

RIVER KEEPERS HANDBOOK

A Guide to Protecting Rivers and
Catchments in Southern Africa



International Rivers Network

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A Guide to Protecting Rivers and
Catchments in Southern Africa

by Lori Pottinger



Published by
International Rivers Network

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Acknowledgements

Many people contributed to this booklet, adding insights, information and ideas on how to make it a more useful document. In particular, we'd like to thank Keith Cooper, Richard Hunt, Chris Neme, Mike Scholand, Bahman Sheikh, the Desert Research Foundation of Namibia and everyone at International Rivers Network. Special thanks to the Richard and Rhoda Goldman Fund and the Compton Foundation for making this booklet possible.

Published by International Rivers Network, Berkeley, CA, USA, 1999

ISBN 0-9662771-2-0

Designed by Jeanette Madden Graphic Design

Printed by West Coast Print Center

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Introduction

Water is life, a basic fact that people have understood for millennia. This has been especially true in arid Southern Africa, where rivers have been revered and treasured. The Tonga poet Fanual Cumanzala captured the spirit of his people's relationship to their river of life, the Zambezi, before it was "tamed" by Kariba Dam:

*Down the mountains lay the mighty river
The Zambezi of the Tonga
Gift of God, river of life
The banks which yielded food for all.*

The Zambezi River was the central defining characteristic of the Tonga, which means "the people of the great river". But the Tonga are no longer truly a river people, having been resettled away from the Zambezi's banks because of the dam. While the name of the people and the river may change, this story has been repeated across Southern Africa in the second half of this century, as people's links to their rivers have been severed by development schemes.

At the receiving end of Southern Africa's large water projects are an ever growing number of urban dwellers living their lives completely removed from the watery sources of life. Some may even think they are less dependent on them, believing that their water comes from taps and power from switches.

Water is arguably the region's most precious resource, and yet life-giving sources of water – the catchments that transform the dew and rain into rivers, wetlands and lakes – are increasingly under threat. The harm that is done to essential natural systems by ill-conceived development schemes is often irreparable. The social inequities that often arise from such development are likewise seen as an unacceptably high price to pay. There is a growing realisation that decisive actions are needed to avoid further degradation of these life-giving arteries. This will require a broad and strong "catchment protectors" movement, working across the region to protect and rehabilitate our precious waterscapes. Such a movement will depend upon citizens who understand the complex workings of their catchments, and their own place within these natural systems. Hence, the impetus for this manual.

The world's hunger for power and thirst for water have both grown exponentially in this century. The first 80 years of this century saw a 200 percent increase in the world's average per capita water use, which accounted for a remarkable 566 percent increase in withdrawals from freshwater resources. Despite a century of unprecedented dam building, by the early 1990s more than 1.3 billion people were without access to fresh water, and more than three billion were without adequate sanitation.

Similarly, world demand for commercial energy has increased nearly threefold in the past 30 years. Yet more than two billion people around the world remain without power.

"From water are born all peoples of the earth."

**MAZISI KUNENE,
SOUTH AFRICAN POET**

Clearly, new solutions are needed for both of these pressing problems.

Human society has obviously benefited in many ways from the growth in power production and the spread of water service that began with the Industrial Revolution. What remains unclear is whether the huge environmental and social costs of this century's unprecedented development in these sectors will in the long run justify their profligate use. What is clear is that the way in which we have developed these resources has been more costly in environmental and social terms than we expected, or than we can afford.

The energy boom has been particularly devastating, and few societies or ecosystems have been unaffected. Big dams, nuclear power plants, mining and excessive consumption of fossil fuels have all had appalling consequences. Sadly, communities that use little or no power are often the ones most harmed by energy development projects.

The explosion in water projects throughout Southern Africa has had serious impacts, too. Large dams and irrigation projects have harmed many communities that depend on rivers for their livelihoods and culture, and have done great ecological harm across the region. The benefits have often been concentrated in the wealthier segments of society, thus increasing social inequities.

Water expert Sandra Postel writes in *Last Oasis: Facing Water Scarcity*, "Grasping the connection between our own destiny and that of the water world around us is integral to the challenge of



meeting human needs while protecting the ecological functions that all life depends on. Our farms, factories, and homes are not just competitors for a resource, they are members of a community embraced and supported by the ecosystems around them. To manage water as if it were separate and apart from us is like cutting off the flow of blood to one part of the body in order to send it to another – the living entity suffers, and, depending on where the diversion takes place, it may not survive."

This booklet aims to create more widespread understanding of the planet's catchments: how they work, what harms them and how to protect them. It was created after numerous communities and groups asked International Rivers Network's Southern Africa staff for more information about catchments, to help them understand the complex issues about large dams and water transfer projects – and alternatives to them – that arise in our work on river issues in the region (See back cover for a description of IRN). We hope this handbook will receive wide use by NGOs, community groups, schools, policy makers, journalists, and individuals with an interest in rivers and water issues. And for those who find it useful, we urge you to take action to protect and restore your local catchment, to become a "catchment keeper". Our future depends upon it.



Part I

Catchment

Basics

WHAT IS A CATCHMENT?

Land and water are ecologically linked in a natural system called a catchment, drainage basin, or watershed. From the smallest droplet to the mightiest river, water works to shape the land, taking with it sediment and dissolved materials that drain to watercourses and, in most cases, eventually to the sea. So, too, is the river a product of the land it inhabits – the type of rock and soil, the shape of the land, the amount of rainfall and type of vegetation are some of the factors that determine the river's shape, size and flow.

We all belong to a catchment (literally, an area of land that catches all the rain and directs it to a stream, river or lake). A



A *catchment* (or watershed) is an area of land from which all water drains into a common river, stream, lake, wetland or estuary. It includes a geographic community of humans, plants and animals, as well as all non-living things such as buildings, roads and geological formations. Catchments come in all sizes, and large ones contain many smaller ones. All the land on earth belongs to a catchment.



catchment also includes all the humans, plants and animals who live in it, and all the things we have added to it such as buildings and roads. Everything we do affects our catchment – from washing clothes and growing food to larger-scale activities such as mining, commercial farming, and building roads or dams. The reverse is also true: our catchment affects everything we do, by determining what kinds of plants we can grow, the number and kinds of animals that live there, and how many people and livestock can be sustainably supported by the land.

One important truth about catchments is that we all live downstream from someone, and upstream from someone else. Anything dumped on the ground in the catchment can end up in its rivers, lakes or wetlands. And anything released to the air can come down again, nearby or thousands of miles away. A catchment's water may be made undrinkable by activities many kilometres away. To understand the water quality of a stream, one must look at the entire area it drains.

We are all connected through catchments. Catchments do not respect political boundaries, and in fact can encompass several cultural, national and economic boundaries. The

Limpopo catchment, for instance, includes parts of Botswana, South Africa, Zimbabwe and Mozambique. What happens in one country's part of the catchment will impact water quality, quantity, or people who depend on it in the countries downstream.

A catchment is a web of life. The life it supports is interconnected, meaning every creature and plant depends on other creatures and plants in the catchment for sustenance. If the whole catchment is like our bodies, then rivers are like our veins – coursing with life and crucial to sustaining it.



Physical Features

Because water runs downhill, a catchment usually starts at the top of a hill, mountain or ridge, which is called a divide or watershed. The top of a mountain can be the starting point for two or more catchments, where water can go off in different directions. For example, the highlands in Angola form the top of the catchment for several large rivers, including the Zambezi, Okavango and Kunene.

Most of a catchment consists of slopes and the river valley. Water eventually makes its way to a major stream or river, and eventually it joins that of other catchments and makes its way to seas and oceans. It may also spend some time underground along the way.

Slopes influence a catchment's drainage pattern. Very steep slopes make it difficult for rainwater to seep into the ground. This causes water to run off and increases erosion. Plant cover is more difficult to establish and infiltration of surface water is reduced on steep slopes.

The catchment's exposure to the sun affects temperature, evaporation, and transpiration (water used by plants) – which in turn affect how we use the land and what will grow there. Soil moisture is more rapidly lost by evaporation and transpi-

ration on steep slopes facing the sun. Slopes exposed to the sun usually support different plants than those facing away from the sun. Orientation with regard to the prevailing winds has similar effects.

Catchments come in all sizes, and large ones contain many smaller ones. A typical catchment is a network of smaller rivers or streams called tributaries, which link to each other, and eventually into a bigger river. Streams can be one of three types, depending on how often they carry water:

▲ Ephemeral streams are small, temporary paths which occur only during a rainstorm or after a flood. The channels are not defined and vary from storm to storm.

▲ Intermittent streams generally flow only during the wet season.

▲ Perennial streams flow year-round, their channel is usually well-defined and they may have several smaller tributaries which join them.

The physical, chemical and biological makeup of a stream relates to surrounding physical features of the catchment. Analysis of these features aids understanding of stream-catchment relationships and predicts effects of human influences on different stream types.

WATER IN THE LANDSCAPE

Reprinted with permission from Sharing Water in Southern Africa by the Desert Research Foundation of Namibia (1997). See Contacts for more information on DRFN and Resources for more on this book.

KEY ISSUES

▲ The landscape hosts the natural resources on which people depend: water, animals, soils, crops, timber, fuelwood, energy, minerals. It is our life support system. Without water, this support system collapses, and the landscape becomes a barren desert.

▲ Southern Africa is characterised by low to fairly good rainfall that falls in the summer, except in the Cape where there is winter rain. Variations in the amount of rain and its timing and intensity during the season are great, especially in the drier parts of the region. Droughts are frequent and can strike at any time.

▲ The water cycle circulates water between the oceans and lakes, the air, the land surface, and underground. Although water is constantly in circulation, the amount that is available is finite. It is impossible to get more 'out of the system' (except by desalination of sea water), although transferring water from an area of surplus to an area where there is a shortage is frequently done.

▲ Southern Africa experiences very high losses of water from evaporation and transpiration, with the result that only a very small proportion of the total rainfall enters streams or groundwater reserves, where it is available to be used directly by people.

▲ What happens to water on land affects the quality and quantity of water in the air, in surface water bodies and underground. Human activities such as commercial forestry, keeping too many livestock that causes overgrazing and soil erosion, polluting rivers or using groundwater faster than it can be recharged, all have consequences on water availability elsewhere in the system. Downstream areas are dependent on how water is used or abused upstream.

▲ Wetlands are extremely rich areas in terms of the numbers and diversity of plants, animals and people they can support. They are natural irrigation systems that have formed in harmony with the local conditions of rainfall, occasional droughts and floods, and the animals and plants that they support. They should be used in ways that do not disturb the dynamic pattern.

Climate

Land and water are closely linked through the water cycle. Energy from the sun drives this and other natural cycles in the catchment. Climate – the type of weather a region has over a long period of time – determines how much water comes to the catchment through seasonal cycles. The seasonal pattern of precipitation and temperature variation control streamflow and water production. Although the amount of precipitation can vary from year to year, the earth has a finite amount of water which cannot be increased.

Some precipitation infiltrates the soil and percolates through permeable rock into groundwater storage called aquifers. Natural groundwater discharge is a major source of water for many streams.

Pumping water from an aquifer for industrial, irrigation, or domestic use reduces the aquifer's volume. Unless withdrawals are modified or groundwater recharge is increased, the aquifer will eventually be depleted. A drained aquifer can collapse from the settling of overlying lands. Collapsed underground aquifers no longer have as much capacity to accept and hold water, because the soil settles and condenses, resulting in less volume to hold water. Recharge is difficult, volume is less, and yields are considerably reduced. Springs once fed from the water table also dry up.

Climate affects water loss from a catchment as well as providing water. In hot, dry, or windy weather, evaporation loss from bare soil and from water surfaces is high. The same cli-

matic influences that increase evaporation also increase transpiration from plants. Transpiration draws on soil moisture from a greater depth than evaporation because plant roots may reach deeper into the available moisture supply. Transpiration is greatest during the growing season and least during colder weather, when most plants are relatively dormant.

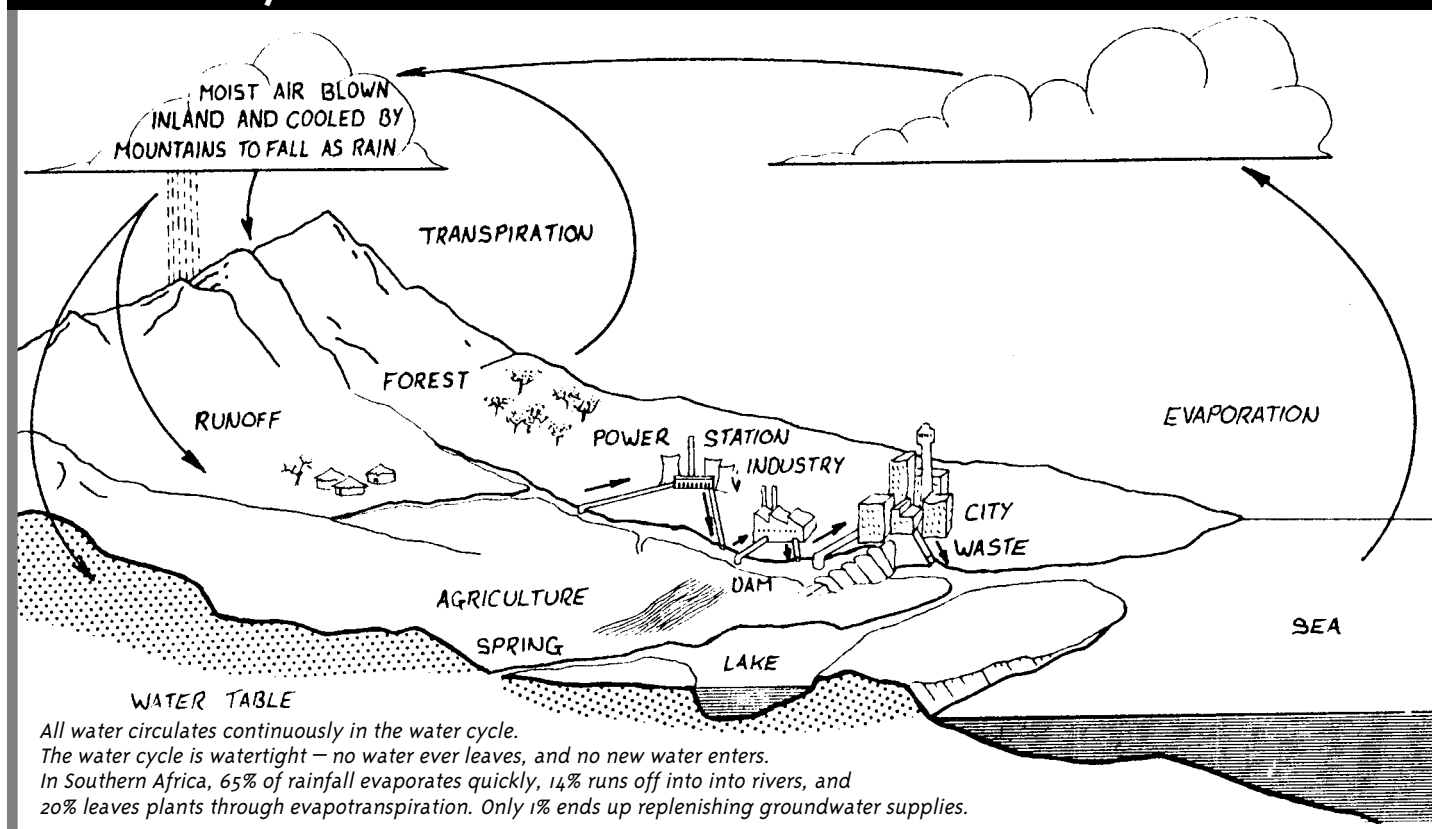
Soils and Geology

Soil is a basic catchment resource that, except over a long period of time, is non-renewable. It may take more than a century to produce a single centimeter of soil and thousands of years to produce enough soil to support a high-yield, high-quality forest, grassland or agricultural crop. Careful management and protection of soil is necessary to preserve its function and productivity. Because soil carries plant nutrients and holds water, it is a key element in a catchment's health.



Soil is a thin layer of the earth's crust composed of mineral particles and organic matter. It occurs as the result of wind and water erosion, gravity rockfall from hills and mountains, rock minerals in rain water, heating expansion and cooling contraction in summer, and the chemical action of lichens and other plants.

The Water Cycle



KEY ISSUES IN WATER MANAGEMENT

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▲ Water resources management has, in the past, concentrated heavily on the technical side of supplying water – pipelines, dams, importing and exporting water, volumes, mean annual runoff, etc. This has its place, but must be balanced with the environmental, economic, social and political aspects of water management. A resource-sensitive approach takes the wider circumstances of demand and supply into account, and aims for equity, efficiency and long-term sustainability in managing water.

▲ Managing water resources should take place at the lowest appropriate levels, that is, at the levels where the constraints and needs are being encountered in society. Community participation is essential in working out the most desirable arrangements and the compromises that may have to be made.

▲ Because water allocation at any one part of a river basin affects other areas in the basin, there must be coordination of the different developments that take place in a river basin. The need for coordination is just as high in basins that are shared by different states, as it is in river basins that lie totally within a country.

▲ It is the role of central government to create an 'enabling environment' that facilitates participation of different levels of society and different sectors of the economy to derive the best benefit from water.

▲ Full participation of both women and men must be encouraged in water resources management, to make water projects efficient and long-lasting.

▲ The public sector (government and municipalities) is in many cases run inefficiently. Active involvement of individuals, community-based groups and NGOs, as well as the private sector (commercially-run companies) in water management, is a means of improving this situation, but must be well coordinated and well monitored to bring real benefits.

▲ Growing water scarcity means that water must be put to its most worthwhile use. Allocation of water for different sectors should therefore take place on a priority basis, that is understood and accepted by all the affected parties. Basic human needs, and water to maintain a healthy environment which will in turn support productivity, should be given first priority.

▲ There is not enough water to satisfy everyone's wishes. This makes it necessary to manage or control the demand for water, especially in the main water consuming activities, i.e., agriculture and industry. Pricing is a very effective way of achieving this – if water is expensive, people will adjust accordingly, and will use water efficiently.

▲ Regulatory measures should be used to prevent gross wastage of water in cases where pricing is ineffective, and to act as a deterrent against polluting water.

Soils can be divided into two types based on how they are formed.

▲ Residual soils are formed from underlying 'parent' rock formations which break up, erode and are mixed in with surface plant cover. They support the local surface plant cover and are usually found at higher elevations in the catchment.

▲ Transported soils are soils which are moved by gravity, wind or water to a different location. These soils are usually found on the valley floor and floodplain. Transported soils make the best soil for farming in the catchment, as they are usually higher in decayed organic matter.

Climate strongly affects soil formation. Rainfall causes leaching – the movement of dissolved particles through soil by the water. Rainfall also transports soils, through the erosive power of runoff. Soil plays a major role in determining which plants will establish a protective vegetative cover in the catchment.

Plants also modify and develop the soil. Plant roots create soil spaces, which help increase a soil's ability to store water. Rotting leaves from plants add organic matter to soil, which

also increases water-holding capacity. Plant debris also slows surface runoff and protects the soil surface from rainfall-caused erosion. Soil depths and moisture-holding capacities are usually lower on steep slopes, and plant growth rates are often slower.

Vegetative Cover

Plant cover benefits a catchment in a number of ways. The canopy intercepts rain and reduces the force with which it strikes the ground, thereby reducing erosion. The canopy also reduces wind velocity and therefore wind-caused soil loss. Grasses, shrubs and trees make up the major plant cover types in a catchment, and all are important to catchment management.

When leaves and twigs fall, they decompose and are eventually incorporated into the soil. Before decomposing, this litter protects the soil surface from rain and evaporation, improves infiltration of water and slows down surface runoff.

Stems and roots lead water into the ground. Roots open up soil spaces for water retention and drainage, add organic mate-

rials to the soil and remove chemicals from the water. Roots take water and minerals from the soil to the rest of the plant. These minerals are again consumed or fall back into the soil through leaves and dead plants. In some cases, through this process plants can remove what would become water pollutants.

An indigenous forest usually includes, in addition to trees in various stages of growth, an understory of shrubs and a low ground cover of forbs (small herbaceous plants) and grasses. While all plants in a forest have some effect on water, trees are the most important in many ecosystems. Trees play a major role in catchments in the following ways:

- ▲ intricate, wide-spreading root systems help hold soil together and prevent erosion;
- ▲ deep roots can extract water from a low water table;
- ▲ the canopy protects people, animals and crops from sun, wind and rain;
- ▲ forests help filter the air;
- ▲ trees store carbon, which might otherwise be released into the atmosphere and increase global warming.

