without any form of lining and therefore prone to collapse if a mechanised desludging vehicle is used. As a result, latrine owners often employ the services of a group of men who clean the latrine manually and dispose of the waste in nearby natural drainage channels.

Another problem relates to the fact that there is only one site that is designated as a disposal site for faecal sludge. Although the site is located in the centre of the city, the travel times to reach the site from many parts of the city are a disincentive to cart the waste there. As the dump site is located on low-lying ground adjacent to the sea, the site is susceptible to flooding. In addition, existing sludge drying beds are completely overloaded and the site's poor engineering and condition of on-site access roads make manoeuvring vehicles difficult.

As a consequence of these factors, the majority of excreta finds its way into the natural drainage channels— either directly or indirectly — which is a serious environmental health hazard. The risk of diarrhoea disease is particularly acute in the slums, particularly in the rainy season when there are regular outbreaks of cholera and other diarrhoeal diseases.

This paper is based upon the faecal sludge management sub-component of the Water Supply and Sanitation Strategy for Freetown, Sierra Leone that was prepared by the consultants on behalf of Guma Valley Water Company and the City Council of Freetown with funding from the UK's Department of International Development.

The MDG's focus attention on the need to increase the coverage of latrines, but there is far less attention on the need for servicing of these facilities. The need to improve the desludging arrangements as part of a city-wide strategy for faecal sludge management was considered to be critical. Thus, faecal sludge management involves the servicing of on-site sanitation (pits and septic tanks) using desludging vehicles and the cartage of excreta to locations for treatment.

The main aim is to improve the frequency and quality of latrine and septic tank emptying operations and the installation of facilities for treatment and disposal of faecal sludge. This involves the identification of possible sites for sludge disposal and development of appropriate management/regulatory arrangements for private sector operators, including an innovative financial incentive to encourage the companies to take the waste to the proper disposal facility.

The approach promoted by the strategy was to introduce an innovative system whereby the licensed operators receive a token for delivery of waste to one of the faecal sludge treatment sites. The operators then can claim back money from the Council based upon the number of tokens which reduces their next payment to the Council which then increases their profitability, invest in new desludging equipment and subsequently their ability to expand their services.

As part of the financial model for promoting these improvements laid down by the strategy, an Innovation Fund is proposed as the mechanism to provide the start up capital to enable small private sector entrepreneurs to set up business. In order to ensure that the approach would be economically and commercially viable, the strategy was based upon a financial analysis of capital investment costs (CAPEX) and operational and maintenance costs (OPEX) over the period of the expected life-cycle of a vehicle.

The strategy supports the private sector in septic tank cleaning operations includes the provision of funding to the City Council to purchase equipment and therefore expand operations. City Council and private operators serving different areas are proposed in order to maximise the efficiency of the operations.

An expanded septic tank cleaning services combined with enforced sanitation regulations will result in an increased volume of waste evacuated from septic tanks and cesspools. This will subsequently result in increased load of faecal sludge treatment that requires a location for disposal. A central component of the sanitation strategy is the use of population census data combined with population growth to predict the number of vacuum desludging trucks and the scale of treatment facilities.

In order to minimise faecal sludge volumes and haulage distances, a system of decentralised waste management is the preferred option with treatment facilities located in different parts of the city. The location of these treatment plants are identified based upon consideration of future developments in the Freetown urban area and the need to minimise haulage distances as the haulage of relatively small faecal sludge volumes is inefficient and uneconomic. The strategy considers various treatment options including the use of reedbeds for faecal sludge dewatering which constitute a promising alternative to conventional sludge dewatering beds.

# Water & Sanitation in Central America. Presentation of a Study Case: Water & Sanitation for 12 Cities in Honduras

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Keywords: water, sanitation, Central America, Honduras, low energy use solutions

Water supply and sanitation in Latin America is characterized by insufficient access and in many cases by poor service quality, with detrimental impacts on public health. Water and sanitation services are provided by a vast array of mostly local service providers under an often fragmented policy and regulatory framework. Financing of water and sanitation remains a serious challenge.