Therefore, removing native trees from catchments can have some of the greatest impacts on its ecological health.

People in the Catchment

People can have a great impact on the health of a catchment, as described above. Not only do we use more water than other creatures, but we make major changes to catchments individually and collectively – some of which are beneficial, and some of which can do serious harm. In general, we have modified catchments so much that they no longer perform many of the useful



functions that protect and support our communities. The following scenario describes a typical series of events undertaken by a community, with the unintended result that their catchment can no longer handle flood waters the way it once did:

- ▲ Deforestation reduces the soil's ability to hold as much water, greatly increasing runoff into local streams and rivers.
- ▲ Increased siltation from deforested slopes changes the shape of river bed and banks, which can lead to changes in the flood regime.
- ▲ Farmers and city planners drain wetlands, thus removing the catchment's natural "sponges" which absorb run-off and rain.
- ▲ Urbanization leads to paved roads, more buildings and less open space. The result is a dramatic increase in runoff, since rooftops and paved roads prevent water from infiltrating.
- ▲ As land pressures increase, more people build permanent structures in the river's floodplain, thus increasing pressure to try to stop floods with dams.
- ▲ Finally, a dam is built for flood control and other uses, and the catchment is permanently changed. The floodplain no

longer serves the ecological function it once did for the community, and more people move into the most flood-prone lands, believing they will be protected from all floods. The dam reduces the frequency of floods, but does not prevent the biggest, most damaging floods from occurring. The result: more expensive damages from floods than ever before.

It takes a lot of actions by a lot of people to do this much damage, but unfortunately it is all too common. The good news is that humans can also be great caretakers of their catchments – all it takes is knowledge and the will to make a difference. Individual actions add up to real change. The next section describes some of the ways people have changed catchments for the worse, followed by sections describing ways we can make positive changes.



Part 2

Threats to Catchments

All kinds of human activities can impact catchments, and therefore harm the people and animals that depend on catchment functions for their livelihoods and lives. The following describes some of the most common catchment threats. These kinds of stresses have occurred, to varying degrees, all over the world.

Deforestation: As described in the previous section, non-plantation forests protect catchments from erosion and flooding, provide shade and habitat for many animal species, and help replenish groundwater by funneling rain through the soil with their root systems. When indigenous forests are removed, the entire catchment suffers. Many African catchments have been damaged by severe deforestation, including the Limpopo, where 99 percent of the original forest cover has been lost; the

Zambezi, with a loss of 43 percent of its forests; and the Orange, which has lost nearly 100 percent of its vegetative cover. (Source: *Watersheds of the World*, see Resources for more information). In fact, the Orange and Limpopo are in the world's top 10 catchments with the highest percentage of original forest loss.

Deforestation is especially prevalent in rural and communal areas in the region where people rely on fuelwood for their energy needs. Fuelwood problems are inextricably linked to issues of poverty and gender. Fuelwood deforestation has negative impacts on ecosystem functions and biodiversity. Some studies show that at current consumption

rates, South Africa's natural communal woodlots will be virtually gone by the year 2020.

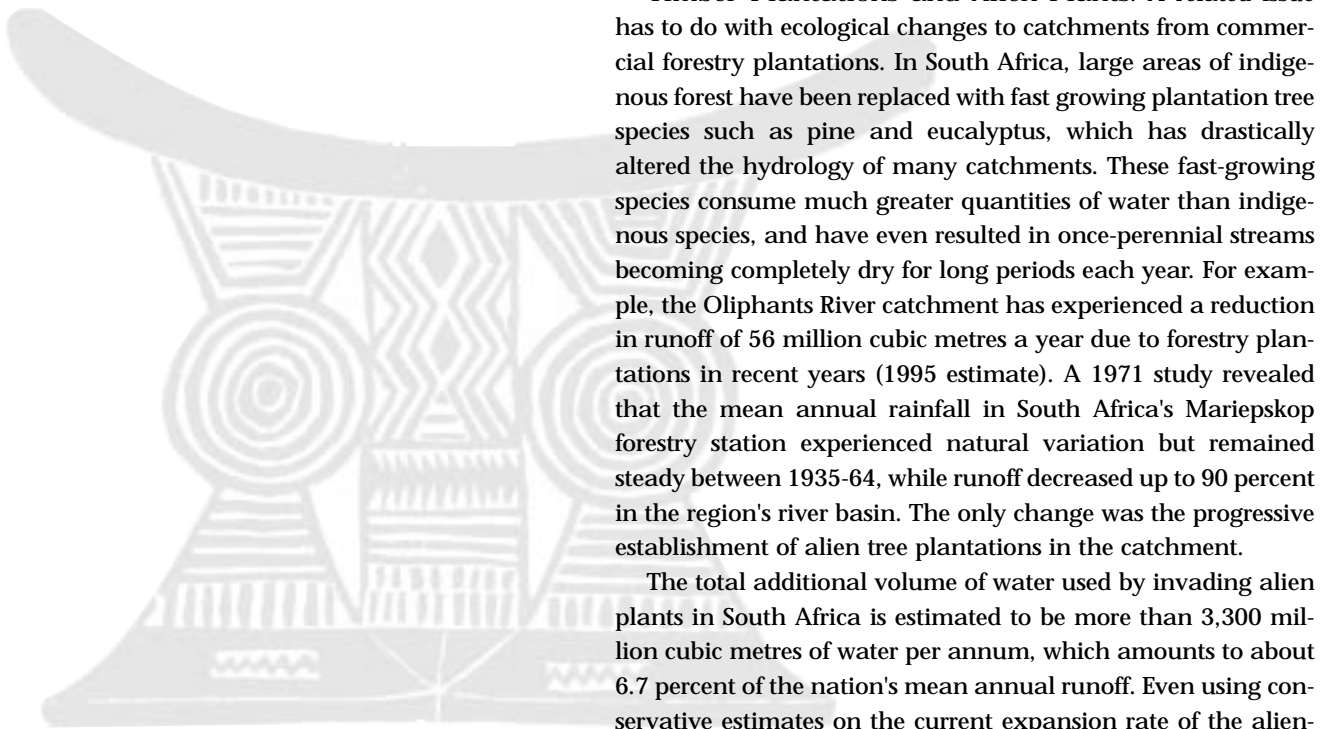
Timber Plantations and Alien Plants: A related issue has to do with ecological changes to catchments from commercial forestry plantations. In South Africa, large areas of indigenous forest have been replaced with fast growing plantation tree species such as pine and eucalyptus, which has drastically altered the hydrology of many catchments. These fast-growing species consume much greater quantities of water than indigenous species, and have even resulted in once-perennial streams becoming completely dry for long periods each year. For example, the Oliphants River catchment has experienced a reduction in runoff of 56 million cubic metres a year due to forestry plantations in recent years (1995 estimate). A 1971 study revealed that the mean annual rainfall in South Africa's Mariepskop forestry station experienced natural variation but remained steady between 1935-64, while runoff decreased up to 90 percent in the region's river basin. The only change was the progressive establishment of alien tree plantations in the catchment.

The total additional volume of water used by invading alien plants in South Africa is estimated to be more than 3,300 million cubic metres of water per annum, which amounts to about 6.7 percent of the nation's mean annual runoff. Even using conservative estimates on the current expansion rate of the alien-plants invasion, these figures are likely to double within the



“Without this water, we will have nothing to drink or bathe with, no fish, no cattle, no wild animals. We will have to move or die”.

**RESIDENT OF AN OKAVANGO
DELTA COMMUNITY COMMENTING
ON PLANS TO BUILD WATER
PIPELINE TO NAMIBIA**



next 15 years, according to the book *Land Degradation in South Africa* (Hoffman, Todd, Ntshona and Turner). Impacts of timber plantations on catchments include increased soil erosion, reduced water runoff, reduced biodiversity, increased maintenance costs due to the invasive nature of many species, chemical changes to the soil, the transformation of rural economies, and the loss of grazing lands, medicinal plants, water and building materials.

The South African government has begun to take steps to control the management and proliferation of alien-tree farms. One of its efforts, the "Working for Water" programme, has cleared alien vegetation around Cape Town. Per unit of water gained, this work costs just 6 percent of what it would cost to build a new dam.

Wetlands Destruction: Wetlands are extremely valuable ecosystems which protect catchments from pollution and flooding, harbor huge numbers of species, and replenish groundwater supplies. One estimate, made by the Institute of Ecological Economics at the University of Maryland (US), puts the global value of wetlands at close to US\$5 trillion a year, based on their value as flood regulators, waste treatment plants and wildlife habitats, as well as for fisheries production and recreation. A study by the Illinois State Water Survey (US) found that a 1 percent increase in wetlands decreased flood peaks in streams by nearly 4 percent.

Wetlands have been badly polluted or dewatered in catchments all around the world. One major cause of wetlands loss has been draining and filling of wetlands to create new urban or agricultural land. Many species of animal life (including migrating species) depend upon wetlands, and have suffered from their destruction. Channelizing and damming rivers can also decrease water available to wetlands, thus desiccating them. For example, water system regulation and drainage for agriculture and urban development have been the major causes of the loss of over 50 percent of the wetlands in Niger, Chad and Tanzania. Recent examples of wetlands in trouble in Southern Africa include the Rietspruit wetlands in South Africa (threatened by pollution from the proposed SASOL strip mine, near the Vaal River); the Zambezi delta in Mozambique (damaged by reduced flows because of Cahora Bassa and Kariba

"Large-scale water projects can no longer be expected to provide the answer to most water problems. Only 4 percent of sub-Saharan Africa's cropland is currently irrigated, yet few good dam sites remain and the costs of large irrigation projects (estimated to be \$10,000-20,000 per hectare) is extremely high ... Major new projects are going to compete with new opportunities for innovative smaller scale, locally managed solutions to water quality and water problems. These include micro-dams, shallow wells, low-cost pumps, water-conserving land management methods and 'rainwater harvesting' approaches. Such methods are more cost-effective and less disruptive to local communities, in part because of traditional experiences of these communities."

FROM THE WORLD'S WATER 1998-99, BY PETER GLEICK (SEE RESOURCES)

dams), the Okavango Delta (which could suffer from reduced flows under a plan by the Namibian government to tap the Okavango River for water supply), and the Rufiji Delta in Tanzania (threatened by a huge prawn farm that would alter its hydrology, produce pollutants and destroy mangrove forests).

Over-allocation: Many of Africa's rivers suffer from "over-allocation" of their waters, meaning that so much water is being diverted for various purposes that the river ecosystem cannot be sustained. The biggest culprit in most countries is agriculture. Crop irrigation consumes 90 percent of all water used in the world's poor countries, according to a 1995 World Bank report, and nearly half of that is wasted and does not get to the plants. In South Africa, irrigated agriculture

uses 50-70 percent of the water supply, and many rivers are in dire shape because of it, including the Orange, Vaal, Oliphants and others. Groundwater, too, is affected by over-use, and in many areas groundwater is being withdrawn far faster than it can be recharged. When groundwater is over-tapped near coastal areas, saltwater can intrude and may eventually contaminate the entire aquifer.

Diverting water from the Nile River, along with build-up of sediments trapped behind dams and barrages, has caused the fertile Nile delta to shrink. Of 47 commercial species of fish once found in the Nile delta, about 30 have become extinct or virtually extinct. Delta fisheries that once supported over a million people have been wiped out. And Lake Chad, in the Sahel region, has shrunk from 25,000 square kilometres to just 2,000 sq.km. in the last three decades from massive diversions of water for irrigation and periodic droughts. The lake's once rich fisheries have entirely collapsed.

The cost-benefit studies for water diversion projects usually do not fairly account for the catchment services they will disrupt. This can result in major economic consequences for society, since the services that a catchment provides can be very costly and difficult to replace. For example, the book *Watersheds of the World* (see Resources) gives this example: An intact floodplain in Nigeria supports tens of thousands of people through fishing, agriculture, fuel wood, tourism and recharging groundwater supplies. When the floodplain's current uses were com-

pared with the alternative of a water diversion plan, the value of water maintained in the floodplain for those existing uses was worth US\$45 per 1,000 cubic meters, while the value of diverted water for increasing crop output was only \$0.04.

Agricultural practices can have huge impacts on the health of a catchment in other ways besides using too much water. Farms that do not practice good soil conservation can affect the soil's infiltration rates, and consequently groundwater recharge. Poor farm practices can also result in soil erosion, which pollutes waterways. Date of planting, type of crop, tillage system (from zero tillage to deep plough), amount of pesticides and fertilizers, plough direction and crop rotations are some of the agricultural practices which can affect water resources.

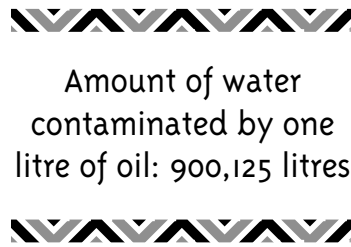
Pollution: Contaminated water of all kinds causes a huge proportion of disease in the developing world. Water can become contaminated by human waste (a major problem where the poor have no access to sanitary systems), industrial pollution, agricultural and urban runoff, air pollution and toxic spills. There are two ways that pollutants enter the water system: from what is known as a "point source", which means the source of the contaminant is easily identified (like a factory pipe), or from a "non-point source" which refers to polluted runoff from sources that are difficult to pinpoint – such as farmland and urban streets. In some parts of the world where the biggest "point sources" have been cleaned up (such as the US), nonpoint source pollution is now the biggest, potentially most dangerous source of pollution for rivers and streams. Examples of Southern African catchments which are particularly polluted include South Africa's Oliphants and Zimbabwe's Lake Chivero.

Pesticide use by agriculture and to control disease-bearing mosquitoes is a serious water-pollution threat in Africa. For agricultural use, there are numerous alternatives and farm systems that can replace or at least minimize pesticides and artificial fertilizers without harming production. As for mosquito control, there are as yet no perfect solutions. Pesticide use can even make the problem worse, by leading to resistance in insects. Still, pesticide use is increasing in some places, sometimes even involving dangerous chemicals that are banned elsewhere in the world. For example, in March 1998, health authorities in Zimbabwe announced a plan to fight malaria with the banned pesticide DDT. The plan to spray 10,000 tons of the poisonous pesticide was very controversial, especially since DDT was banned for local agriculture three decades ago because of its persistence in the environment and its ability to move through the food chain. Biologists at the Zimbabwe University and the conservation group Environment 2000 warned that a new build-up of DDT in the food chain posed long-term health risks which outweighed the dangers from malaria.

In addition to a lack of adequate sewage treatment in poor communities as a source of water pollution, "water inequity" in poor communities can also increase the incidence of water-

borne diseases overall, because people without adequate water supply may not have enough water to wash their hands regularly or keep food-preparation utensils clean, therefore contributing to the spread of these diseases.

Mining is a major pollution source for the region's rivers and catchments. The main types of mining pollution include contamination from heavy metals produced by mining, from mining processing-chemicals like cyanide, and acid mine drainage from mining waste. Another source is the failure of dams used to contain mine wastewater (called tailings dams), which dump large quantities of contaminated mine waste into rivers. Such failures have been known to immediately kill all life for many kilometres downstream. Abandoned mines also continue to cause pollution. One example: tributaries feeding the Oliphants pass over unrehabilitated coal mines abandoned in the 1950s; the Department of Water



Amount of water
contaminated by one
litre of oil: 900,125 litres

Affairs believes the longterm solution to this problem will cost R200 million. Newer methods of mining have been shown to dramatically reduce such pollutants, but governments must first develop tough standards for mining and then enforce them.

Mining is also a very heavy water-user. Mining uses water for processing mining products and also by de-watering mine shafts to facilitate underground work, which can lower water tables to the point of drying up local wells and springs. Another mining impact on catchments is sedimentation pollution. Although not toxic, the erosion of rock and soil into waterways from mine sites can cause severe environmental damage to streams and rivers, smothering riverside vegetation and killing aquatic life. Sedimentation can also increase flooding downstream.

Aquatic Weeds: Aquatic weeds can do major harm to waterways such as rivers and lakes. One of the most destructive and common weeds in Africa is the water hyacinth. The water hyacinth increases water loss through evaporation (loss of water in a weed-covered water body can be up to six times higher than from weed-free lakes and reservoirs), lowers water quality, harbours water-borne diseases and contributes to the reduction in the number of fish species and population.

Water hyacinth first surfaced in South Africa in 1902, the Congo in 1950, Zimbabwe in 1960 and Zambia in the early 1980s. The free floating vegetative plant has an extremely wide root network and is able to double itself every 15 days. The weed is also threatening Lake Victoria and many other African waterways. Dams have increased the plant's spread, both in the unnaturally slow waters of reservoirs and because of decreased flow in rivers downstream of dams. At one point, one-fifth of the surface of the Kariba Dam's reservoir – more than 1,000 square kilometres – was smothered by aquatic plants.

Global Warming: There is a growing and often contradictory literature on climate change in Southern Africa. Considerable uncertainty exists concerning the timing, intensity and direction of change of rainfall in an environment expe-

Southern Africa Water Index

Although Southern Africa includes 14 countries with a wide range of water availability, the region as a whole is water-poor, and increasingly facing water shortages. The problem is exacerbated by growing demand for water-rich lifestyles as well as high population growth (although the biggest increases in population come from poorer segments of society, who use relatively little water). Most of the region is classified as either arid or semi-arid. Droughts are common, and much of the region experiences very high losses of water from evaporation. It has been estimated that the number of people living in water-stressed countries worldwide will increase tenfold by 2025, to some 3 billion, most of whom live in Africa and South Asia.

Number of major river basins in Southern Africa: 15

Number of these major rivers that are shared by two or more nations: 15

Number of present and proposed major water-transfer schemes in Southern Africa: 26

Number of Southern African nations with total domestic water use below the international standard of 50 liters per person per day: 7

Southern African countries with total domestic water use above 50l/person/day: South Africa, Namibian, Botswana, Zambia

Estimated percent of South Africa's population which currently gets less than 50l/person/day: 25-45

Percent of water piped to South African township of Soweto that is lost to leaks and other "unaccounted uses": 50

Percent of water piped to rural villages in Botswana that is lost: 20-40

Amount of rainfall that can be caught per household using a rooftop catchment system during a storm that delivers 30mm of rain: 1200 litres

Percent of South Africa's irrigated agriculture that used efficient drip-irrigation systems in 1991: 9

Percent of Israel's that did: 48.7

Potential income from one cubic meter of water used for agriculture in Namibia: N\$0.6-N\$3

Potential income if that same cubic meter of water is used to support tourism: N\$50

Increase in water use in Namibia in past 25 years: 352%

Number of Southern African nations in the list of the top 50 nations producing the most fresh water from desalination: 1

Estimated percent decrease in summer rainfall over central South Africa as a result of global warming: 10-20

Expected percent increase in evapotranspiration rates across Southern Africa from global warming: 5-20

Water Withdrawals

Annual total freshwater withdrawal (in km ³ /yr)	Annual renewable freshwater resources (in km ³ /yr)	Percent of freshwater withdrawal by sector:			
		Domestic	Industrial	Agricultural	
Angola: 48	Angola: 184	Angola	14	10	76
Botswana: 87	Botswana: 14.7	Botswana	32	20	48
Lesotho: 28	Lesotho: 5.2	Lesotho	22	22	56
Malawi: 107	Malawi: 18.7	Malawi	10	3	86
Mozambique: 39	Mozambique: 216	Mozambique	9	2	89
Namibia: 140	Namibia: 45.5	Namibia	29	3	68
South Africa: 377	South Africa: 50	South Africa	17	11	72
Swaziland: 830	Swaziland: 4.5	Swaziland	2	2	96
Tanzania: 43	Tanzania: 89	Tanzania	9	2	89
Zambia: 202	Zambia: 116	Zambia	16	7	77
Zimbabwe: 126	Zimbabwe: 20	Zimbabwe	14	7	79

(Sources: *Sharing Water in Southern Africa*, *Last Oasis*, *The Status of Freshwater Resources in Namibia*, SA Central Statistical Services Household Survey and *The World's Water 1998-99*)

riencing doubled rates of CO₂. This is especially true in South Africa, where the topographical influence on rainfall patterns is so large.

Some of the more recent predictions suggest the following global-warming-caused changes to Southern Africa:

- ▲ A 10-20 percent decrease in summer rainfall over South Africa's central interior
- ▲ An increase in the intensity and frequency of floods and droughts
- ▲ A gradual and linear increase in temperatures with rising CO₂ levels, reaching 1.5 degrees C hotter than present by the year 2050 with an associated increased frequency of higher-temperature episodes

The implications for catchments include:

- ▲ Increased evapotranspiration rates of 5-20 percent across Southern Africa;
- ▲ A major increase in runoff in eastern parts of the region with an associated increase in the variability and therefore reliability of runoff
- ▲ A shift in biological communities (biomes), with grasslands being largely replaced by savannah vegetation as a result of increased temperatures.

These changes are likely to significantly increase land degradation in the region since both high temperatures and low rainfall are closely related to high levels of soil and vegetation degradation.

Changes from global warming may already be upon us. Recent studies suggest that there has been an increase in mean annual temperature over Southern Africa in this century, and it is likely to rise even more as a result of greenhouse gases. Patterns of reduced rainfall, too, have been noted. Up until 1980, rainfall followed an 18-year pattern, with roughly nine wet years and nine dry years. However, following the relatively wet decade of the 1970s, the years 1980-94 have been exceedingly dry throughout Southern Africa. Although not as dramatic as the reduction in rainfall in the Sahelian region, the record suggests that there has been an approximately 5-10 percent reduction in midsummer rainfall (Dec.-Feb.) in parts of Southern Africa. In some localised regions the reduction in annual rainfall totals has been far greater. (*Source: Land Degradation in South Africa 1999, by Hoffman et al.*)



THE BIG DAMS DEBATE

"In this century [in the US], dams that were clearly justified for their economic value gradually gave way to projects built with excessive taxpayer subsidies, then justified by dubious cost-benefit projections. The public is now learning that we have paid a steadily accumulating price for these projects, in the form of fish-spawning runs destroyed, downstream rivers altered by changes in temperature, unnatural nutrient load and seasonal flows, and delta wetlands degraded by lack of fresh water and saltwater intrusion. My parents' generation gloried in the construction of dams across America's rivers. My generation saw how those rivers were changed, deformed, killed by dams. The next generation must help decide if, how and where those dams stand or fall."

US SECRETARY OF THE INTERIOR BRUCE BABBITT, IN AN AUGUST 1998 SPEECH ON DECOMMISSIONING DAMS

Of all the ways to tamper with or harm a river, a large dam usually has the most immediate and far-reaching effects because of the huge changes it causes to a river's hydrology – its very circulation system. The impacts can be felt throughout the catchment.

Water scarcity is commonly used to justify new water-supply dams and river diversion projects in Southern Africa. It is certainly true that dams are an obvious way to store large quantities of water for distribution at drier times of the year. It is also a fact that water use has increased dramatically in modern times. The first 80 years of this century saw a 200 percent increase in the world's average per capita water use, which accounted for a remarkable 566 percent increase in withdrawals from the world's freshwater resources. But dams and pipelines don't actually create new water, they merely move it from one set of users to another – usually, from the poorest to the richest or, put another way, from the most frugal users to the most profligate.

In fact, dams can even reduce potable water supplies by creating better environments for disease organisms, by concentrating pollutants, and through evaporation from reservoirs. For instance, the proposed Epupa Dam in Namibia would evaporate more than 40 times Windhoek's annual water supply.

While the world's growing thirst is a serious problem, the story is more complicated than just too many people putting their straws in the glass. The growing conflicts over water use revolve around the broader questions about ownership of common resources, and equity of access to those resources. In many cases, large-scale damming of the world's rivers has led to greater water inequity. In the past 50 years, the number of large dams (those greater than 15 metres in height) has increased more than sevenfold; a high proportion of these were built to expand industrial-scale irrigated agriculture, which can use 75-80 percent of the regional water supply in dry parts of the world. In fact, large dams have often promoted greater, more wasteful water use by fewer people, and usually at the expense of the rural poor who lose access to water, land, fisheries and forests to such projects. By adding to the world's "water inequity," large dams may do more harm than good. For today, despite a century of massive dam building, more than 1.3 billion people are still without access to fresh water, and more than 3 billion are without adequate sanitation.

Large-scale hydropower has been integral to development strategies in many industrialized and non-industrialized countries, yet more than 2.1 billion people remain without power today. Hydropower has been at the center of major controversy for more than a decade. With an estimated 78 percent of the earth's hydropower potential yet untapped, proponents continue to promote hydro as an important source of electricity, despite the fact that around the world there is growing recognition that large dams are vastly expensive, environmentally devastating, and can be socially unjust.

Sustainable Water Planning

Sustainable water use is that which supports the ability of human society to endure and flourish into the indefinite future without undermining the integrity of the hydrological cycle or the ecological systems that depend on it. The following sustainability criteria further define sustainable water use:

1. A basic water requirement will be guaranteed to all humans to maintain human health.
2. A basic water requirement will be guaranteed to restore and maintain the health of ecosystems.
3. Water quality will be maintained to meet certain minimum standards. These standards will vary depending on location and how the water is to be used.
4. Human actions will not impair the long-term renewability of freshwater stocks and flows.
5. Data on water-resources availability, use, and quality will be collected and made accessible to all parties.
6. Institutional mechanisms will be set up to prevent and resolve conflicts over water.
7. Water planning and decision-making will be democratic, ensuring representation of all affected parties and fostering direct participation of affected interests.

Reprinted with permission from The World's Water 1998-99: The Biennial Report on Freshwater Resources by Peter Gleick (see Resources)

When local communities have a say in how their catchment is used, they are unlikely to approve of projects that could do the kind of lasting harm to natural and cultural resources that a large dam will. But because rivers often run for long distances, across provincial and even national lines and through communities with many different interests, conflict often arises over how to handle development that can affect rivers and catchments. Contributing to the problem is that many national governments see rivers as assets to control and develop, and such development is often based on models that ignore the cost of pollution, environmental destruction, damaged communities, or the loss of places with great cultural, spiritual or aesthetic value.

Planners and policy makers are having to consider the problems associated with the past approach to hydropower and to reconsider its future role. Civil society, meanwhile, continues to demand participatory planning processes that will identify not just appropriate means to generate electricity, but also the appropriateness of the goals that this electricity is intended to achieve. Is more electricity necessary? If so, what is the best way to generate it? These are the questions we all need to be asking.

The Environmental Impacts of Large Dams

Large dams directly impact rivers in a variety of physical and biological ways. The most significant impact is the reduction or alteration of a river's flow, which affects the river ecosystem and the landscape through which the river flows. A dam holds back sediments, especially the heavy gravel and cobbles. The river, deprived of its sediment load, seeks to recapture it by eroding the downstream riverbed and banks, undermining bridges and other riverbank structures. Riverbeds downstream of dams are typically eroded by several metres within a decade of first closing a dam; the damage can extend for tens or even hundreds of kilometres below a dam. Riverbed deepening will also lower the groundwater table along a river, threatening vegetation and local wells in the floodplain and requiring crop irrigation in places where there was previously no need. Altering the riverbed reduces habitat for many fish that spawn in the river bottoms, and for invertebrates such as insects, mollusks and crustaceans.

Before completion of the Aswan High Dam, the Nile River carried about 124 million tons of sediment toward the sea each year, depositing nearly 10 million tons on the floodplain and delta, thus replenishing the soil with vital nutrients. Today, 98% of that sediment gets trapped behind the dam. The result has been a drop in soil productivity and depth, among other serious changes to Egypt's floodplain agriculture. As a result, the livelihoods of many thousands of families have been destroyed. The



"I used to get water from a river which was situated where the dam is today. Now I have to go to KwaSikhosana and it takes about two hours to get there. The dam robbed us of our forefathers' fields which were our source of food and the worst part of it is that many of us received nothing in return."

**A PERSON RESETTLED FOR
HEYSHOPE DAM IN SOUTH AFRICA'S
MPUMALANGA PROVINCE**



Aswan Dam has also led to serious coastal erosion, another problem stemming from the loss of sediments in a dammed river. Another example of this problem is along the mouth of the Volta River in Ghana. Akosombo Dam has cut off the supply of sediment to the Volta Estuary, affecting also neighboring Togo and Benin, whose coasts are now being eaten away at a rate of 10-15 metres per year. A project to strengthen the Togo coast has cost US\$3.5 million for each kilometre protected. The story is the same on other coastlines where dams have stoppered a river's sediments. And in South Africa's Orange River, fish populations have been significantly affected by the Gariiep and Vanderkloof Dams. The dams even out the river flow and prevent the floods, and without this genetically entrenched cue, the fish do not spawn.

Hydrological Effects: Dams also change the pattern of the flow of a river, both reducing its overall volume and changing its seasonal variations. The nature of the impacts depends on the design, purpose and operation of the

dam, among other things. All parts of a river's ecology can be impacted by changes to its flow.

A river's estuary, where fresh water meets the sea, is a particularly rich ecosystem. Some 80 percent of the world's fish catch comes from these habitats, which depend on the volume and timing of fresh water flows and nutrients. The alteration by dams and diversions of the flows reaching estuaries is a major cause of the precipitous decline of sea fisheries in the Gulf of Mexico, the Black and Caspian Seas, California's San Francisco Bay, the Eastern Mediterranean and a number of estuaries in Africa. The regulation of the Volta River in Ghana by the Akosombo and Kpong dams has led to the disappearance of the once-thriving clam industry at the river's estuary, as well as the serious decline of barracuda and other sport fish. Dams on the Zambezi have seriously harmed the coastal prawn fishery in Mozambique, and have also depleted floodplain fisheries upstream.

Changes to Flooding: The storage of water in dams delays and reduces floods downstream. River and floodplain ecosystems are closely adapted to a river's flooding cycle. The native plants and animals depend on its variations for reproduction, hatching, migration and other important life cycle stages. Annual floods deposit nutrients on the land, flush out backwater channels, and replenish wetlands. It is generally recognized by biologists that dams are the most destructive of the many abuses causing the rapid disappearance of riverine species. About 20% of the world's recognized 8,000 freshwater species are threatened with extinction.

The Major Impacts of Dams

Dam safety: Mass of water in reservoir can increase earthquakes. Safety planning for downstream communities is often a low priority. Many older dams pose hazards from years of poor maintenance.

Water quality problems: Trees left in reservoir rot, polluted runoff is not diluted, heavy metals accumulate in sediments behind dam.

Reservoir floods farmland, forests, wetlands and riparian habitat, and displaces people. The world's dams have displaced 30-60 million people, and flooded 400,000 sq. km. of land.

Enormous loss of water through evaporation.

Slow waters of reservoir and irrigation canals spread disease especially malaria and bilharzia.



Dam wall acts as physical barrier for migrating fish species. Reduced water and silt flows cause severe problems for downstream agriculture, fisheries and ecosystems.

Reservoir changes river's chemical composition, seasonal timing of flows, and temperature of water, harming fish and other species downstream.

Riverbed erosion increases dramatically downstream of dams, reducing biodiversity downstream.

The floodplain itself is also affected by dams. Studies on the floodplain of the Pongolo River in South Africa has shown a reduction in diversity of forest species after it was dammed. And forests along Kenya's Tana River appear to be slowly dying out because of the reduction in high floods due to a series of dams.

The Negative Human Consequences of Large Dam Projects

Hydropower dams and river diversion projects have led to the forced resettlement of many hundreds of thousands of people in African countries, causing both social dislocation, loss of livelihoods and increasing pressure on environments. Resettlers are often moved to marginal lands with poor soils and higher rates of erosion. These problems are made worse by having more peo-



ple concentrated on less land. For example, in Tanzania the Pagan Falls Dam project led to increased environmental stress such as erosion and siltation of rivers because of impoverished small-holders being forced onto marginal lands unsuitable for farming.

Dams also have serious long-term social effects on people who live downstream, usually because the loss of the annual flood has devastated traditional floodplain farming, fishing and grazing. Kainji Dam in Nigeria, for example, directly displaced 50,000 people, but adversely affected hundreds of thousands more who had formerly grazed their livestock and

grown crops on land irrigated by the annual flood. Floodplain yam production reportedly fell by 100,000 tons after the dam was completed in 1968 and downstream fish catches plummeted by 60-70 percent.

Another Nigerian dam, Bakolori on the Sokoto River, a tributary of the Niger, reduced the area of rice grown downstream by 7,000 hectares and that of dry season crops by 5,000 hectares. The dam altered both the timing and the extent of flooding which changed which crops would grow and when. During the dry season, the falling water table meant that farmers had to dig their wells ever deeper, greatly increasing the time and money spent on watering their crops. A survey in the 1980s found that three-quarters of the dry-season irrigators in affected villages had given up farming. In general, only the richer farmers survived.

Health problems are another human consequence of large dams. Reservoirs, spillways and irrigation canals often serve as the perfect breeding ground for vectors for waterborne diseases such as bilharzia and malaria. Construction workers bring diseases such as AIDS into remote areas where it has not been a problem in the past.

Dams also destroy the wildness in rivers. The human impacts of such a loss should not be underestimated. This impact is wide-ranging, too, affecting anyone who has ever loved a wild river: those who find spiritual solace in them, those who enjoy them recreationally, and those who first learned to love nature at the banks of a rushing stream.

Resistance to Dams

Because of the devastating social impacts, communities that will be affected by dams often resist such projects. The following are some African examples.

In the 1960s, construction of Kariba Dam in Zimbabwe led to eight people being shot dead, because they were resisting forced resettlement. "The police of what was then the British colony of Northern Rhodesia shot dead eight villagers and wounded over thirty in a confrontation during the 'poorly conceived and trauma ridden crash programme' to clear the lands that were to become Kariba Reservoir," according to the book *Silenced Rivers* (see Resources).



The Himba people in northern Namibia have actively opposed the proposed Epupa Dam, which would flood their lands and scenic Epupa Falls. In addition to speaking out both in Namibia and abroad, the people have submitted statements of protest, written to governments considering supporting the project, filled public hearings and formed their own development committee. Himba

Headman Hikuminue Kapika said, "All the Himba were born here, next to the river. When the cows drink this water they become fat, much more than if they drink any other water. The green grass will always grow near the river. Beside the river grow tall trees, and vegetables that we eat. This is how the river feeds us. This is the work of the river." The Himba are working with

the Legal Assistance Centre in Windhoek to determine how best to protect their communal lands. Kapika told Survival International in 1997, "They will have to shoot all the Himba before they build the dam."

Floodplain farmers, fishers and herders whose livelihoods have been damaged by dams in the Senegal River valley have been pressing for changes in dam management to help restore their catchment. A local farmers' group has demanded the re-establishment of natural river flooding upon which their agricultural systems depend and which the dams had effectively

ended. The dam project is supported by the World Bank and the African Development Bank, both of which have resisted making the changes demanded by the farmers. The Peasant Association of the Senegal River Valley described the problem: "Those who remain in their villages, in spite of their work, harvest very little, sometimes nothing. The fish have disappeared. Our livestock die. The trees die. The land is becoming exhausted... The development of the river is condemning us to live without hope." Peoples' organizations have been pressing the government to operate the dam in a way that more closely mimics the river's natural pattern, to restore some of the floodplain agriculture and fisheries destroyed by the project.

In Sudan, the Nubian people have threatened mass suicide to protest the taking of their land for the Kajbar Dam, proposed for the Nile River in Nubia, near Merowe. These people have been dislocated for dams five times before in this century, most notably for the High Aswan Dam, and have now undertaken an international campaign to stop the project from destroying their culture. "Allowing our land to be taken means the extinction of our distinct language and culture forever. Our intention is that we must die before our culture and our language," says a spokeswoman for the people. "Where can we go if our area is taken?" More than 100 villages will be submerged by the project.

Mtshabezi Dam in one of Zimbabwe's drought-prone districts was completed in 1994 despite protests by local villagers. Today, the dam stands unused, because the intended beneficiaries refused to tap its expensive water, a local newspaper reports. The Zimbabwe government spent Z\$35 million building the 52-million-litre capacity dam to support the city of Bulawayo which suffers regular water shortages. The dam was also expected to support irrigation schemes and water-based projects for villagers. However, after construction, several promises were not kept. The villagers claim that they agreed to the construction of



"They will have to shoot all the Himba before they build the dam."

HEADMAN HIKUMINUE KAPIKA, OF THE HIMBA TRIBE, WHICH WOULD LOSE LANDS TO EPUPA DAM. NAMIBIA, 1997



the dam because the government promised to help them to embark on commercial irrigation schemes. But when the dam was complete, they said they were told that no such scheme could be sustained in the mountainous area. Forty-two families were displaced by the 440-hectare reservoir. The city of Bulawayo, which was initially going to purchase the water, has also backed out. "It will be unwise to fund the piping of that water ... it will not be worth the money we will lose," said Bulawayo mayor Abel Siwela. City leaders are displeased that the government built the dam without including them in the initial plans of the dam.

Upcoming dams in which local people are beginning to organize include the Sondu-Miriu River Dam project in Kenya, the Bujugali Falls Dam on the White Nile in Uganda, Batoka Gorge Dam in Zimbabwe, and numerous projects in South Africa.

The Future of Large Dams

A new coalition of environmental and social activist groups from around the world was recently formed to help promote the decommissioning and removal of dams that have become uneconomic, hazardous or otherwise troublesome. The group, called "Living Rivers: The International Coalition for the Restoration of Rivers and Communities Affected by Dams," will focus on restoring rivers and the well-being of communities which depend on them by working to drain reservoirs, remove dams and change the operating patterns of dams.

The group says that, for many rivers, the best option for restoration is dam "decommissioning" – defined as anything that will bring a dammed river back to life, from allowing more water to flow through, to totally removing a dam and restoring the river to its pre-dam state. While dam removal is a costly and challenging proposition, in some cases it will prove to be the most economically and ecologically sound alternative. The coalition will focus its attention on dams which have reached the end of their functional life, are unsafe, or whose maintenance or mitigation costs exceed the benefits to be gained by their operation.

The coalition was formed in July 1998. The coalition's founding declaration notes that "Worldwide ... rivers are degraded by hundreds of thousands of dams, which have flooded huge areas of the world's most beautiful and ecologically rich habitats and the lands and homes of tens of millions of people ... The promised benefits of many dam projects have never been realized, and their adverse effects are more serious than predicted."

Living Rivers' first efforts will be developing case studies on successful dam decommissioning efforts and on river restoration. It will also work to ensure that the newly formed World Commission on Dams (see next page) assesses the issue of dam decommissioning in depth.

Dam Management

One way to help restore downstream ecosystems which is currently being researched and experimented with is "artificial

flooding" from existing dams. This is an effort to restore the positive ecosystem functions of flooding by releasing more water in more natural patterns from dams. Artificial flood management may prove to be an effective management tool to help downstream ecosystems and communities harmed by dams, but at present there is very little research on the long-term impacts of these new practices.

If improved dam management proves to have positive long-term impacts on downstream environments, it could help reduce ongoing degradation of dammed rivers. But there are some complexities that may make this approach less viable. Most dams built for power generation are being operated to make a profit. Water that is released to mimic natural floods must bypass the electricity generators, thereby reducing the amount of electricity a hydropower dam can produce. Unless given an economic incentive or required by law or regulation to do so, most dam operators will not be willing to give up potential power income to support downstream ecosystems.

Another problem is designing an artificial flood that benefits downstream communities. Floods can be characterized in many ways, including the total amount of water that flows down-



stream during the event, the rate at which the floodwaters rise, the height to which floodwaters reach, for how long the peak flow is sustained, and the rate at which floodwaters recede. How a flood behaves in each of these aspects can have negative or positive effects downstream. Poorly planned artificial flooding can have devastating impacts on downstream agricultural

communities and river ecology. For example, too much water released at the wrong time can catch people off guard, flooding homes and washing away crops. If an artificial flood is not big enough or is not sustained long enough, it might not create the desired results of washing away excess sediment in the river channel and depositing it on floodplains.

The Manantali Dam in West Africa is an example of how artificial flooding, even when done with good intentions, can devastate local communities. A few years ago, unannounced dam releases caught the downstream villages unexpectedly, drowning people and washing away their entire seed supply. According to the Senegal River Basin Development Organization (OMVS), a schedule of water releases from September through November, which would allow flood recession agriculture downstream of the dam, is being planned. Unfortunately, for the water releases to begin, representatives from Senegal, Mauritania, and Mali – the three countries responsible for operating the dam – must agree on the timing and amounts which they have not done thus far. Meanwhile, floodplain farmers continue to suffer the consequences of the loss of life-sustaining natural floods.

The World Commission on Dams to Review the Global Record

The World Commission on Dams (WCD), founded in February 1998 and based in Cape Town, South Africa, is an independent research body with a two-year mandate to review the development effectiveness of large dams around the world. The WCD is also charged with developing standards, criteria and guidelines to advise future decision-making on dams, and to study the viability of alternatives to dams. The commission is chaired by Professor Kader Asmal, former Minister of Water Affairs and Forestry of South Africa. The WCD was formed primarily at the request of NGOs for an impartial body to assess the effectiveness of dams worldwide. The group will undertake nine river basin studies (including South Africa's Orange River), three countrywide studies, and compile basic information on 150 other dams. The WCD's final report is expected to be complete in June 2000.