Access to water and sanitation remains insufficient, in particular in rural areas and for the poor. According to the Joint Monitoring Program of the World Health Organization and UNICEF 50 million people or 9% of the population of Latin America and the Caribbean did not have access to improved water supply in 2004 and 125 million or 23% did not have access to adequate sanitation (WHO/UNICEF Joint Monitoring Program for Water & Sanitation, 2006). Increasing access remains a challenge, in particular given the poor financial health of service providers and fiscal constraints on behalf of central and local governments.

As far as sanitation is concerned, only 51% of the population has access to sewers. Only an estimated 15% of the collected wastewater finds its way into wastewater treatment plants (, which often are not properly functioning (Pan American Health Organization/Division of Health and Environment: Regional Report on the Evaluation in the Region of the Americas, Washington, 2001). 26% of the population has access to forms of sanitation other than sewers, including septic tanks and various types of latrines (WHO/UNICEF Joint Monitoring Program for Water & Sanitation, 2006).

The Millennium Development Goals (MDG) aim at halving, by 2015, the proportion of people without sustainable access to safe drinking water and adequate sanitation, from a base year of 1990. This is achievable for some countries in Latin America and the Caribbean, while it represents a enormous task for others. According to the World Bank even those countries on track to achieve the MDG targets face tremendous challenges in improving service quality, in particular to attain continuity of supply and to increase wastewater treatment.

Water supply and sanitation coverage in Honduras has increased significantly in the last decades. However, the sector is still characterized by poor service quality, poor efficiency and coverage gaps still remain, in particular in rural areas. In 2003, a new Framework Law for water supply and sanitation was passed. It includes service decentralization from the national utility SANAA to the municipalities. It also creates a policy council and a regulatory agency. Nevertheless, the new institutions remain weak and the process of decentralization has been slow. Furthermore, there is no policy of sector financing. Current coverage ratio may look acceptable but in many cases the quality of the service is low and the systems are not sustainable. Additional infrastructure is needed in order to attain MDG both in water and sanitation (UNICEF, A Report Card on Water and Sanitation, September 2006).

In this context the project Water & Sanitation for 12 Cities in Honduras was carried out, taking

into account the local conditions and proposing solutions which required low energy input and were easy to operate.

Concerning water supply, the solutions involved in most cases surface water supply considering water sources located in watersheds located at a higher level than the cities served, allowing thus to avoid pumping costs and energy use. Sanitation was realised by sewer pipe systems and treatment in stabilisation ponds, which are very robust and require low energy to operate. Operation manuals were produced as a material for local capacity development. Tariff studies were carried out basing on cost recovery principle. In parallel to the project, measures for institutional strengthening programme have been carried out in order to facilitate the creation of a water and sanitation service provider at a municipal level.

At the moment, the overall implementation of the project is assigned to a central state agency responsible for social investments but due political reasons and lack of experienced personnel has delayed the execution of the planned investments.

The paper will present the conditions, problems encountered and possible solutions in order to attain adequate levels of water & sanitation in Central America in general and in Honduras in particular, taking the project Water & Sanitation for 12 Cities in Honduras as a study case.

# Sanitation – A Dysfunctional Sector Demanding Immediate Political Attention

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Keywords: sanitation, sustainable, disease burden, sewage, bottled water

Although all creatures excrete by-products as part of natural cycles, humans have managed to turn this into a very taboo subject. As a result there is a serious lack of political, institutional and intellectual attention paid to this subject and more than half the world is grossly suffering for this. Sanitation is first about human behaviour. But people don't normally want to talk about toilets, excreta, urine, faeces, etc. let alone hand-washing. The last meaningful discussion you had about this subject may have been during your last diaper change when you were 3 years old. And since then you have been basically on your own.

This question of sanitation really has to do with our link with nature. Urbanisation has really disconnected humans from natural cycles. Most urbanites know nothing about where their water supply comes from or where it goes after use. When we in the North happen to suffer from "tourist diarrhoea" while visiting exotic countries, there is really no comprehension. After all, we wouldn't want to return if the explanation was faecal contamination of water and food.

When you were taught about hygiene in school why didn't the word faeces come into the picture? Why are epidemic diseases spread through faecal-oral contamination not properly explained? Without a dialogue on hygiene and sanitation, the world will remain in a fix.