As a result of the WCD being based in Cape Town, one of the local NGOs, the Environmental Monitoring Group (EMG), has embarked on a process of monitoring the WCD and facilitating the flow of information between the WCD Secretariat and global and regional NGOs and community groups. The overarching aim of EMG's involvement is to ensure that the findings and recommendations of the WCD accurately reflect the impact of dams on the environment and the experience and perspective of dam-affected communities, particularly in Southern Africa, and to ensure that affected people's groups and other NGOs are brought into the WCD decision-making process. EMG has worked with the WCD secretariat to ensure that affected people are fully brought into the process, and has a full-time staff member monitoring the WCD's work.

(For more information on EMG or the WCD, see Contacts.)

Artificial flooding was used in 1995 in the United States to try to restore ecosystems downstream of the Colorado's Glen Canyon Dam. The general consensus is that this experiment brought some short-term benefits to downstream ecosystems, but that many problems caused by the loss of sediments to the river (because the dam holds them back) cannot be solved with dam releases.

Dam releases are also being considered in southern Africa. One dam being studied for changes to its operation is Cahora Bassa on the Zambezi, which has been called "the least studied and possibly least environmentally acceptable major dam project in Africa" by fisheries experts in the region. Partially restoring the river's natural flows would go a long way toward restoring the tremendous ecological damage caused by this dam and the upstream Kariba Dam. *(See www.irn.org for an article about this effort.)*



Rivers in Peril

Major Development Projects That Threaten Southern African Catchments

Widespread Problems

Across the Region:

- Acid rain caused by coal-fired plants harming water quality and ecosystems in South Africa, Lesotho and elsewhere
- Overextraction of water harming ecosystems
- Lack of sanitation services poses serious water quality & health problems

ZAMBIA

- Toxics from copper smelters contaminating groundwater
- High use of pesticides by commercial farming
- More than 250,000 hectares of forest cover disappearing each year

NAMIBIA

- Cunene River:**
- Epupa Dam
 - Existing dams

- Cuanda River:**
- Proposed commercial sugarcane farming

BOTSWANA

- Diamond mining
- Risk of overextraction of groundwater

Okavango Delta

- Okavango Pipeline Project
- Pesticide spraying for Tsetse flies

THE ZAMBEZI RIVER

Proposed Large Dams:

- Lower Kafue Gorge
- Batoka Gorge
- Devil's Gorge
- Kariba Extensions
- Katombora Dam
- Mepanda-Ncua
- Victoria Falls
- South Bank
- Mupata Gorge

SOUTH AFRICA

Oliphants River:

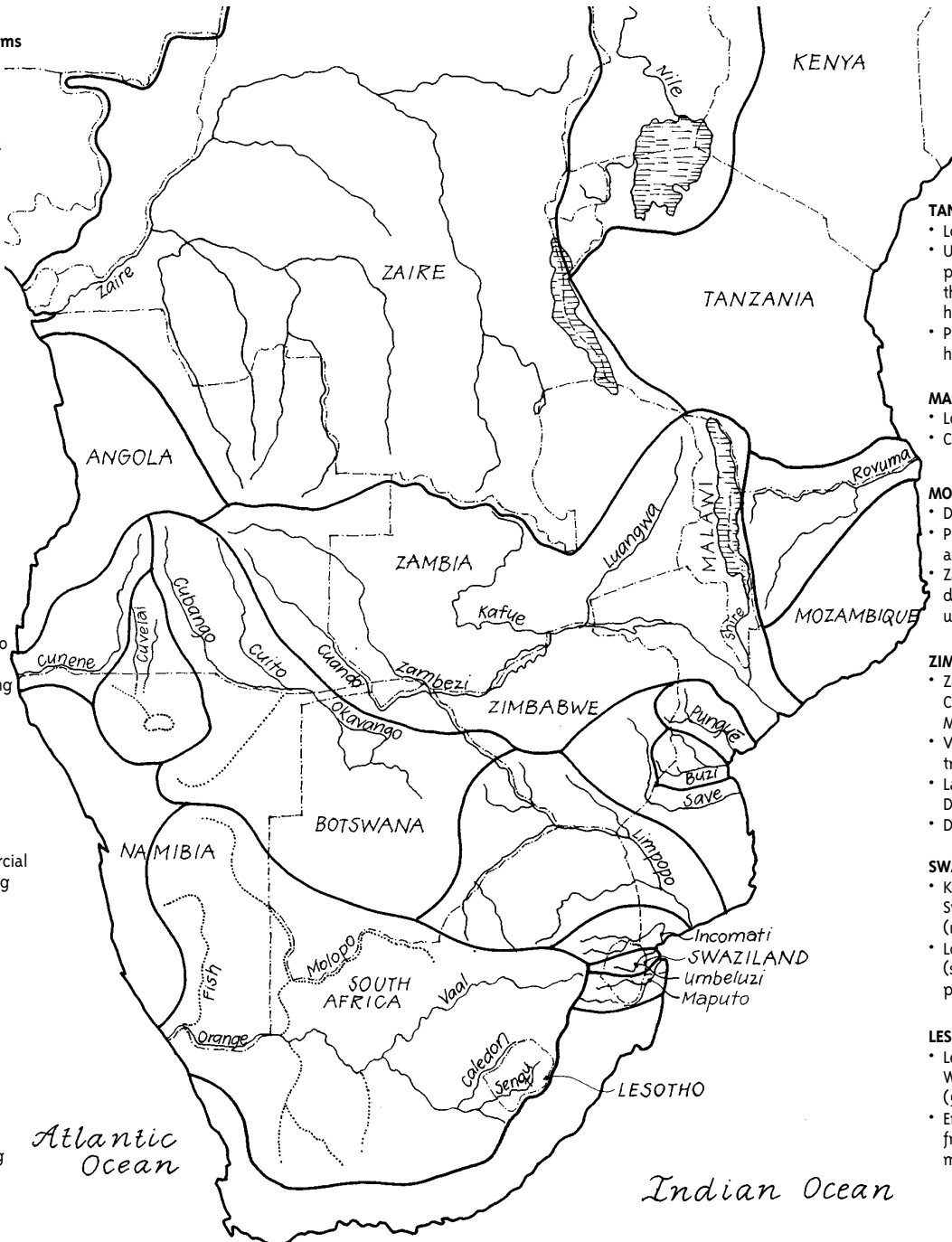
- Over-extraction from commercial agriculture, mining, and reduced runoff due to exotic forestry plantations and existing dams
- Extreme pollution from abandoned coal mines, copper mines, agricultural runoff
- Erosion from overgrazing, leading to silted-up dams

Orange-Vaal River:

- Over-allocation (23 major dams, irrigation, diversions)
- Agricultural pollution
- Deforestation
- Pesticides used for black fly control impacting other species
- Soil salinization & polluted runoff from commercial agriculture
- Northwest Strip Mine (Coal)

KwaZulu-Natal Province:

- 10 dams planned, including Jana Dam



- TANZANIA:**
- Lower Kihansi Dam
 - Upstream dams proposed in Kenya threaten wildlife habitat
 - Prawn farms would harm Rufiji Delta

- MALAWI:**
- Lower Fufu Dam
 - Coal mining

- MOZAMBIQUE:**
- Dams on Zambezi
 - Pollution from aluminum smelting
 - Zambezi wetlands desiccated from upstream dams

- ZIMBABWE**
- Zambian Consolidated Copper Mines
 - Various large water-transfer schemes
 - Large-scale use of DDT (Tse Tse, Malaria)
 - Dams on Zambezi

- SWAZILAND:**
- Komati Basin Swazi Project (up to 5 dams)
 - Lower Usutho Basin (sugarcane irrigation project)

- LESOTHO:**
- Lesotho Highlands Water Project (5 dams)
 - Erosion & siltation from diamond mining

River Projects to Watch

The following are just a few large-scale projects either planned or underway in Southern Africa that could have major impacts on rivers, and on regional water and power planning.

Batoka Gorge Dam, Zambia/Zimbabwe

▲ *River Affected:* Zambezi

Project: 181-meter-high hydropower dam, sited about 50 km downstream of Victoria Falls. Would inundate a 26-square-kilometre area. *Power Output:* 1,600 megawatts

▲ *Status:* Under consideration since 1971, but still no start-up date. There have been three feasibility studies thus far. Zimbabwe has been anxious to proceed with the project, but Zambia - which has excess generating capacity and several alternative sites for hydropower - is not.

▲ *Problems:* The reservoir would force the removal of a group of people who had been relocated to Batoka Gorge for the construction of Kariba Dam. Tribal leaders in Zambia have rejected the project and have vowed to fight it. The reservoir could increase health risks from water-borne diseases such as malaria. Critics also argue that the dam will harm tourism.

Epupa Dam, Namibia/Angola

▲ *River Affected:* Kunene (also spelled Cunene)

Project: 163- or 200-meter-high hydropower dam (two sites are being considered); the larger dam will have a 380-sq-km reservoir. *Power Output:* 360 MW

▲ *Status:* Scandinavian aid agencies NORAD and SIDA helped finance the feasibility study, though they say they have no interest in funding the project. Namibian government officials say they want to build the dam soon, but Angola seems to have lost interest in the project for now. At this writing, no funders had been lined up. At one point, China had reportedly expressed interest.

▲ *Problems:* It will affect thousands of the semi-nomadic Himba people, probably destroying their way of life forever. The Himba are overwhelmingly opposed to the dam, and have refused to cooperate in creating a social mitigation plan for the project, which may make the project "unbankable". The environmental problems are serious, too, as it will seriously change the riparian ecosystem of the only perennial river in northwestern Namibia. The reservoir will evaporate 600 million cubic metres of water per year - a huge amount for this arid country. Namibia also has better options for power that will do less harm and cost less.

▲ *Key Players:* The Namibian Ministry of Mines and Energy is actively pressing for the project to go ahead. Nampower, the Namibian electric company, would be one of the project developers. The feasibility study was done by a consortium called Namang, which included the Namibian company Burmeister, plus Norwegian and Swedish consulting firms. Opposition has been heard from the Himba communities, Earthlife-Namibia, Wildlife Society of Namibia, and a number of international groups.

Okavango Pipeline Project, Namibia/Botswana

▲ *River Affected:* Okavango

▲ *Project:* A proposed 250-km pipeline from the Okavango River to divert water to Windhoek. Cost estimated at N\$603 million.

▲ *Status:* Namwater and the Department of Water Affairs (both Namibia) have been studying this project for years, but recent droughts have added urgency to its development. Currently, the project is being seriously considered.

▲ *Problems:* A costly option, especially compared to groundwater sources, which are 200 kilometres closer to Windhoek and quicker to come online. Impacts on Okavango Delta's health are largely unknown, but environmentalists fear that this project will "open the tap" for other water diversions that could do serious cumulative harm to the ecosystem.

▲ *Key Players:* Namwater (Namibian water company) and the Namibian Dept. of Water Affairs are proposing it. The Okavango Liaison Group (see sidebar on page 29) is pressing for alternatives, as well as community involvement in planning for the Delta. The following funders have expressed interest: the European Investment Bank, the African Development Bank, Germany's Kreditanstalt Fur Wiederaufbau, Japan's Overseas Economic Cooperation Fund (OECF), Development Bank Of Southern Africa, Commonwealth Development Corporation (UK), Netherlands Development Finance Company.

Lesotho Highlands Water Project, Lesotho/South Africa

▲ *River Affected:* Senqu or Orange

▲ *Project:* This 5-dam scheme to transport water to South Africa's Gauteng region is one of the world's largest infrastructure projects under construction today. In addition to dams and tunnels through the Maluti mountains, the project includes a 72-megawatt hydropower plant that will supply power to Lesotho.

▲ *Status:* The 182-meter-high Katse Dam (Phase 1A) is now complete, and the 145-meter-high Mohale Dam (Phase 1B) is underway. At this writing a third dam, Phase 2, is being discussed by both governments.

Problems: If built out, this water-transfer scheme would divert about 40% of the Senqu (known as the Orange in SA) River's water to South Africa; ecologists say the river cannot support such diversions. Approximately 24,000 people have been affected by Phase 1A, losing either their homes or agricultural lands. Another 7,400 will be affected by Mohale, and about 300 households being forcibly relocated. Replacement housing has taken years to complete. The loss of some of Lesotho's best arable lands has also had major nationwide ramifications, not only in regards to food security but because the rural farmers displaced by the project are now expected to take on new livelihoods in a stagnant economy with huge unemployment. Dam-induced earthquakes have severely damaged housing, and concerns about the dam's earthquake safety remain. A development fund intended to provide retraining has so far been unsuccessful at finding new livelihoods for most of those who have lost land. Official corruption has also risen dramatically since the project began to bring money into the country.

▲ *Key Players:* The scheme is being managed by the Lesotho Highlands Development Authority (LHDA), which is responsible for resettlement and compensation issues, environmental protection and overall construction management. The World Bank, Development Bank of Southern Africa and European Union are funders. South Africa's Department of Water Affairs is the major agency involved. Concern over the need for the water has been voiced by South Africa's water supplier, Rand Water, various Civic organizations from the townships of South Africa, and numerous NGOs inside South Africa's and internationally. Lesotho groups monitoring the project's impact on affected people include the groups Highlands Church Solidarity and Action Centre and Transformation Resource Centre.

Komati Basin Project, South Africa/Swaziland

▲ *River Affected:* Komati River

Project Description: 2-dam water project, primarily for growing sugar cane.

▲ *Status:* Maguga Dam is under construction in Swaziland, and is expected to be completed by 2001; the other (Driekoppies, in South Africa) is built. Up to 5 more dams may be built in this scheme.

▲ *Problems:* At least 800 people will be resettled for Maguga Dam, and no compensation plan has been devised although engineering work is proceeding. The dam will flood some 1,500 hectares of arable land, and another 2,000 or so of grazing/forestry land. Although officials have said disadvantaged farmers will benefit, it appears possible this project will benefit primarily rich white farmers.

▲ *Key Players:* The Komati Basin Water Authority (KOBWA) is a Swazi-South African commission overseeing the project. SA's Dept. of Water Affairs will benefit from water deliveries. DWAF has been primarily responsible for project implementation on the RSA side with KOBWA help, while KOBWA is currently coordinating work on Swazi side. The Development Bank of Southern Africa is a major funder.

Mepanda-Ncua Dam, Mozambique

▲ *River Affected:* Zambezi

Project: A 2000+MW hydro project 70km downstream of Cahora Bassa Dam, to supply the South African aluminum company Alusaf with power at below-market rates. (Aluminum production consumes vast amounts of electricity, and therefore is usually given very cheap rates.) *Status:* Still being studied, but the aluminum factory has gone ahead, meaning the pressure to build the dam may remain high.

▲ *Problems:* The aluminum factory for which this dam will be built will eventually need 900 megawatts, in a country where the current total power consumption is only 200 megawatts. The dam's impacts on the ecosystems of the already heavily dammed Zambezi will be devastating.

▲ *Key Players:* Electricidade de Mozambique and South Africa's Eskom are project developers. Interested parties include Britain's Overseas Development Agency, the European Investment Bank, Canadian and US financial institutions and agencies. Both the dam and aluminum plant are sponsored by the South African mining company Genco, which owns Alusaf. The World Bank funded preliminary studies.

Part 3

Making a Difference

BECOMING A CATCHMENT KEEPER

The goal of this section is to provide people with guidelines on what they need to know about proposed projects in their catchments. By gathering the type of information described below, civil society will be better able to participate in the process in a meaningful way.

Large development projects often include only minimal input from local people, and then usually only after the project is already far along in the planning. Even projects which are very inappropriate for a nation's needs or have huge costs compared to expected benefits can advance from planning stages to

reality very quickly. A number of factors can help along a bad project: "professional optimism" by project planners, who tend to overlook potentially negative impacts; corrupt governments and corporations, lack of large-scale river basin planning, understudied ecosystems, and lack of communication between project planners and local peoples. Grassroots movements can help ensure that local people's voices are heard, that major questions about the project are brought to the light of day, and that larger issues about who owns natural resources such as rivers are given a full hearing.

Here, then, are steps to take to get involved in protecting your catchment, and questions to ask about proposed water projects.

First Steps

Become Informed: Catchment Basics

Learn about your local catchment. Get information about all major projects in and proposed for your catchment, including those upstream and downstream of your location.

Establish communication with the local government. A good connection to local government can provide access to updated information on new water projects in the region.

Find out about communities that could be affected by proposed projects. Determine if they need assistance in learning about the project, and get information to them. Collect information on affected communities: Take down oral histories of how they live and use the catchment. Research how many people could be affected and in what ways. Talk to leaders to find out where the community stands on the project.

Get information from community leaders and elders about the cultural, historical and spiritual significance of the river and ecosystems to the community. Document important places that could be affected by the project, such as graves or sacred places.

Collect ecological information on the catchment that will be affected. For example, get as much information from local fishermen as you can about average catches, what kind of fish are

There are ever-increasing demands for development, but these demands are infinite while the resources of the world are finite. We have to establish more justice between people, a more equitable distribution of the finite resources of the world and a more sustainable use of them.

ARCHBISHOP NJONGONKULU
NDUNGANE, SOUTH AFRICA

caught, and when. Get water samples to be tested for water quality. Solicit help from ecologists to survey existing catchment resources like wetlands, forests and animal life.

Gather public resources on projects proposed for your catchment: environmental reports, newspaper articles, etc. Find out which project planning documents are publicly available and which are not, and get copies of those that are available.

Get Information on Who Controls Water Resources

Each country has different laws on water rights and the use of water resources. Research your country's national water policies. Local and regional governments may also have laws affecting the use of rivers, natural resources and water.

Educate yourself and your community. Keep a small library of information on these topics:

- ▲ Local and national laws on land and water.
- ▲ The policies of major development-project supporters: the World Bank, United Nations Development Programme (UNDP), Development Bank of Southern Africa, and the African Development Bank. These policies are publicly available from the various agencies and major lenders.
- ▲ National and regional environmental protections.
- ▲ International environmental and human rights laws (law schools or international NGOs may be of help).
- ▲ International laws on shared water courses.

Questions to Ask About Proposed Water Projects

If there is a large-scale water development project proposed for your area, the following questions will reveal where potential problems lie, and may help you become an active participant in a project's planning. Some of these questions may require you to get outside expert help, if your group is unable to evaluate the information internally – for example, an economist could help you evaluate the project's economics, or a hydrologist or ecologist with questions about impacts to the river.

Not all of the following questions apply to all projects. These questions are adapted from a helpful guide, called "Questions to Ask About Water Projects," written by Gerald Meral, former deputy director of California's Department of Water Resources. As Dr. Meral wrote, "The art and science of identifying project benefits is sufficiently well developed, and few project advantages are ever omitted. But the optimistic enthusiasm of water-project sponsors frequently leads them to overlook potentially negative impacts. These questions are designed to reveal previously unidentified problems or costs."

Project Description

- ▲ Is the entire project described? Are future additions included?
- ▲ What is the implementation schedule?
- ▲ What is the plan for public involvement?

▲ Are the project's objectives properly described in terms of the needs it is supposed to meet rather than its structural features? For instance, a proper objective would be, "Develop programmes to match energy needs with energy supply." This allows for a better analysis of all alternatives than a project with the objective, "To build a dam that can produce 500 megawatts of power."

Project Economics

▲ Does the project schedule reflect actual experience in the region? (Project economics can be thrown off if a project is delayed or takes longer than expected to build.)

▲ Is a realistic inflation of project costs included in the final cost?
 ▲ Are loan interest rates consistent with probable rates at time of bond sale or loan?

▲ Are project mitigation measures fully and fairly costed out? The total should include development, operation, maintenance costs, and possible decommissioning costs.

▲ Does the project's economic analysis fully and fairly cost out environmental and social costs and benefits? (For example, hydrodams with large reservoirs in dry climates will evaporate large quantities of water. Has the lost water been properly valued?) Frequently excluded costs to be considered:

- lost local jobs (agriculture, fisheries, recreation and tourism jobs);
- full relocation costs, including those to help people re-establish livelihoods;
- lost economic values of natural ecosystem functions, such as the water-purification values of wetlands, and erosion-control and groundwater recharge benefits of forests and savannah.

▲ What subsidies are included? For example, will large corporations receive power subsidies? Will any taxes be waived to pay for any part of the project? Will power supply aspects of the project subsidize other aspects of it, such as water supply or navigation?

▲ Are distribution costs included in the cost of the project (e.g., power lines, water delivery system)?

▲ Will the water need to be treated for human use, and are those costs included?

Risks and Uncertainties

▲ Are per-capita demand projections for the power or water included? Do projections reflect a full commitment to an aggressive conservation programme? Are projections up-to-date and do they account for all recent changes that could affect demand (such as economic downturns reducing the need for power, or slowdowns in population growth in the region)?

▲ Are there adequate contingencies included in project cost estimates for all of the following unforeseen problems: project delays due to strikes, adverse weather, unexpected construction conditions (for example, adverse tunneling conditions, or re-evaluation of seismic risks), re-engineering, lawsuits, drought during operation, accidents, civil disobedience or political unrest?

Rethinking the Planning Process

Key to arriving at an appropriate energy or water project is the planning process that determines it. No single process can serve as a blueprint ready to be applied universally. The many steps of a process must fit within the context of overall energy sector and water resources planning. Because catchments (and, often, water and power supply systems) cross national boundaries, international politics and agreements must be taken into consideration. In addition to having a process that is transparent and participatory, planning that ensures appropriate project development must include the following fundamental tenets:

- ▲ assessment of the sector as a whole before considering options among individual projects;
- ▲ development of a national master plan for rivers and catchments;
- ▲ development of national energy and water-management plans and policies;
- ▲ achieving the highest possible level of conservation;
- ▲ full public discussion of acceptable (if any) levels of resettlement;
- ▲ projects selected for optimal enhancement of local capabilities in planning, financing, environmental management, construction, design, manufacture, operation and maintenance; and
- ▲ projects are based on the highest standards of scientific/technical/economic merit.

Civil society's contribution to such planning is critical. Successfully meeting competing needs for scarce resources requires active public participation in open and thorough sector-wide planning processes. When national energy- or water-development strategies are informed by civil society,

the likelihood of significant conflict over individual schemes is greatly reduced. Similarly, when the specific project planning process has involved the public early on, the likelihood of conflict is reduced. Such conflict often arises after projects which are far along in the planning process are presented to affected communities as a "fait accompli."

To be a success, the overall planning process must begin with an in-depth analysis of existing use, existing supply, and realistic demand projections. The next step is to examine the costs and benefits of both demand- and supply-side resources, to develop the least-total-cost mix of utility resource options. Such a process, known as "integrated resource planning," includes a means for considering environmental damages caused by electricity supply and transmission and identifying cost-effective energy efficiency and renewable energy alternatives.

Environmental guidelines for energy and water supply options should include setting national environmental policies and goals, as well as clear articulation of the rights of traditional users of land and resources under consideration for development. Comprehensive environmental impact assessments for all projects with significant (or cumulative) impacts should be undertaken.

The economic cost of energy services includes both financial and non-financial costs. The financial price (sometimes called the market price) of delivering most energy services to end-users only takes into account those costs that are directly paid for by producers and consumers: the cost of buying the fuel, the cost of transforming the fuel into usable energy (i.e. the cost of building a power plant or a refinery), and the cost of distributing the fuel/energy

Edited extract from *Beyond Big Dams*. See Resources for more information.

- ▲ Does the analysis compare the risks of the proposed project to the risks of alternatives?
- ▲ Are there signed contracts for the project's power or water?
- ▲ Irrigation projects: Are agricultural needs for water consistent with the availability of good farmland with good drainage (since irrigating lands with poor drainage will soon lead to salinization problems)? Will market trends for crops grown in the area to be irrigated support agriculture's ability to pay for the water? Are subsidies being paid for these kinds of crops already?
- ▲ What is the risk that higher rates to consumers, conservation or other factors will significantly reduce the demand for the project's output?

- ▲ Has the risk of dam failure or other structural problems been adequately assessed?

Alternatives

The following questions will help you evaluate whether equal planning efforts were undertaken to evaluate feasible, non-structural alternatives:

- ▲ Have alternatives to the project been fairly costed out?
- ▲ Has conservation been fully considered as an alternative to the project? (Note: conservation is frequently the least-cost alternative to hydroelectric and water-supply projects, yet full DSM conservation studies are rarely done as part of such projects' feasibility studies.)

▲ Have scaled-down, less-damaging project designs been considered?

▲ Has a net energy analysis been performed? This reveals how much energy would be used in the project's construction and operation. It should calculate the following:

- Construction energy required: manufacturing project equipment and supplies, moving materials, tunneling, grading, disposing of spoils, transporting workers to construction site and back, etc.
- Transmission line losses (up to 10 percent for some projects).
- Operations and maintenance activities (replacing equipment, dredging accumulated silt, etc.)
- Pumping project water to areas of use.
- Energy required for treating project water before use.
- Pumping water uphill for “pumped storage” projects.

▲ Does the analysis indicate how long it would take the project to become a net-energy producer? (Many hydrodams can take decades to do so, if all the above energy requirements used to build it are taken into account.)

Social Issues

▲ How many people will be dislocated from the project area? Are there opportunities to re-create their ways of life in comparable areas without causing other dislocations or overcrowding?

▲ Are adequate funds and full plans included for the relocation and resettlement of people to be displaced?

▲ Are the majority of affected people willing to be relocated? If not, how are their concerns being handled by the government/company?

▲ Have the local people been consulted about the project? Have they freely given their consent that the project should be built?

▲ Are there laws that require developers to inform local people about projects that would affect their communities? Have they been upheld?

▲ What groups in society will realize benefits from the project? Are they corporations or individuals?

▲ What groups will lose benefits? What is the value of their losses, and has it been calculated into project costs?

▲ What is the proposed compensation policy for affected people? How will it be implemented? Have affected people had input into the policy? Are they satisfied with it?

▲ How will the project affect water or power rates? Will rates be raised across the board, or will only some users pay higher rates?

▲ What are the expected health effects of project? The following should be addressed:

- Diseases brought by migration of workers
- Pollution
- Diseases caused by the changes in the river ecosystem, especially increases in water-borne diseases such as malaria, schistosomiasis, etc.

▲ Have the safety impacts to people downstream of the reservoir been analyzed?

▲ Has the report analyzed the impact on existing communities of increased populations moving into their area?

▲ Would the project harm downstream floodplain farmers, either by cutting off the natural flood or by holding back replenishing silts?

▲ Will the project cause an unsustainable “boom and bust” economic impact on local or regional economies?

▲ Will the project destroy areas of cultural or spiritual value? Since these impacts are usually not mitigable, have the project promoters taken this issue to the public for comment?

Environmental Issues

▲ Has the rate of reservoir siltation been considered in calculating operations and maintenance costs, and in calculating the project's estimated lifespan?

▲ Does the estimate for power production take into account adequate allowance for downstream water needs (called instream flow requirements)?

▲ If multiple phases are planned, are the cumulative impacts from all projects studied together?

▲ What are the project's impacts on species diversity?

▲ Is there a mitigation plan for project impacts so there will be no loss of fish or wildlife?

▲ Was a search for rare and endangered species done by properly qualified staff at the appropriate times of year for the species to be detected?

▲ Have the effects of the changes to the river on fish and wildlife been analyzed? Especially look for information on changes in river temperature, flow and nutrient levels.

▲ Will agricultural land, forests, wetlands, riparian habitat, meadowlands or designated critical habitat be adversely affected by the project (either upstream or down)?

▲ Have construction impacts such as new project roads been analyzed?

▲ Will the project reduce the outflow to any delta or bay? What would be the impacts on water quality or fisheries? Would it cut off sands from flowing downstream and replenishing ocean beaches?

▲ What are the project's impacts on recreational resources?

Next Steps

If a project is moving forward with problems that local communities and NGOs want to see addressed, it may be time to form a network to work on the issue, and to bring the issues raised to the attention of the wider public. Some ideas:

Gather Supporters

▲ For NGOs not based in the immediately affected area, it is crucial to work directly with local leaders who are well-respected in the community and supportive of the effort.

▲ Include a diverse, representative group in the initial process. Encourage full participation and activism among all ranks in the community, from children to elders. Because

Write Letters!

Writing letters to top officials or politicians involved in planning large water or power projects can be a very effective tactic, especially if a large number of people or groups sign on. A letter-writing campaign can be an effective way to galvanize a community to get involved in an issue. This is an open letter from Okavango Delta Communities to the Governments of Namibia, Angola and Botswana, and OKACOM about a proposed water pipeline that they fear would harm the delta and their livelihoods; it brought widespread public attention to the issue, thanks to an effort by a local NGO coalition to write press releases and articles about the communities' efforts.

For more information on Delta communities' campaign, see Contacts.

women are the primary caregivers, water gatherers and food producers in Southern Africa, they are often the most negatively impacted by river basin development. Ensure that they can be part of the process by planning meetings at a time and place that is accessible to women with families.

- ▲ Use the local language for handouts and meetings.
- ▲ Keep a list of contacts in the region who are on both sides of the issue. Such people could include: affected people, technical experts such as engineers, developers, Ministers of Agriculture, Natural and Water Resources, and Environment.
- ▲ Keep a list of activists in the surrounding region and internationally who are supportive of your efforts.
- ▲ Keep a list of companies, lenders and agencies who are working on the project.

Getting Project Information Out to the Public

▲ Begin disseminating information early, to help bring people to the cause who otherwise might not have heard about it. Increase public awareness through letter writing and press releases.

To whom it may concern:

We, the communities living in and around the Okavango Delta in Botswana, would like to voice our concerns about planned water extractions from the Okavango River. We depend on the Okavango River and Delta for water, fish and other foods, housing material and our livelihood. The river and delta have already dried considerably in the last 20 years, causing hardship to us. We feel we do not have any extra water to spare.

We understand that the Okavango River is shared by three countries, and that each country needs water. However, we are very concerned that extracting water from the Okavango River will hurt our communities, wildlife, fisheries, farming, cattle and tourism. Therefore, we request that no water be extracted from the Okavango River unless there is no alternative.

If there is no other water source available, we urge the governments of Botswana, Namibia and Angola, and OKACOM, to study the river and delta and determine how much water can be taken out without hurting the delta and our communities. This should be done before any water extraction project is constructed.

If an extraction must be built, we urge the governments of Botswana, Namibia and Angola to commit to extracting no more water than is determined to be safe for the Okavango Delta and our communities, and to allow monitoring of any extraction project to ensure compliance.

Furthermore, we request that any proponent of a water development scheme consult with our communities to describe the proposed project and its impact on us, and to listen to our concerns before the project is constructed. Finally, we request to be involved in planning and managing the future of the Okavango River and Delta.

Thank you for your consideration,

Signed by more than 3,000 people in Okavango Delta Communities

▲ Work with the local media. Submit articles and press releases to the local paper. If local newspapers are not willing to publish the information, try regional and national and even international publications which might be interested. Consider going through a neighboring country, especially if water resources are shared. Look for regional environmental or human rights publications.

▲ Write letters to government officials asking for detailed information on planned projects. Follow up with further questions. (See opposite page for an example by Okavango Delta communities.)

▲ Consider using the Internet to disseminate information.

HOPE FOR THE FUTURE: CREATING CATCHMENT COMMUNITIES

Most modern societies turned their backs on their rivers long ago, and badly damaged them with development projects and pollution. This is shifting, though, and a growing number of communities around the world are rediscovering the value of healthy rivers. And, of course, there are many communities around the world whose appreciation for their rivers and commitment to sustainably managing their catchments never flagged.

The key to protecting and restoring rivers lies in treating the entire catchment with care and respect. Thinking on a catchment level means seeing rivers as integral parts of a complex and dynamic system of land and water and life. Disrupting any part of the system will eventually affect all other parts. Looking after rivers thus means looking after water, soils, ecosystems and the air (because in industrialized nations, much of the pollution entering aquatic systems comes from air pollution).



Any sensible strategy of freshwater management must aim to have healthy catchments. This means they are not badly degraded by deforestation, unsustainable farming practices or excessive

urbanization; and have intact wetlands and rivers which, to the greatest extent possible, are unpolluted, support a wide variety of life forms and are able to flood according to their natural pattern. The solution to many of today's water problems – including floods, lowering groundwater tables and water-quality problems – is to protect and restore catchment ecosystems. If this is not done, no amount of new dams or other technologies will be able to prevent these problems.

Catchment thinking means recognizing and respecting the complexity of the interactions between land, water and atmosphere. It means adapting to this complexity rather than making counter-productive efforts to control and simplify it. It also means respecting the diversity of different catchments and the natural and human communities that live within them. It means finding ways of living which allow our economic, cultural and spiritual needs to be satisfied while maintaining healthy watersheds. Most importantly, it means thinking about our catchments, and making their proper management a community priority. It means creating a catchment community.

Creating an effective catchment community involves bringing together the many diverse interests which use the catchment to evaluate the entire spectrum of human activities that are stressing the catchment. While it may seem difficult to do, this community must include all the different interest groups in the catchment, including those that might be perceived to be the cause of problems. Since no one group alone can solve all of a

catchment's problems, a diverse catchment community – one that includes citizens, community leaders, politicians, government agencies, environmentalists, recreationalists, educators, farmers, bankers, factory owners, students and scientists, to name a few important players – is key to success. One of the more difficult but important tasks for such a group is to build trust among all these partners, so that all will accept and work toward the goals the group sets out.

Diversity of Groups

Catchment or watershed groups are springing up all around the world. These groups take an active role in catchment protection and management. There are a number of approaches for such groups, depending on the group's focus. It may be primarily to inform people about local water issues, to fight projects that will greatly harm the catchment, to restore ecosystems in the catchment, to monitor and manage these ecosystems to protect plant and animal species, or some combination of these. A group's reasons for coming together can be as varied as the problems they are trying to address. Perhaps there are too many agencies with conflicting goals working in the catchment, fragmenting planning and leading to poor decisions. Or perhaps existing laws that deal with catchment protection are not being enforced.

One successful group in the United States, the Henry's Fork Watershed Council in Idaho and Wyoming, was formed because there were at least 25 federal, state and local agencies with management jurisdiction in the watershed. The area faced a number of threats, including polluted agricultural runoff, dams and increasing demands for irrigation water. Lack of agency coordination was making problems worse in the basin. The group came into being to evaluate projects and problems from an overall catchment perspective. Members include citizens, scientists and agency representatives who reside, make a living in or have legal responsibilities in the catchment.

Janice Brown, the group's executive director, said, "We need to clarify the misunderstanding that 'consensus' can only be achieved through compromise. Rather than settling for 'common ground,' we had better be moving to 'higher ground' where achieving harmony among all interests becomes far more important than plunking ourselves down between two extremes." The group has successfully built trust between historic adversaries, such as fishermen and farmers.

The Henry's Fork Watershed Council has developed the following 10 criteria for evaluating the merits of projects or programmes being proposed in their catchment. The criteria were distilled from a list of 80 different ideas for catchment health and vitality. The criteria are:

- ▲ Catchment Perspective: Does the project employ or reflect a total catchment perspective?
- ▲ Credibility: Is the project based on credible research or scientific data?

Grassroots Group Works Toward a “Clean, Safe” River

The Greater Edendale Environmental Network (GREEN) is a grassroots group that focuses on good management of the catchments in South Africa’s Pietermaritzburg-Msunduzi area. Says Sandile Ndawonde, the group’s coordinator, “Our vision is ‘A clean and safe Msunduzi River by the year 2009.’ We believe that the vision is one that every stakeholder can buy into.”

GREEN is participating in most of the area’s water management and land use projects on a collaborative basis. The group has undertaken a number of plans and actions with regard to the increased demand of access to clean and safe water resources, and to ensure that the management of water resources is done at a catchment level.

GREEN is involved in creating awareness on environmental issues and to educate communities about the need for sustainable use of natural resources. The group began its work after severe floods in the region in 1995, which killed 160. After these floods, an Integrated Catchment Management (ICM) programme was initiated by the Institute of Natural Resources (INR) in partnership

with the Computing Centre for Water Research (CCWR), GREEN and Share-Net.

The group’s vision includes specific goals. A clean river, according to GREEN, means “reduced soil erosion (encouraged by better land-use practice), reduced faecal contamination (improved water supply and sanitation) and reduced industrial pollution.” And a safe river means reduced contamination and reduced risks from flooding.

In addition to its efforts on an integrated catchment plan, the group has developed a permaculture plan to make best use of the floodplain, initiated an effort to rehabilitate the catchment through tree-plantings and other efforts, begun an environmental education campaign, and lobbied local government officials to press for increased sanitation services and flood warning systems.

“The process is based at catchment level because a catchment is an obvious eco-hydrological unit that goes beyond political and socio-economic groupings,” says Ndawonde.

For more information, see Contacts.

▲ **Problem and Solution:** Does the project clearly identify the resource problems and propose workable solutions that consider the relevant resources?

▲ **Water Supply:** Does the project demonstrate an understanding of water supply?

▲ **Project Management:** Does project management employ accepted or innovative practices, set realistic time frames for their implementation, and employ an effective monitoring plan?

▲ **Sustainability:** Does the project emphasize sustainable ecosystems?

▲ **Social and Cultural:** Does the project sufficiently address the catchment’s social and cultural concerns?

▲ **Economy:** Does the project promote economic diversity within the catchment and help sustain a healthy economic base?

▲ **Cooperation and Coordination:** Does the project maximize cooperation among all parties and demonstrate sufficient coordination among appropriate groups or agencies?

▲ **Legality:** Is the project lawful and respectful of agencies’ legal responsibilities?

Projects can be endorsed by the Watershed Council if they adequately address these questions. The council includes not only community groups and NGOs but technicians and scientists to help evaluate projects.

Forming a Catchment Group

Efforts to protect a catchment can be initiated by citizens and private groups, or by local, district or national governments. Citizens may form a group with help from environmental agen-

cies or other government bodies. The University of Colorado (UC) has studied dozens of US watershed groups, and discovered some crucial similarities that were indicators of success. While such groups vary widely in scope, the UC researchers found that nearly all groups need these elements in order to be effective and sustainable: a coordinator or organizer, a broad range of participation, and outside technical assistance. The UC report, *The Watershed Source Book*, also offered these lessons from successful watershed efforts:

“First, education of participants in the watershed effort and the general public on watershed issues should be an early thrust of the effort. An effective education programme will help build support for the watershed effort and avoid misunderstandings about the effort. Second, to avoid unproductive meetings and planning processes, concrete goals should be established for the group and for each group activity. Third, meaningful problem solving requires identification of the root causes of the problems, not merely symptoms.

“According to experienced participants, time spent educating members of a watershed group and the public in general on watershed issues and the purposes of the group is time well invested. Additionally, concrete goals, set by the watershed group, provide direction and lay the foundation for a productive effort. Long planning processes with no deadlines and inadequate structure can seem pointless, and people become discouraged and lose interest. Finally, several group coordinators recommend avoiding ‘quick and dirty’ solutions to watershed problems. Many problems have evolved from years of watershed

Bringing Okavanga Delta Communities into the Planning Process

The Okavango Liaison Group (OLG) is a regional coalition of non-governmental organisations, communities and individuals working for the sustainable development of the Okavango River and Delta. A primary goal of OLG is to increase community awareness of the importance of the Okavango Delta in people's lives, and thereby ensure its protection. The Delta is home to 30 communities with approximately 100,000 people. At least 15 per cent of these people draw their water for domestic use directly from the river, and most rely on the river for medicinal plants, fish, reeds for building their huts, and other natural resources important to their livelihoods.

The group's goals are as follows:

- ▲ To enhance and facilitate the participation and contribution of various stakeholders in management efforts on the Delta;
- ▲ To increase stakeholders' awareness and understanding of the Okavango's unique ecosystem dynamics and functions and foster a stewardship ethic;
- ▲ To establish networks among stakeholders and non-governmental organisations within the region;
- ▲ To monitor proposed developments in the catchment.

OLG will be involved in an Integrated Basinwide Management Plan for the Okavango River and Delta. OLG's main objective is to work with OKACOM, the official planning body, to facilitate public participation in the process. The group will hold a series of basin stakeholder workshops to bring local people into the process.

The OLG has also launched an education campaign to teach stakeholders and communities about the basic dynamics and functions of the Okavango River and Delta ecosystem. Says project coordinator Olive Sephuma, "We are developing educational materials that will be used in this campaign such as booklets, slides, an educational video and a model of the river. The OLG has also begun visiting junior secondary schools to talk to students about the Okavango River, and on World Water Day we held a major event to educate communities about the catchment." the event included an enlightening discussion on the topic of "Whose water is the Okavango River?" In future, the OLG hopes to organise other public debates covering issues on the Okavango Basin.

For more information, see Contacts.

degradation, and finding and applying effective solutions may take a significant period of time.