The successful fight to eliminate polio was done through the wonders of modern medicine and vaccination. But did we really learn anything from this? What child or parent was informed about prevention of other serious viral diseases through improved hygiene practices and proper toilets that work? What about the following threatening diseases that also follow the fecal-oral route: giardiasis, hepatitis A and E, bacillary dysentery, typhoid fever, vibrio parahaemolyticus infections and cholera? Pathogens and parasites found in human excreta, if ingested, can result in a variety of illnesses, including diarrhoea leading to malnutrition. If left untreated these illnesses can result in poor growth, iron deficiency (anaemia), vitamin A deficiency, and leave the body's immune system weakened and susceptible to more serious infections. Safe sanitation is an imperative for any society and its people to function properly.

That 5000-6000 children die every day in the world due to water borne diseases linked to lack of basic sanitation; that 2.6 billion people lack basic sanitation excreting about 4.5 million tons of urine and faeces (90% of which is urine) in the open; that 700 million people in 50 countries eat food from 20 million ha of agricultural land irrigated with untreated sewage; that there are annually 60 million DALYs caused by diarrhoea (disease expressed as person/years suffered), that 3.5 billion people are infected with helminth worm parasites – should all be a big deal – at least as big as HIV/AIDS, TB or malaria. The global sanitation crisis is not a general knowledge thing. That 2008 has been declared by the UN as International Year of Sanitation has yet to hit the streets. It's all a big secret.

People will pay any price to avoid using tap water and the bottled water industry is booming, especially in North America, Europe, parts of Asia and Brazil. World consumption was 154 billion litres in 2004. Our lack of confidence in drinking water may have something to do with the fact that only about 80 major European cities in the north have advanced sewage treatment and the others have either less advanced or no treatment at all (at least 35 major cities are still waiting). But the real insult is that the money people are spending on bottled water (about 100 billion USD per year) is about three times the investment needed to meet the MDG targets on water and sanitation.

Some basic facts are important to acknowledge. The average adult produces only about 500 litres of urine and 50 litres of faeces per year. Urine from healthy bodies is basically sterile. Faeces, on the other hand, are a source of pathogens and require containment and treatment. With the advent of the flush toilet some 100 years ago, significant improvements in hygiene and health, odour control, collection and transport were achieved and a new behaviour called “flush and forget” was born. The 550 litres became 15,000 to 20,000 litres per person per year. In addition, water used in kitchens and bathrooms and even storm water drainage were added into the same collector pipes. A sewage treatment plant today needs to treat anywhere from 50,000 to 100,000 litres per person per year. The fact is cities in developing countries cannot afford these investments and even if they are installed using grants from donor countries, the maintenance and operational challenges are enormous requiring capacities that are not available.

Only about 1.1 billion people in the world have access to conventional sewage systems. Of these only about 30% receive advanced end-of-the-pipe treatment. About 3 billion have access to other types of toilets varying mainly from pit latrines (“hide and forget”) to pour flush/cess pits. About 2.6 billion lack access to basic sanitation services. The latter are classified as open defecators.

The era of sustainable development within the sanitation sector has yet to come. Some progress is being made at the pilot and demonstration level, however, including the use of source-separating toilets that allow for true containment, sanitisation and recycling of urine and composted faeces and also decentralised piped systems excluding drainage water. Because sanitation is the final chapter in human development, and the sector is characterised by a high level of dysfunction, we still have a long way to go in order to develop innovative, affordable and sustainable approaches to solve this crisis.



# How to Bring Sanitation to the 2.6 Billion Toiletless People

Author: **Mr. Jack Sim**  
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Keywords: market-driven, sustainability, emotional needs, habit change, innovative financing

WTO was created as a global network and service platform for all toilet and sanitation organizations to learn from one another and leverage media and global support and in turn influence governments to promote sound sanitation and public health policies. Founded in 2001, it now has 80 member organizations in 44 countries continuously eliminating the toilet taboo and bringing toilets on centre stage. Our series of World Toilet Summits and World Toilet Expo and Forum that have now been hosted in Singapore 2001, Seoul 2002, Taiwan 2003, Beijing 2004, Belfast 2005, Moscow 2006 and New Delhi 2007. Each event addresses the critical issues of toilet and sanitation from technologies, development, funding, to design, maintenance, social entrepreneurship, capacity buildings, research and various other related topics, creating massive media coverage and momentum. This year, the World Toilet Summit 2007 was open by President Abdul Kalam and Prince of Orange of the Netherlands William Alexandra.