"Thus, watershed group participants recommend focusing initially on educating interested parties in the watershed, then setting concrete goals and ultimately working to resolve the root causes rather than the symptoms. While each watershed group faces unique challenges, these lessons are basic enough to apply to all groups."

The Real Hope for the Future: The Next Generation

Children hold the real hope for a more sustainable, equitable water future. Any efforts that help children learn about catchments, water management and issues affecting water resources will pay off in a future whose citizens know the value of a healthy catchment. There are a number of programmes for school children that focus on these issues. One good programme

is South Africa's "Water Audit: How your school can be water wise" by the Department of Water Affairs (see Resources). This curriculum guide that teaches the value of water conservation and other water issues. It includes classroom activities, curriculum links and comics. The intended audience is students in Std. 4-8. Another international programme is the annual River of Words poetry and art contest, which helps children explore their own catchments and their importance to our lives through the arts. A River of Words programme is being explored for schools in Botswana and Namibia (any school can join). Finally, there are any number of environmental groups making presentations to school children about water and river issues (see sidebar, above, for one example in the Okavango Delta).



South African Environmental Group Tackles Integrated Catchment Management

When the Minister for the Department of Water Affairs and Forestry, Professor Kadar Asmal, challenged environmentalists and communities to become involved in protecting local catchments and working to promote Integrated Catchment Management (ICM) plans, the Wildlife and Environment Society of South Africa jumped at the chance. The Karkloof Integrated Catchment Management Project, initiated in October 1996, was the result.

The Karkloof River catchment, chosen for the pilot project, is situated 50 km north west of Pietermaritzburg and 95 km from Durban in the province of KwaZulu-Natal. The Karkloof River is a tributary of the Mgeni River which rises in the foothills of the Drakensberg range and flows into the Indian Ocean at Durban.

There were two primary reasons for choosing this catchment. The Karkloof River catchment is one of the most important conservation areas for biodiversity in private ownership in KwaZulu-Natal. It is also an important source of water for the region, supplying water for the urban and peri-urban corridor between Pietermaritzburg and the Durban Metropolitan area.

The primary aims of the Karkloof River Integrated Catchment Management Project are to encourage all stakeholders to participate in the conservation of the existing resources and manage these resources in a sustainable way with particular emphasis on water use. The project aims to encourage catchment land owners to become part of a stakeholder network that will look at ways in which the existing natural resources can be conserved; assess the present land use of the catchment; prepare a land use plan for the area, and recommend

ways it can be carried out

The project held a workshop to inform people of the principles behind the new Water Act; outlined the proposed governing structures for catchment management; recorded the concerns of all parties, and established a catchment management forum. Baseline data on the catchment is being collected as well.

During the past few years the Society has gained experience in the setting up and running of a catchment management project. Some of the key lessons learned include: Identify and involve any social structure or organisation already working in the study area; offer practical benefits to interested and affected parties immediately so that people know you mean business; set goals and dates to work towards; make sure that the process is a transparent one; and start the information transfer process as soon as possible.

The project intends to prepare and implement a catchment management plan for the Karkloof River in line with the requirements of the new National Water Act; to establish a water quality monitoring programme as part of this management plan; and to assist with the establishment of forums and management plans for the other sub-catchments within the larger catchment. In early 1999 the Society drafted a proposal for financing integrated catchment management projects, similar to Karkloof, in all South African catchments.

The Society strongly believes that integrated catchment management is the way forward for conservation in Southern Africa, and should be widely used to help in the conservation and wise management of all river catchments. *For more information, see Contacts.*

NEW APPROACHES TO ENERGY AND WATER SUPPLY

In the past 40 years, Southern African nations have increased water and power supply by more than fivefold. The development of most of this capacity followed the traditional engineering and supply approach – in other words, building large dams and power plants. Alternatives were seldom considered. In fact, such alternatives used to be discounted as experimental concepts that couldn't meet the demands of the “real world.” But in the past decade or so, alternatives to traditional water and energy supply approaches have proved themselves in real-world applications around the globe. The following section describes the many alternatives now being practiced in energy and water supply which can help human society flourish without undermining the integrity of the ecological systems we depend on.

Conservation and Demand Management

Conservation can save a huge amount of water and power before it is even used – and money, too, since it prevents the need for building expensive large-scale projects. An entire field of expertise that focuses on conservation and efficiency measures, called “demand management,” has arisen to develop effective ways to conserve both power and water. Demand management treats the volume and pattern of water- or power-consumption as variable, and aims to change the behaviour of consumers either voluntarily (prices, education) or involuntarily (regulations, policies). Demand management has many benefits to society besides reducing wasteful use of water and power. Such measures can reduce pollution and environmental damage, create more jobs than building new water and power plants would, save money (and thus free up funds to help bring water or power to the poor), and pose less economic, environmental and social risk to society than large-scale infrastructure projects.

It seems logical that securing “new” supplies of water and power through the conservation of existing resources should always be considered first. Yet only recently has this approach drawn much official interest in the region. Although conservation and efficiency measures are being used more often in Southern Africa, civil society can play a major role in pressing to ensure that demand management is explored first when water or power needs increase, and that it is given a full analysis as a legitimate alternative. Too often, such measures have been seen as a way to merely supplement the output of large development schemes rather than replace them. (See “Rethinking the Planning Process,” page 24.)

Demand-management plans may include a number of tactics, including the following:

- ▲ Offering rebates – to consumers for purchasing efficient equipment and to manufacturers for designing and producing it;
- ▲ Managing power or water supply to increase efficiency;
- ▲ Educating consumers about conservation and efficiency measures available to them;

- ▲ Offering training programmes for the building trades to ensure that efficient equipment is properly installed and maintained (this is primarily true for energy efficiency improvements), and

- ▲ Improving efficiency on the supply-side, such as reducing losses through the distribution system.

It is important to remember that the cost of efficiency measures and the ease with which they can be implemented will vary greatly from place to place.

ENERGY CONSERVATION

Energy efficiency measures can reduce pollution and greenhouse gas emissions, save money and create jobs. They also pose significantly less risk for society than large-scale power plants. For example, what happens if the government has committed to build a large-scale power plant in anticipation of future needs and then the economy suffers a serious downturn? Most supply-side investments require long-term commitments, so someone is going to pay for that unneeded power plant for some time to come, whether it is needed or not. In contrast, demand management efforts are much more flexible, and can be ramped up and down as needed, tracking the economy's ups and downs. For example, energy-efficient building standards will provide lots of energy savings when the economy is booming and the energy savings are needed the most (because more people are using more energy), and much lower savings when the economy is stagnant and energy savings are less important.

The potential for saving money by saving electricity is enormous. Electricity costs the world more than \$500 billion annually, according to the US-based efficiency research group the Rocky Mountain Institute. Energy experts believe that energy efficiency measures could save 30-50 percent or more (and even greater in developing countries that are still using old, inefficient technologies).

Efficiency measures are not free, but they are very cheap compared to new power supply – and bring other economic benefits besides lower costs. Utilities report that the average cost of implementing electricity savings of all kinds has been 2¢ per kilowatt-hour (kWh), and the best-designed programmes are many times cheaper than that. In contrast, each kWh generated by an existing power plant costs upwards of 5 cents (and as high as 20 cents), and that does not include the cost of repairing the environmental impacts of energy plants. Numerous studies have shown that undertaking efficiency measures also brings more jobs than building new power plants. It takes many more energy auditors to go through one million buildings, make recommendations, add insulation, install efficient lighting, etc. than it takes construction workers to build the power plants necessary to provide energy to the same one million buildings.

In some countries (especially those using the most energy), demand management has advanced significantly. For example, since 1973, the United States has gotten more than four times as

much new energy from demand management savings as from all expansions of domestic energy supplies put together, according to the Rocky Mountain Institute. The energy savings already achieved have cut Americans' energy bills by more than \$200 billion a year, compared to what they would collectively be spending if they used energy at the same rate as in 1973.

Although it may seem hard to believe, the opportunity for energy savings in developing countries is very high, despite their overall low per-capita use of energy. One reason is because older equipment is not replaced or maintained as often as in richer nations, meaning that already-inefficient machinery is operating even more inefficiently than when it was first purchased.

Developing countries have also become "dumping grounds" for inefficient appliances or technologies that are no longer allowed in developed countries. It may seem logical for poor countries to buy, say, cheap air conditioners that do not meet US efficiency standards and therefore can no longer be sold there, but those same cheap air conditioners will require more power plants to run them – and more money out of consumers' pockets every time they are used. Finally, since most developing nation governments have been most concerned about bringing services to unserved citizens, they have been slower to develop standards and policies to increase efficiency. Therefore, new buildings and locally manufactured equipment may be very inefficient.

Leveling the Playing Field

In the past decade, nongovernmental groups in North America have witnessed a leveling of the energy-planning playing field as they press utilities to use demand management programmes as alternatives to new power plants. Environmental groups in parts of the US and Canada have been given access to funds to hire expert consultants to perform extensive, in-depth analysis of demand management potential. The result is that regulators, legislators and sometimes even the utilities themselves accept the work as credible and compelling enough to force changes in the way utilities operate. Where did these NGOs get the money for this research? The surprising answer: from the utilities themselves.

Why would the utilities give NGOs money that would only be used to oppose their plans? First, in some jurisdictions, they have no choice. Some government regulators have developed policies recognizing that NGOs represent legitimate public interests and establishing funding mechanisms that permit NGOs to intervene in regulatory proceedings over utility plans. For example, the Ontario Energy Board, which regulates all of the electric and natural gas utilities in Canada's largest province, requires utilities to reimburse NGOs for all legal and analytical costs incurred in challenging the utilities' plans if it determines that the NGOs provided constructive input into the regulatory process. This allows the NGOs to hire the lawyers, demand management experts and other consultants necessary to analyze and critique the usually voluminous studies utilities develop to support their positions. Although NGOs still tend to face uphill battles in most cases, they often win at least some concessions from regulators and utilities and occasionally have substantial victories (as when the Ontario Energy Board

rejected Union Gas' 1996 demand management plan as inadequate and forced it to resubmit an entirely new, more aggressive plan).

In addition, in some places, NGOs have succeeded in convincing utility managers that they would be better off negotiating settlements on demand management and power plant investments than entering protracted and costly legal battles. Negotiated settlements in the late 1980s set the stage for aggressive approaches to demand management in California, Massachusetts and a number of other states by advancing new regulatory proposals which enable utilities to make more money from successful efficiency investments than from building new power plants.

Since then, NGOs have continued to negotiate with utilities in fora commonly known as "collaboratives." Under collaboratives, utilities will provide substantial financial resources to NGOs (often hundreds of thousands of dollars a year for a single utility) so that the NGOs can hire their own demand management experts for advice in negotiations with the utilities. Although the utilities are providing the money, the demand management experts are answerable only to the NGOs. In many cases, the experts have successfully won the respect and trust of utility officials over time, to the point that some utilities have accepted and implemented the demand management programmes the NGO's experts have recommended. Although they are far from universal, such "collaborative" arrangements remain common in several parts of the United States, particularly the northeastern states. As a result, there is a small but effective industry of demand management experts who work primarily for public-interest advocates.

Chris Neme, Vermont Energy Investment Corporation, Burlington, VT/USA

Group Promotes Energy Efficiency in Ghana

Ghana is currently facing an energy crisis, in large part because 95 percent of its energy has historically come from the Akosombo Dam, which has suffered from numerous drought-induced power shortages in recent years. To help reduce the impacts of the crisis, during 1997 Ghana had to import US\$18 million of power from Côte d'Ivoire, selling it for just 18 percent of what it paid for the electricity to keep industrial economic activities running normally and to maintain investor confidence.

The Alliance to Save Energy – Ghana (ASE) is one of the first NGOs in Africa to specifically promote the efficient use of energy. The region faces not just a growing need for power to accommodate rising population, but the economic imperative to make every kilowatt count. This goal was being consistently undermined by a lack of national efficiency standards in African countries, which resulted in the region becoming a dumping ground for inefficient products no longer permitted in Northern countries. ASE believes that promoting energy efficiency standards on just two key products – air conditioners and refrigerators – could greatly reduce wasted energy. ASE focuses on these major issues:

- ▲ Raising the awareness of major energy consumers about efficiency and the benefits of reducing energy waste;
- ▲ Informing local consumers and industries of the benefits of energy-efficiency programmes;
- ▲ Creating policy and regulation reform for equipment standards, and developing local energy-saving capabilities and equipment;
- ▲ Developing a network in Ghana between those who have the expertise in energy-saving technology, funding agencies, and those who can benefit from energy-saving investments.
- ▲ Working to make Ghana a model for sustainable energy development in Africa.

For more information, see Contacts.

The Importance of the Right Regulatory Framework

Demand management efforts have been most effective when governments have required utilities to periodically submit long-term plans for meeting consumer demand in the cheapest way possible (usually this is part of an integrated resource planning process). This requires them to look at demand management as well as supply-side options. Although a utility's assumptions may not always be a fair assessment of what is really possible with efficiency measures, the process is open to public debate, thus NGOs have some leverage in influencing the process.

Another unique lesson about demand management is now being learned in the US, which is in the process of deregulating its energy markets to open the field up to competition. As this process gains wider footing, many states that are deregulating their energy market are moving in the direction of taking responsibility for demand management away from utilities and placing it in a newly formed, government-run (or government-overseen) "efficiency utility." The argument is that, despite regulators' best efforts to give them the right incentives, most utilities continue to perceive themselves as having conflicting interests: they have to do demand management on the one hand but sell electricity on the other. California, New York and others have placed a tax on all electricity sales to collect a pool of money that will be spent on demand management programmes. A state agency will use this money to hire firms to implement demand management programmes with this money.

Some Ways to Save Energy

There are many, many ways to capture energy through efficiency improvements, with new innovations coming out all the time. The following describes some of the most common and best efficiency measures.

Residential

▲ **Lighting:** Great progress has been made in making lighting more energy efficient. Traditional incandescent light bulbs use 90 percent of their energy to produce enough heat to glow, compared to compact fluorescent light bulbs, which are four times more efficient and last 9-13 times longer. In Japan, 80 percent of homes are lit by compact fluorescent bulbs. Making use of natural daylight through windows is also an effective way to save energy (and costs to the consumer) from lighting. According to the Rocky Mountain Institute, a 1x1.6 metre window in direct summer sun lets in more light than a hundred 60-watt light bulbs.

▲ **Home appliances:** Over the past three decades many developed countries have greatly reduced their energy consumption because of improvements to appliances. Household appliances such as furnaces, water heaters and cooking ranges have cut their electricity use by an average of 50 percent. Appliances such as refrigerators, electric water heaters and stoves have the potential of becoming 3-6 times more efficient (and in sunny climates, solar water heaters can reduce a home's energy use even further). When older appliances are being replaced, it is good to prioritize to get the most energy savings:

air conditioners are the single biggest energy user in a home, followed by refrigerators.

▲ **Buildings:** Houses and apartment buildings can be made more efficient (for both heating and cooling) by increasing insulation levels in the walls and roof, improving the energy-efficiency of the windows and, for hot climates, planting shade trees near the building. Windows bring light and warmth into buildings, but can also be a major source of heat loss in the winter and heat gain in the summer. However, modern energy-efficient windows can help minimize a home's heating, cooling, and lighting costs by 35-45 percent, according to some estimates. The factors which affect the energy efficiency of a window are the type of glazing material (e.g., glass, plastic, treated glass); the number of layers of glass; the size of the air space between the layers; the heat conductance of the frame materials, and the "tightness" of the installation.

Shade trees reduce solar heat gain by absorbing heat from the sun before it can reach the building, as well as cooling the surrounding air through evapotranspiration. Air conditioning savings from landscaping range from 25-60% over the course of the summer, depending on building type, amount of insulation, landscape design and climate. Some utilities in hot climates have sponsored tree-planting programmes. For example, The Sacramento Municipal Utility District (SMUD) in California is operating one of the US's most ambitious tree planting programme. SMUD plans to plant 500,000 trees by the year 2000 through its Shade Tree Programme, and had planted more than 160,000 trees by 1995, mostly in residential areas of the city. The utility funds the programme, which is implemented by the non-profit Sacramento Tree Foundation. Fast-growing deciduous trees are a good choice, as they allow sun in winter.

Commercial, Institutional and Industrial

▲ **Technologies and Appliances:** Improving efficiency in industrial settings almost always includes improved basic production technologies – especially motors, which use up to two-thirds of industrial electricity in most countries, according to the Stockholm Environment Institute. The science of energy efficient motors is complex, and often specific to the industry application. In the steel industry, which uses a considerable share of energy in many countries, advanced technology furnaces can result in 40-45 percent energy savings. Similarly, it has been estimated that aluminum production can be 50 percent more efficient through the use of improved equipment, and even further through the use of aluminum recycling (secondary use of aluminum requires just 4 percent of the energy needed to produce it the first time). For some industries – such as supermarkets, restaurants and hospitals – refrigeration is an area where big savings can be found.

▲ **Buildings:** Although there are some similarities in efficiency measures for residential and commercial buildings, the best ways to make commercial buildings more efficient are through improvements to air conditioning and lighting systems.

WATER CONSERVATION TECHNIQUES

Using water more efficiently can, in effect, create a new source of supply. According to Sandra Postel, an expert in international water scarcity problems, technologies and methods are now available which could cut water demand between 40 and 90 percent in industry, 30 percent or more in cities, and between 10 and 50 percent in agriculture without reducing economic output or quality of life. In developing countries, the potential benefits of water demand-side management programmes are huge in terms of money saved and ecological damage avoided, as well as freeing up water supply to extend coverage to the unserved.

Water management expert S. Mtetwa of Zimbabwe described the goals of demand management programmes for water at a 1998 United Nations conference on freshwater management in Zimbabwe:

"Water demand management aims to:

- ▲ safeguard the rights of access to water for future generations;
- ▲ limit water demands;
- ▲ ensure equitable distribution;
- ▲ protect the environment;
- ▲ maximise the socio-economic output of a unit volume of water, and
- ▲ increase the efficiency of water use."

Demand management includes several approaches to conserve water, including economic policies, notably water pricing; laws and regulations, such as restrictions on certain types of water use; public and community participation, to ensure that solutions are workable and have public support, and technical solutions, such as installing water flow restrictors. Reducing the amount of water consumed is key to cutting both water and energy expenses. Demand management cannot be thought of only from a technical angle. Water-saving technical measures always have economic, legal, institutional and political aspects that must be considered as well.

Below is a checklist of specific ways to cut demand. Most are designed for use by local or regional water suppliers or government agencies. Citizens should press to ensure their water utilities and governments are doing as many of these things as possible.

To reduce water wastage nationally or regionally:

- ▲ Do overall system water audits, leak detection and repair. In places with apartheid-era water pipe systems, such as the township of Soweto, up to 50 percent of water supplies are lost due to leakages. In Windhoek, Namibia, up to 33 percent of water is lost by leaking distribution systems.
- ▲ Offer public information programmes in communities, businesses and schools. (See Resources for a good South African water audit programme for schools)
- ▲ Meter all new connections and retrofit existing connections.
- ▲ Price water appropriately, after providing at low- or no- cost a "lifeline" level of water as required for human health (considered to be 50 litres/day by WHO). "Non-conserving" pricing pro-

vides no incentives to reduce use. Such pricing is characterized by rates in which the unit price decreases as the quantity used increases (declining block rates); rates that involve charging customers a fixed amount per billing cycle regardless of how much

water is used, or pricing in which the typical bill is determined by high fixed charges and low commodity charges. Conservation pricing provides incentives to customers to reduce average or peak use, or both. Conservation pricing can include

Finding Water Through Demand Management

Southern Africa water experts agree: water demand management can reduce water consumption by at least 30 percent in most cities. Moreover, these savings can be achieved with no noticeable reduction in quality of service, nor with any longterm cost to consumers. In fact, some cities in the region have already achieved significant reductions through demand management. Windhoek, Namibia achieved 33 percent reductions through pricing strategies, appliance upgrades, water re-use and other measures. The cost of these savings was less than one-tenth the cost of developing new sources such as piping water from the Okavango River 700 kms away.

In Hermanus, South Africa, the city's conservation programme begun in 1996 reduced water demand by 32 percent in the first year. The Hermanus programme included measures such as promoting water-wise gardening, improving the metering system, removing thirsty alien vegetation from water catchment areas and conducting water audits in schools and homes. This was South Africa's first longterm water conservation programme for a municipal area. It was based on a successful demand-management plan for Kruger National Park which managed to cut water use by park visitors by an amazing 73 percent, and electricity use by 60 percent.

Although South Africa does not yet have a national programme to replicate the Hermanus programme more broadly at this time, the Department of Water Affairs' water conservation programme in May 1999 released the "Water Conservation and Demand Management National Strategy Framework," which may lead to more clearcut guidelines for South Africa's water planners. The report states, "Reducing the growth in demand can result in postponing large infrastructure requirements and will thus result in significant financial savings ... It is estimated that if the growth in demand in Gauteng is not reduced, over the next 20 years, R10 billion will have to be spent on new wastewater treatment plants and R17 billion will have to be spent for new water augmentation schemes. The net present potential value of postponing all new bulk water supply infrastructure projects in Gauteng by one year alone exceeds R2 billion."

Another city that has made progress with water conservation include Bulawayo, Zimbabwe. Like many other

cities in Southern Africa, it had to battle with the effects of a crippling drought in 1991-92. The city implemented an aggressive increasing block-rate tariff structure, with heavy fines for excessive use. New metres were installed in many businesses and homes, and bicycle patrols were established to check the 2100-km water-distribution pipeline for leaks. The city was able to reduce domestic demand by more than 30 percent and industrial demand by 40 percent or more. In addition, the sewerage system serves about 90 percent of the city's population, and through reclamation, provides 8,000 m³/day used to irrigate parks, sports fields and road margins. Since the drought passed, however, growth in demand has nearly resumed the pre-drought trajectory.

Remarkably, despite the relative ease and effectiveness of water demand management approaches, very few countries in the region practice it at a meaningful scale. At a March 1999 water demand management meeting, water managers from across the region cited the lack of political will as the single biggest obstacle preventing widespread application of water demand management in Southern Africa today. Creating the political will to change this state of affairs will require an informed public that is willing to be outspoken in pressing for water demand management as an integral component in planning for water supply in coming years.

Part of the problem is that the region's biggest water user is powerful big agriculture. Farming in Southern Africa consumes more water than any other sector by a wide margin: 80 percent in Mozambique and Zimbabwe, 66 percent in Namibia and 50 percent in Botswana and South Africa. By contrast, the domestic and industrial sectors typically account for less than 15 percent each. Irrigation losses are often quite significant and it is estimated that less than half of water abstracted from water resources is wasted. If South African irrigators, for example, could improve efficiency by only 20 percent, water available for urban or industrial use would be doubled. Clearly, tremendous gains stand to be made through water conservation applied to the agricultural sector, and yet no country in the region widely promotes efficient water use in agriculture.

Steve Rothert

any of the following: price increases as the quantity used increases; seasonal rates; excess-use surcharges to reduce peak demands during dry months; rates based upon the long-run marginal cost or the cost of adding the next unit of capacity to the system.

▲ Develop efficiency standards for water-using appliances and irrigation devices, and for new industrial and commercial processes.

To reduce water wastage in individual households:

▲ Conduct water survey to check for leaks, water-wasting appliances and irrigation practices.

▲ Develop strategies to offer financial incentives for high-efficiency washing machines and other high-water-use appliances.

▲ Develop strategies to distribute or directly install low-flow showerheads, toilets or toilet displacement devices, and faucet aerators.

▲ Require swimming pool and spa covers to reduce evaporation. Namibia has studied this problem and found that each pool in Windhoek loses about 40 cubic metres of water per year. Plastic covers are now required, and have reduced this loss by up to 95 percent.

▲ Refit existing hydroelectric and thermal power generating equipment with more efficient power generators and turbines.

▲ Install rainwater roof-collectors.

▲ Promote water-wise gardening techniques.

To reduce water wastage for large landscape water users (parks, sports fields, large hotels)

▲ Offer conservation programmes, staff training and incentive programmes. May include landscape water use surveys, voluntary water use budgets, installation of dedicated landscape meters, training in irrigation system maintenance and irrigation system design; financial incentives to improve irrigation system efficiency (loans, rebates, and grants for water efficient irrigation systems).

▲ Prohibit water waste, such as non-recirculating systems in all new commercial laundry systems.

▲ For new landscaping, provide information on climate-appropriate landscape design, efficient irrigation equipment and management to customers.

▲ Install climate-appropriate water efficient landscaping at water agency facilities.

Industrial Water Conservation

Industry is, generally speaking, water-intensive. According to South Africa's Department of Water Affairs, a factory can use 450,000 litres of water to produce a small car, 130 litres to produce a bicycle, and 53 litres to make a pair of shoes. Coal mining in Mozambique has been estimated to use up to 1 cubic

meter per second in the mining and washing process. Although water use for the industrial sector is relatively low in Africa (for example, it is under 8% in South Africa), there is still much room for improvement. In some parts of the world, certain water-intensive industries have greatly reduced the amount of water needed for production, including chemicals, iron and steel, and paper. In some countries these industries are both reusing and recycling water in current production processes and redesigning production to require less water. For example, in the US, industrial water use dropped by over one-third between 1950 and 1990, while industrial output nearly quadrupled. In the former West Germany the total amount of water used in industry today is the same as in 1975, while industrial output has risen

by nearly 45 percent. In Sweden, strict pollution-control measures have cut water use in half in the pulp and paper industry, while production has doubled in little more than a decade.

Progress has been slow in developing countries, however. In China, for instance, the amount of water needed to produce a ton of steel ranges from 23 to 56 cubic metres, whereas in the US, Japan and Germany, the average is less than 6 cubic metres. Similarly, a ton of paper produced in China requires around 450 cubic metres of water, twice as much as used in European countries. China now faces severe, chronic water shortages in many of its largest watersheds. China's Yellow River, one of its largest rivers, is now consid-

ered to be ephemeral because it is so over-allocated. China also has more than 100 cities that are sinking dangerously due to excessive extraction of groundwater.

Modified Agricultural Practises

Since agriculture accounts for nearly 70 percent of the world's fresh water withdrawn from rivers, lakes, and underground aquifers for human use, the greatest potential for conservation lies with increasing irrigation efficiency. By reducing irrigation



by 10 percent, we could double the amount available for domestic water worldwide. This can be done by converting to water-conserving irrigation systems; taking the poorest and steepest lands out of production; switching to less-thirsty crops (which may

require changes to government subsidies for certain crops); implementing proper agricultural land drainage and soil management practices, and reducing fertilizer and pesticide use.

Typically, governments provide water to large commercial farmers at greatly subsidized rates, decreasing the need for con-



A toilet with even a tiny leak can waste 75,700 litres of water a year. A tap leaking 50 drops a minute adds up to 1,838 litres a year. And uncovered swimming pools lose up to 1,000 litres per week to evaporation.



servation and promoting wasteful practices. This has led to widespread use of wasteful irrigation systems. Studies show that just 35-50 percent of water withdrawn for irrigated agriculture actually reaches the crops. Most soaks into the ground through unlined canals, leaks out of pipes, or evaporates before reaching fields. Although some of the water lost in inefficient irrigation systems returns to streams or aquifers where it can be tapped again, water quality is invariably degraded by pesticides, fertilizers and salts. This is in fact another way that commercial agriculture “uses” water: by polluting it so that it is no longer safe to drink. In areas where commercial agriculture is prevalent, runoff from farms has poisoned water supply with dangerous levels of toxics.

Poorly planned and poorly built irrigation systems not only harm water quality, but can also irreparably harm the crop-growing capability of the land through salinization. Especially in arid areas, salts that occur naturally accumulate in irrigated soils. Poorly drained irrigation water can pollute water supply, and raise the groundwater table until it reaches the root zone, waterlogging and drowning crops. Globally, some 80 million hectares of farmland have been degraded by a combination of salinization and waterlogging.

Switching to conserving irrigation systems has the biggest potential to save water used for agriculture (experts say drip irrigation could potentially save 40-60 percent of water now used for agriculture). The most common water-conserving irrigation systems are some form of drip irrigation (also called micro-irrigation). Conventional sprinklers spray water over crops, not only irrigating more land than is needed to grow the crop but also losing much to evaporation. Drip irrigation, however, supplies water directly to the crop’s root system in small doses, where it can be used by the plant’s roots. Water is delivered through emitters that drip water at each plant, or perforated piping, installed on the surface or below ground. This keeps evaporation losses low, at an efficiency rate of 95 percent.

Although by 1991 some 1.6 million hectares were using drip irrigation worldwide, this is still less than one percent of all irrigated land worldwide. Some countries have made drip irrigation a serious national priority, such as Israel, which uses drip irrigation on 50 percent of its total irrigated area. But clearly it is the exception, and most dry countries have a long way to go.

Another promising irrigation system, called low-energy precision application (LEPA), offers substantial improvements over conventional spray sprinkler systems. The LEPA method delivers water to the crops from drop tubes that extend from the sprinkler’s arm. When applied together with appropriate water-saving farming techniques, this method also can achieve efficiencies as high as 95 percent, according to the report *Solutions for a Water-Short World*, published by the Johns Hopkins Population Information Programme (US). Since this method operates at low pressure, energy costs also drop by 20 to 50 percent compared with conventional systems. Farmers in the US state of Texas who have retrofitted conventional sprinkler systems with LEPA have

reported that their yields have increased by as much as 20 percent and that their investment costs have been recouped within one or two years, the report states.

Another growing practice is to reuse urban wastewater on nearby farms growing vegetables and fruits (more on this starting on p. 41). Today, at least half a million hectares in 15 countries are being irrigated with treated urban wastewater, often referred to as “brown water.” Israel has the most ambitious brown-water programme of any country. Most of Israel’s sewage is purified and reused to irrigate 20,000 hectares of farm land. One-third of the vegetables grown in Asmara, Eritrea, are irrigated with treated urban wastewater. In Lusaka, Zambia, one of the city’s biggest informal settlements irrigates its vegetable crops with sewage water from nearby settling ponds.

Traditional Water Harvesting

Southern Africa has a rich tradition in small-holder farming. Water consumption in such systems is usually sustainable. Such systems may include rain- and groundwater harvesting, micro-dams, shallow wells, low-cost pumps, and moisture-conserving agricultural practices. Careful consideration of traditional water-saving techniques combined with effective modern methods may help to balance the needs of dryland agriculture and help to meet the developing world’s water demand.



Up until recently, many of these traditional irrigation methods were excluded from official irrigation programmes in Southern Africa, such as UN Food and Agricultural programmes. According to water expert Sandra Postel, although they are now getting greater recognition, Africa’s small-scale irrigation methods are rarely offered the investment credits, extension services and other forms of support given to large public irrigation schemes. “As a result, small-scale irrigation’s potential in Africa remains constrained and underdeveloped, and food production remains less secure,” Postel writes in *Last Oasis* (see Resources).

Runoff agriculture has been used in regions where the average yearly rainfall is 100mm or less. During high rainfall, rainwater is collected and diverted into storage tanks and used throughout the dry season.

The Sonjo of Tanzania divert water with small brushwood dams, up to three metres high, to irrigate the slopes of Mount Kilimanjaro. Small dams of this type are easily destroyed by floods, a feature which can enhance the sustainability of the overall system as the floods then wash away most of the sediments behind the dams. Unlike large dams, brushwood dams still permit water to flow through, thereby decreasing ecological damage downstream. Because the dams are built with local materials and labour, rebuilding them is usually not a major expense.

Another traditional method involves placing long lines of stones along the contours of gently sloping ground to slow runoff and spread the water across a wider area. Developed in the Yatenga region of Burkina Faso, this method is now being used on over 8,000 hectares in 400 villages throughout the country. It is also used in Kenya and Niger. This practice has increased crop production by about 50 percent, according to *Solutions for a Water-Short World*.

Dambo farming in Zimbabwe is a classic example of the sustainable uses of a natural water resource. Dambos are small (usually less than half a hectare), seasonally waterlogged valleys at the head of a drainage basin where water makes its way to larger channels. Water collected from the runoff of higher ground and channels support the many gardens growing in these valleys. Dambos can maintain water during prolonged droughts, and have been the only farms to produce maize during some droughts.

Permaculture

A more comprehensive approach to reducing all agricultural inputs, from water to fertilizer, is to adopt the lessons of permaculture. This is a sustainable agricultural system based on observing natural systems and working with, rather than against, nature. It integrates animal husbandry, energy-efficiency, and water harvesting and conservation techniques. It emphasizes growing a variety of crops which offer different benefits and soil management. Plants and animals are grown for their fertilizer or because they produce natural pesticides; plant and animal waste is composted and put back in the soil. Pests such as snails are “harvested” to feed livestock such as ducks and geese, and the land is contoured to catch rainwater and mulched to reduce evaporation. Multipurpose use of the land helps makes the system stronger against floods, fires, and pests.

Permaculture’s particular practices can vary from place to place, based on observation on what works for that climate, soil and cultural setting. Some traditional farmers in Africa practice their own version of what is now known as permaculture. The modern system of permaculture has been practised in Botswana, South Africa and Lesotho.



In contrast to large-scale irrigation schemes in Africa, small-scale irrigation has had largely positive experiences and this offers considerable untapped potential for expansion involving both public and private investment. The difficulty is... that few governments have been willing to forego investment in large-scale schemes simply because they are inefficient. Large-scale systems are more amenable to central government control and, therefore for attractive to the entrenched urban bureaucracies of many African states.

GEOFFREY STILES, “DEMAND-SIDE MANAGEMENT, CONSERVATION AND EFFICIENCY IN THE USE OF AFRICA’S WATER RESOURCES”



NEW SOURCES FOR WATER AND ENERGY

Although demand management should always be examined first when additional power or water is needed, conservation will not always preclude the need for new sources of supply. There are many sustainable ways to get power or water which cause less damage to ecosystems and communities than the large-scale infrastructure projects currently in favor with planners. Not all options can truly serve as “alternatives” to large infrastructure projects because their capacity is substantially smaller. Large-scale projects are not always the most appropriate option, however – but this needs to be evaluated in the context of nationwide and regional planning for energy development and catchment management. In addition, some of the systems described below already have or are

beginning to have large-scale application – wind power, for example. Here are some ideas worth exploring.

Water

Groundwater Replenishment

Groundwater currently makes up a large part of the water supply of many Southern African countries. While some countries appear to have plentiful groundwater resources, others recognize that in some cases their water supply aquifers are being rapidly depleted. Because of the region’s erratic rainfall pattern, it is not uncommon for water managers to temporarily over-extract water from certain aquifers to make it through dry periods, and allow aquifers to recharge during wetter years. But longterm over-pumping of groundwater can cause the water table to drop (up to hundreds of metres), or allow salty water to be move into the water table, making it unpotable or causing land subsidence. Usually aquifers will recover if allowed to rest and recharge, but they can compress when water is removed and never regain their previous storage capacity.

Namibia has been studying the possibility of using aquifers as underground reservoirs to stretch existing surface supplies. By artificially injecting certain aquifers with purified surface water to be extracted later, the Windhoek municipality hopes to reduce the amount of water lost each year to evaporation. The city estimates that it could save more than 10 percent of its water supply using this method.

In India, two-thirds of the villages in Gujarat now have no permanent, reliable source of water, mainly because of the over-exploitation of groundwater. To help solve the problem, villagers are building small earthen impoundments across seasonal streams to create a small pond during the monsoon, which is used to recharge groundwater supplies. After the monsoon, the pond gradually recedes. The impoundments are only used to restore the groundwater, and are never tapped directly for water supply. The technology is very simple, relatively cheap to build, and easy to maintain. A government-funded group helps villagers design and pay for the impoundments. Villagers are responsible for building and maintaining their impoundments, and about 20 percent of the building costs. One Indian engineer believes such projects could ultimately collect up to 50 percent of the water that falls on the state.

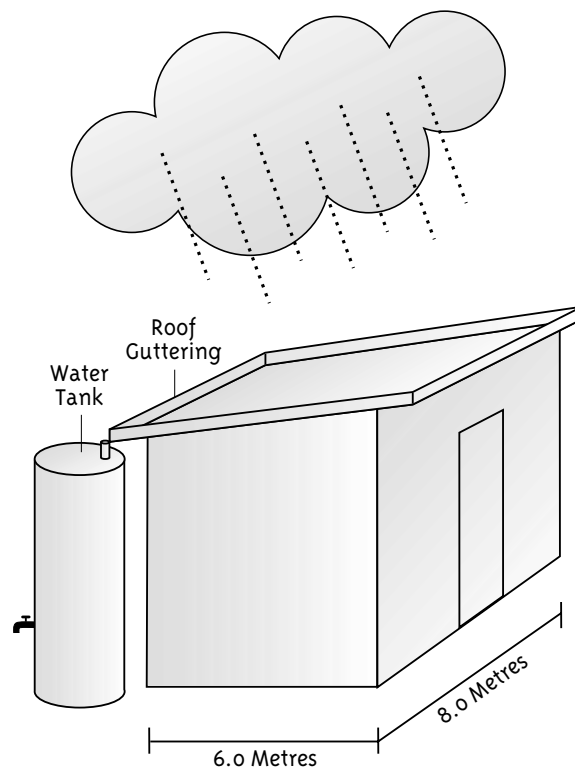
Groundwater dams provide another way to replenish groundwater. These are underground water barriers which trap groundwater in a certain area and prevent it from flowing away underground. In some areas the groundwater table has fallen so dramatically that even a good rainfall will not raise the water table. By collecting rainwater in these underground reservoirs, the water table in some places has risen from a depth of 200 feet to 20 feet. People in India's deserts have been using this kind of technology for centuries, and now this practice has been introduced to the hillsides as well. The head of one village stated, "Dried wells now hold water round the year."

Rainwater Harvesting

In Africa and elsewhere around the world, more communities are returning to small-scale water harvesting, often using a system that collects water from house rooftops. A January 19, 1999 article in the Ethiopian newspaper *The Monitor* describes a successful roof water harvesting programme begun by the Ministry of Agriculture with help from the Swedish International Development Agency (SIDA) and a local NGO called Water Action. "This new introduction can enable households to save water that they can use for drinking purposes for up to five months, and with an average size reservoir. Such households might even have some extra water to spare for garden plants." The only issue for most Ethiopians, the article notes, is the cost. The water tank, water conduit system and gutter cost more than most farmers can afford. It is hoped that the programme will get wider usage with the help of subsidies through international aid agencies, and research efforts to bring down the cost of the materials.

A South African group, Association for Water and Rural Development (AWARD – see Contacts), has created an information sheet on how to collect water from the roof of a house, school or other building. The group calculates that for every 30mm of rain falling, a house with a 50-square-metre roof designed to funnel it into a water tank could collect 1200 litres. AWARD estimates that this could save a person 16 trips to the local water-collection source. The group estimates tank costs at anywhere from

Catching Rainwater



This roof can catch 1200 litres for every 30mm of rainfall.

R180 for a 2500 litre concrete block tank to R1000 for a 4500 litre steel tank purchased from a manufacturer.

Desalination

Some 70 percent of the earth's surface is water, but most of that is undrinkable seawater. By volume, only 3 percent of all water on earth is fresh water, and only about 1 percent is easily accessible surface freshwater. Water desalination is a process used to remove salt and other dissolved solids from brackish or salt water to create fresh water.

Desalination is an attractive water source for many reasons, especially because the supply is virtually limitless and unaffected by drought. For coastal countries, desalted water is not vulnerable to political changes, unlike water supply from shared rivers. For landlocked countries, piping water from the coast involves additional costs and cooperation. Desalting technologies can be built in stages to meet demand, unlike most large-scale water infrastructure projects. Desalination projects also do not lead to the displacement of indigenous peoples, changed agricultural lifestyles or serious ecological impacts.

Desalting processes are mainly used to convert salty water into drinkable water. It is also used to clean up agricultural drainage and industrial waste water contaminated with


nitrate, pesticides and organic matter; to improve the quality of drinking water that is high in dissolved minerals; for municipal waste water treatment; and to improve taste, odor and color of drinking water.

In most cases, desalted water is not the sole source of a community's water supply – though this may change as the cost of desalted water goes down (and especially for coastal areas that are very short of water). It is usually combined with water from less expensive sources. In 1991, desalting plants in approximately 120 countries worldwide had the capacity to produce 15.54 billion litres a day. In many areas of the Caribbean, North Africa and the Middle East, desalted water is used as the main source of municipal supply. At this time, Saudi Arabia ranks first in total capacity with about 24 percent of the world's capacity.

The most common concerns about desalination are that the process is too expensive and consumes too much energy. In some places, desalinated water costs many times more than conventional local water sources (on Namibia's dry northern coast, for example, water from a new desalination plant is expected to cost 35 percent more than local groundwater). However, technical breakthroughs are beginning to lower the price (although still not to the artificially low levels that the agriculture industry is used to paying for water). Cost comparisons for desalted water are often made to existing water supplies, which generally did not include a full, fair cost-benefit analysis when they were developed. To be fair, comparisons should be made to the cost of developing other new sources (and all costs should be included in the analysis, such as environmental and social costs). Given that scenario, desalting may be found to be financially and environmentally competitive with building dams, aqueducts and other new water infrastructure.