Asia Development Bank will co-host with WTO the 2008's World Toilet Summit in Macau on 4-6 November.

2004, WTO has mobilized USD 700,000 funding to rebuild toilets and small sanitation treatment systems in the tsunami devastated areas in Sri Lanka and Aceh, Indonesia. WTO also implemented rural school sanitation in Shanxi, China in collaboration with Lien Aid as part of the New Socialist Countryside program in China.

WTO also declared its founding day of November 19 as World Toilet Day and this day now being celebrated by all over the world increasing awareness and generating local action for better sanitation.

- 2005, WTO started the World Toilet College training toilet design, maintenance and implementation of Ecological Sanitation systems and rural schools hygiene courses.
- 2006, WTO awarded Social Entrepreneur of the Year and Schwab Foundation fellow.
- 2007, WTO became Ashoka Global Fellow.
- 2008, MOU with International Code Council to set sanitation standards and codes.
- WTO is a founding member of the Sustainable Sanitation Alliance and is now member of the WEFForum's Global Agenda Council on Water Security.
- WTO believes that the MDG for Sanitation is achievable through facilitating networked synergies, leverages and its market-based model.

## FACT 1

2.6 billion People still have no access to proper sanitation.

## FACT 2

Most funding allocated for Water & Sanitation went to water. Sanitation remains neglected.

## FACT 3

5,000 children die everyday from diarrhea alone. 3.5 billion have intestinal worms. Everyday, half

of the world's hospital beds are occupied by patients suffering from water-borne diseases. Untreated faeces are a killer. Proper sanitation is the cheapest preventive medicine.

### **What can we do to address these issues effectively?**

We see 2.6 billion poor as potential customers demanding a toilet with sewage treatment. An efficient market economy is the best sustainable solution. Donors' funds are not available in sufficient number to solve this problem. Funding individual development projects in isolation cannot solve the whole problem. We need a systematic approach to create a vibrant marketplace and fund the building of market-infrastructures to generate competition and innovation and serve this sector so the poor can learn to become business people serving their local needs. Sanitation is still a dysfunctional market today. Open defecation is a habit for generations. To change habit, we need to drive demand.

The poor, like the rich, is motivated stronger by their emotional needs rather than rational needs. Their fears of being looked down, the avoidance of embarrassment, the need for privacy and dignity have higher priorities than their perceived needs for health, and productivity. To be successful, we must position toilet as a status symbol and an object of desire, just like a Louis Vuitton handbag!

Cost has often been cited as a barrier. Nobel laureate Mohd Yunus has shown us that micro-loan can do wonders. If the poor can get access to financing, they can pay by installments.

Other innovative models of funding are available. In India, Sulabh International's Pay-for-use public toilets sustain itself by cross-subsidizing profitable city center toilets against loss-making slums toilets. World Toilet Organization and other social entrepreneurs organizations and commercial banks are now cooperating to create innovative financing solutions within a comprehensive framework to create a paradigm shift. These are:

- Map the network of existing resources/ Best practices
- Drive demand for sustainable sanitation
- Teach the poor to become sanitation businessmen
- Fund and build Market Infrastructure for sanitation -Scale up Winning Models through innovative financing.
- Fund a Support Center: Bridge to Funding
- Simplify technologies into expert-system software that is picture-based so that the unschooled can learn to be sanitation engineers.

WTO is now looking for companies interested in making the flat-pack toilet by plastic injection molding. We can become the IKEA of the poor by delivering well-designed low-cost and desirable sanitation products.

2.6 bil customers allow us to exploit grand economies of scale in supply side and push cost down in financing, promotion, production, distribution, capacity building, and market expansion into other sectors.

Growing up from poverty in the 1960s in Singapore, I know how good governance can transform a poor country into an economic powerhouse. The right policies, taxes and allocation of sanitation services reduce hygiene-related diseases and improve the livelihood, health, dignity and poverty alleviation. I've visited many villages and slums in India, China, Africa, Russia and other countries. The spirit of enterprise of the poor often impresses me. By the above blue-print, we can help the toiletless people to help themselves.

# Total Sanitation Efforts in India: Problems and Prospects

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Keywords: sanitation, latrinisation, India, behavioural change, strategic communication

## Introduction

Sanitation has been recognised as an important development goal in rural India and addressed through the Central Rural Sanitation Programme (CRSP) launched in 1986. CRSP was restructured in 1999, with a new approach comprising demand-driven, community-led and people-centred campaign – Total Sanitation Campaign (TSC) – with a focus on IEC and cost-sharing in construction of sanitation facilities. Besides, a number of national and international NGOs (such as WaterAid) are also working with similar approaches. A common interesting incentive has been the award given to villages and panchayats that achieve total sanitary coverage primarily in terms of the infrastructure construction.

Statistics show that the overall coverage figures as a result of sanitation efforts in the country have risen from 14% in 1990 to 33% in 2004. However, a number of pertinent questions emerged from preliminary observations made by the author in field: How effectively are the sanitation infrastructures actually being utilised by villagers? Has a demand-driven IEC-based approach necessarily promoted a change of sanitation behaviour? What more needs to be done for achieving total sanitation?

A first-hand in-depth field study on the impact of current sanitation efforts in India was undertaken in a number of villages in the states of Madhya Pradesh (M.P.), Orissa and Bihar, using ethnographic methods. Data regarding sanitation approaches and perspectives of different agencies was also collected through documents review and interviews with key personnel.

## Findings/results

Findings of the study show that there are significant gaps and contradictions between policy, planning and implementation, and the community realities. The Indian policy aims to achieve total sanitation by 2012, which would imply a total reversal of the current practice of open defecation. However, the targets set out in the programs build upon ‘numbers’ of infrastructures created. Nowhere is an adequate emphasis laid on the indispensability of sustainable adoption of the infrastructures for achieving total sanitation goals. Perhaps it is assumed that if latrines are constructed, especially with user’s own investment, usage will start spontaneously.

The community data shows that a large number of those who have shared the cost of constructing latrines in their houses do not actually make use of them, not even women who have been a major group targeted in the efforts. On the contrary, those to sustainably use the latrines in rural areas are the ones who got them constructed even before TSC was introduced. The field-level staff of local implementing NGOs admit failure of the efforts because the extent of decrease in open defecation is actually quite low.

A number of factors were identified as influencing the process of change in people’s sanitary behaviour. First, doubts and fears about long-term adequacy of the new technology in case of regular use by the entire family. For example, they perceive the size of the pit to be very small. Second, practical limita-

tions such as water scarcity especially in summers and difficulties in fetching domestic water in drier areas. Third, the social function served by open defecation especially for women, as this provides an easy and desirable communication platform in situations of otherwise restricted interactions. Fourth, the contents of the IEC messages are not convincing enough or sometimes even contradictory to cultural beliefs and practices.

### **Conclusions and recommendations**

It emerges from the study that though the sanitation efforts in India intend to bring about a total change in the sanitary practices in rural communities through a demand-driven participatory approach, there are problems. First, an attempt has not been made to distinguish 'latrinisation' from 'sanitation'. What the policy intends to achieve is total sanitation, but what is attempted in practice through programme interventions is no more than mere 'latrinisation'. This error needs to be corrected urgently. Second, the centrality of behavioural change in sanitation issues and the need of designing appropriate behavioural change communication strategies has to be realized. Communication needs to be designed in a way that it appropriately addresses people's needs for behavioural change – so that doubts and fears get clarified, contradictions with cultural beliefs and values get identified and addressed, and more effective appropriately designed messages be delivered to properly identified target groups. There is clearly a need to develop a 'strategic communication framework' to promote sustainable behavioural change in the sector. There is also need to address the practical limitations through research and development on appropriate technologies.



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