The amount of salt to be removed greatly affects the cost of desalting, as does the method used to remove salts. The more salts to be removed, the more expensive the desalting process. The capacity of the desalting plant also impacts costs, with larger plants generally being more economical. The most significant factor in desalinated water is energy. Energy for most current technologies amounts to about 30-40 percent of the total cost. Other factors include the amount and type of treatment required, treatment process selected, disposal of the removed salts (concentrate), regulatory issues, land costs and conveyance of the water to and from the plant.

There have also been recent breakthroughs that are expected to reduce the costs for desalination, primarily by cutting back how much energy is required. For example, in 1998 the



"We try to farm in a way that we do not eat from our children's plates. Our farming systems have developed over many years to best suit our lands and our communities' needs. The keeping of cattle and ploughing of crops are two inseparable aspects of our farming. In the Tswana language we say "cattle and crops are like husband and wife. They need each other, they are mutually beneficial on the farm."

**STATEMENT BY WESTERN
TRANSVAAL COMMUNITIES, SOUTH
AFRICA, 1983 (FROM NEW GROUND)**

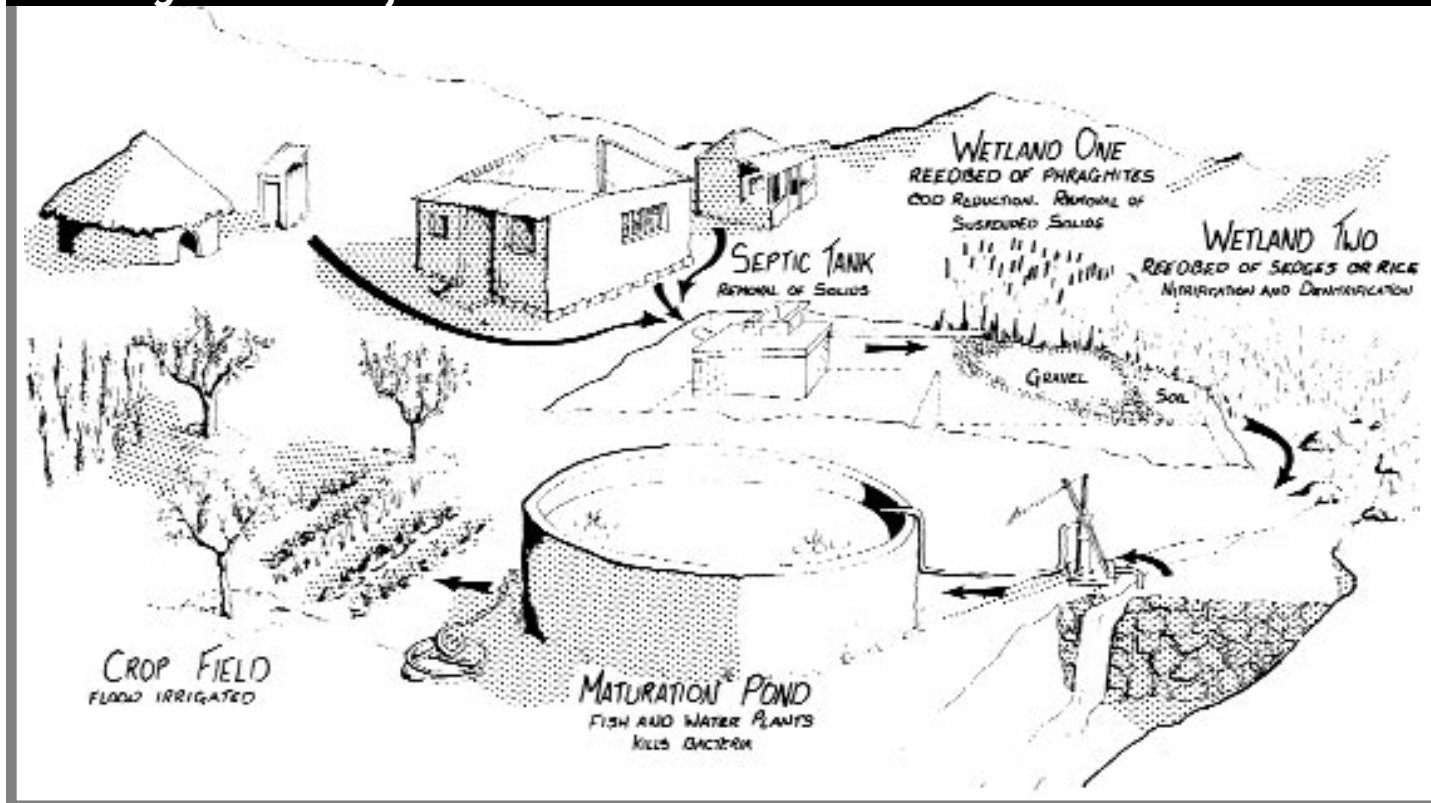


Singapore-based company AquaGen International announced that it has developed a cheaper, portable water desalination plant that can be assembled anywhere quickly. AquaGen International chief Gavin Liao said the modular system of its plant makes installation easy. The unit can produce 100 cubic metres (25,000 gallons) of water for less than US\$300,000. Liao said AquaGen sells two types of desalination plants – one that uses steam and the other with electricity to generate the heat needed to extract the salt. The company says that both types are up to three times more energy efficient than those now in use. The plants are relatively small, producing up to 5,000 cubic metres of drinking water per day compared to up to 327,000 cubic metres/day for the big plants in the Middle East. AquaGen is doing a feasibility study for a large-scale plant that can process 45,000 cubic metres and hoped would be operational in four years.

Israeli, Palestinian and US scientists are embarking on an ambitious desalination programme that is intended to create a "New Desalinated Middle East," according to one of the scientists working on the project. One of the programme's goals is to build solar-powered desalination machines that can fit on a truck, then teach villagers to use them and even make them. The programme will also look at how water is affected by salt and pollutants. According to *World Water & Environmental Engineering* (January 1999), it began work in July 1998, in conjunction with the US Department of Energy and US Environmental Protection Agency. A larger solar-powered desalination unit is undergoing testing now. The fully self-supporting desalination system was being evaluated in early 1999 by Al-Azhar University in Gaza, Palestine, and the Japanese company Ebara. The system can desalinate up to 600 litres of brackish water a day. The system is being designed with irrigation in mind, and the company plans to develop micro-irrigation systems in parallel. The company also plans to develop larger-scale units, although the advantage of the smaller scale one is its portability and ease of installation. The units require little maintenance, as they have few moving parts.

New developments in alternative energy may prove to be a boost for desalination as well. Solar thermal power and fuel cells (both of which are described in this section) may provide good sources of power for desalination plants. Since places with good solar power potential are usually the places most in need of water, there is a huge potential to link the two.

Making the Most of Wastewater



Graphic: New Ground (South Africa)

Recycling Wastewater

A largely untapped source of water for irrigation and groundwater recharge is treated municipal wastewater. Recycling a “waste” product into a reliable water supply has huge benefits. Recycling wastewater makes use of the nutrients in sewage to feed crops and keeps them from polluting waterways. It postpones the need to enlarge and update costly new sewage discharge systems, and eliminates the problems from discharging wastewater into rivers and oceans. It protects freshwater ecosystems by reducing the amount of water extracted from rivers and lakes. Recycled wastewater can also be used to help restore aquatic ecosystems harmed from over-extraction. Using recycled wastewater instead of importing water from hundreds of kilometres away can also result in significant energy savings.

Israel has the most advanced system of wastewater recycling. Currently, 70 percent of sewage is treated and used for irrigation. Officials predict that by 2010, one-fifth of the nation’s total water supply will come from recycled wastewater. Israel uses many different treatment schemes for its many water-reuse projects. One method relies on algae-activated organisms to treat the wastewater. The wastewater is initially stored in a series of ponds in which the anaerobic and aerobic treatment is sufficient to irrigate crops.

Calcutta, India, channels much of its raw sewage into a system of natural lagoons, where fish are raised. The city’s 3,000 hectares of lagoons produce about 6,000 metric tons of fish a year for urban consumers. The fish are safe to eat because the

complex biological interactions in the lagoons remove harmful pathogens from the sewage.

The municipality of Grahamstown, South Africa has built demonstration ponding systems to treat wastewater using bacteria and other microorganisms, according to *On Track* (May-June 1995). Algae produced in these ponds provide a rich feed for a range of livestock (see graphic, page 39.)

As the technology to treat wastewater has improved, so have the applications for the use of the water. A small but growing number of cities are beginning to use highly treated wastewater to supplement drinking water supplies. Windhoek, Namibia, for example, was the first city in Southern Africa to use recycled wastewater in its public supply and has been doing so for more than 15 years.

Highly treated wastewater cannot be piped directly into a water supply. Most commonly, wastewater is used to augment the drinking-water supply by adding it first to a lake, reservoir, or underground aquifer. The mixture of natural and reclaimed water is then subjected to normal water treatment before it is distributed as drinking water for the community.

A 1998 report by the US-based National Research Council notes that governments and water managers must not take shortcuts in planning to use wastewater. Before deciding to add reclaimed wastewater to urban water supplies, they must first fully assess health impacts from likely contaminants and develop comprehensive systems for monitoring, testing, and treatment. Reclaimed water may contain sources of contamination

that cannot be determined through current testing or treatment processes.

There is also much water to be gained by reducing that used for sewage treatment. Treating waste is a hugely water-intensive process, and the commonly used systems cannot be sustainably expanded to serve the three billion people now without access to sewage treatment. Natural water treatment systems such as using wetlands often can be an alternative to modern water treatment technologies. Recycling waste for agricultural purposes by using oxidation ponds and aerated lagoons does not require as much land as is often assumed; however, the land requirement of oxidation ponds is a stumbling block for their use – particularly in urban areas. Moreover, it decreases pollution, reduces the need for fertilizers, and often can be accomplished with small-scale, low-cost technology that is based on local traditions, is decentralized and ecologically sound.

New Energy Generation

Solar

Solar power is now the world's second fastest-growing energy source, increasing on average 16 percent per year since 1990. Each year the earth's surface receives about 10 times as much energy from sunlight as is contained in all the known reserves of coal, oil, natural gas and uranium combined, according to *Scientific American* magazine. Using just 1 percent of the earth's deserts to produce solar energy would provide more energy than is currently being produced worldwide by fossil fuels, say industry analysts. While solar has its limitations, it is especially appropriate for off-grid applications, where most of the world's 330 million families (2 billion people) without power live. Still, production of PV units (not to mention the money to purchase them) lags behind need. Mark Hankins of Energy Alternatives Africa (see Contacts) calculates that to supply each of the world's off-grid families with 20 watts of power (enough for a couple of lights and a radio for 4 hours a night) would require 6,600 megawatts of power – or 66 times the current annual production.

There are a number of ways to convert energy from the sun. The two most common are photovoltaic cells (PV), and solar thermal. Solar thermal has more potential as a large-scale energy source, while PVs are excellent for powering buildings off the energy grid.

PVs work by converting the sun's light energy into direct-current electricity. PVs have no moving parts and use no fuel. The price for PVs have dropped more than 100 fold in the past 25 years, as their use has grown. Already, new technologies are lowering the cost of manufacturing solar cells. Scientists believe

that such technologies can cut solar cell costs from \$4,000 per kilowatt in 1998 to \$1,000 in the next decade, which would make them a competitive source of electricity in many parts of the world.

PVs have many advantages:

- ▲ There is no cost for the energy, only the equipment.
- ▲ It is clean, silent, and requires very little maintenance.
- ▲ Local people can be trained to install and repair PV systems, providing a source of employment as well as reducing reliance on the government for grid electricity. Kenya has a thriving PV industry, and more households now get their electricity from

solar systems than from the national grid and local people are trained in installing and maintaining solar units.

According to the WorldWatch Institute, approximately 500,000 homes around the world are now generating their own power with PVs. For the more than 2 billion people not connected to a grid, solar power could be the most affordable way to get energy.

Botswana, Namibia, South Africa and other countries in the region have incentive programmes to install PV systems in rural areas at low cost. In Namibia, for example, the Solar Home System project has trained more than 100 technicians who install and maintain solar systems. And in Botswana, the National PV Rural Electrification Programme's goals are "to raise the standing of PV lighting systems as a renewable energy source, enhance the reputation of the local PV companies, and to assist

rural people in finding financing for these systems." The programme, begun in 1997, offers loans at good terms for rural villages wishing to have PV systems installed; it keeps costs down by requiring villagers to form groups of interested parties. Botswana's capital, Gaborone, has cut electricity demand by 5 percent by installing 3,000 solar water heaters. The government of South Africa has pledged to electrify more than 2.5 million households with solar by the turn of the century.

In April 1999, then-President Nelson Mandela launched a huge rural-electrification programme in the Eastern Cape of South Africa. The Powerhouse programme, a joint venture between Eskom and Shell Renewables, will bring solar panels to 500,000 homes in 50,000 rural communities. Households will not be required to purchase or maintain solar equipment, which can be unaffordable to many rural dwellers without subsidies, but instead will pay R150 to have the system installed and R47 a month for the use and maintenance of the PV. Locally owned outlets will cover installation and maintenance of the systems. The system was designed to prevent theft.

In the US and elsewhere, some utilities have set up "net metering" systems, which allow grid-connected homeowners who have installed solar systems to feed solar energy back into the grid sys-



A one-kilowatt PV system:

- ▲ prevents 150 lbs. of coal from being mined,
- ▲ prevents 300 lbs. of CO₂ from entering the atmosphere,
- ▲ keeps 398 litres of water from being consumed each month!

SOLAR ENERGY INTERNATIONAL



tem. Feeding in their own solar power makes the homeowner's electricity meter run backwards, thereby reducing the household's energy bill accordingly. At the end of the month, if the consumer has used more energy than their solar system generated, they owe the utility the difference; if they generated more electricity than they used, the utility owes them. No special metering equipment is required. This system encourages the installation of solar systems because homeowners get advantages even if they are not home to use the power they are generating. Currently, 20 states in the United States have such programmes.

Larger scale solar power systems can be used to replace a utility's outdated or highly polluting energy plants. Solar thermal systems generate heat by using lenses and reflectors to concentrate the sun's energy. Because the heat can be stored, these plants can provide power around the clock. Prototypes have been developed that can provide large-scale power generation. A US programme, ReCast, is working to create "Solar enterprise zones" to encourage this kind of technology around the world. The group says that these plants should be producing 700 megawatts by the year 2003, and 5,000 MW by 2010. As the volume in this technology increases, prices will go down. Solar thermal is already being explored in South Africa and Namibia.

Wind Power

Wind power is in the short term one of the most promising renewable energy sources. Technological advances have caused the price of wind power in favourable locations to drop dramatically. According to the American Wind Energy Association, the global wind-energy industry set a record for new installed generating capacity in 1997. The rate of growth appeared likely to maintain wind's position as one of the world's fastest growing energy sources. Although wind power cannot produce power 100 percent of the time and therefore cannot be relied upon for all of a country's power (just as hydropower cannot, due to droughts), it could provide a much greater proportion of energy production in places with good winds.



If wind power is to become a major electricity producer, wind farms must be developed in such a way that they benefit the communities in which they are installed. Denmark is perhaps one of the best examples of this. It began its wind power programme from the 'bottom up', and Danish communities were made shareholders in windfarm co-ops. Denmark now leads the world in its wind power capabilities.

Egypt is in the pilot stage of a programme whose goal is for the nation to become Africa's Number 1 wind-power generator. Egypt's Red Sea coastline is one of the world's best sites for wind power potential. In places, winds average 23 miles per hour for 95 percent of the year (the biggest wind power farms in Europe and the US average 16 mph winds). The 43 percent greater wind speed found in Egypt delivers almost 300 percent as much

power. The power from these excellent winds is also cheap: at one new site, windmills are expected to generate power at a cost of 4 cents per kilowatt hour, or one-third the average cost in Germany. Wind farms are being built in a 32-square-mile area of desert set aside by the government near Zafarana. By the end of the year 2000, the farms should be generating 90 megawatts (enough to power a town of 15,000). Egypt's renewable energy authority hopes the farms will generate 600 megawatts by 2005, which is about three percent of the country's current needs.

Fuel Cells

A fuel cell produces energy electrochemically, without combustion, by harnessing the reaction of hydrogen and oxygen to produce electricity, water and heat – and almost no pollution. A fuel cell works like a battery but, unlike a battery, it does not run down or require recharging. It will produce energy as long as fuel is supplied. Natural gas or other fuels can be used if the fuel cell has a reformer to convert the fuel to hydrogen. Fuel cells are a very efficient form of energy production. And the good news for dry regions like Southern Africa is that, unlike high-pressure steam turbines and other power-production technologies, fuel cells consume very little water.

Fuel cells can be used to power vehicles, individual buildings and large-scale utilities. They offer a very decentralized form of power production, since they can be put to use as needed at individual buildings or at local power plants, making long-range transmission wires unnecessary. The technology has the potential to have a big impact in reducing worldwide greenhouse emissions: for example, 10,000 fuel-cell vehicles running on non-petroleum fuel would reduce oil consumption by 6.98 million gallons per year. Fuel-cell cars are expected to be widely available by 2003 or even sooner. Fuel cell automobiles offer the advantages of battery-powered (electric) vehicles but can be refueled more quickly and go longer between refuelings. A recent study by General Motors noted that fuel cell car engines could be built for about the same price as an internal combustion engine.

Fuel cells can also be used to take advantage of methane and carbon dioxide emissions produced by wastewater treatment facilities. The US has a number of fuel cell installations at wastewater treatment plants, which not only produce electric power and heat for the community but also eliminate the pollution produced as a by-product of wastewater treatment.

Fuel cells can promote energy diversity and a transition to renewable energy sources. A variety of fuels – hydrogen, methanol, ethanol, natural gas, and liquefied petroleum gas – can be used. Energy also could be supplied by biomass, wind and solar energy.

Small-scale Hydropower

In some areas, small-scale hydropower schemes may be the most appropriate energy source. When carefully planned and implemented, small dams (under 10 megawatts) can be less

Eco-Housing for South Africa's Poor

The International Institute for Energy Conservation - Africa (IIEC-Africa) is working with a network of South African organisations to support the new policy direction of the Department of Housing, as well as contribute to more sound energy practices in the country. IIEC is an international NGO founded in 1984 to promote sustainable energy policies, technologies and practices in the world's developing economies. IIEC has offices in Johannesburg (since 1996), Bangkok, London, and Washington. IIEC's experience has shown that through conserving energy, countries can meet rising demand for energy services at a much lower cost, allowing them to concentrate resources on other development priorities such as education and health-care.

IIEC-Africa's work centers around partnerships and projects in renewable energy, low-cost sustainable housing, greenhouse gas mitigation and sustainable transport. The group runs two housing projects: Eco Home Advisors, and the Sustainable Homes Initiative.

Changing the face of South Africa's housing sector requires good examples, and that is the motivation behind the Eco-Home Advisors programme. The programme promotes passive-solar, energy efficient housing and smart water- and waste-management. Water conservation measures include low-flow showerheads and dual flush toilets, as well as the use of grey-water for gardens. The advisors also encourage community greening practices to promote food security and community beautification through gardening and tree planting.

The Eco Home Advisors programme trains housing delivery groups in environmentally sound construction principles. Following training, advisors selected by the local partner organisations work to realise change within their housing delivery area. IIEC-Africa is working through its partner organisations, such as Afesis-corplan in East London and Development Focus in Pietersburg, to bring Eco-Homes to people in five provinces. The Eco-home pilot projects being conducted by these partner organisations will serve as provincial 'best practice' demonstration sites, and thereby spur replication. IIEC-Africa hopes to have at least one advisor in all nine provinces by early 2000.

Like the Advisor's programme, the Sustainable Homes Initiative (*Sihlangene ngezeZindlu*) promotes environmentally sound housing among the historically disadvantaged communities of South Africa. This three-year programme

incorporates a range of support, training, outreach and networking functions to bring about a change in the building, finance, training and materials sectors with the objective of tens of thousands of new Eco Homes. Building off the pioneering work of groups like the Kutlwanong Civic Integrated Housing Trust, the Nova Foundation, the Thlolego Learning Centre, PEER Africa and Holm Jordaan and Partners, this project promotes healthy and environmentally sound low-cost housing.

IIEC-Africa is also working with the Department of Housing to explore special finance schemes that could be made available to commercial builders who adopt eco-home construction practices. This financing programme will be modelled after 'green finance' incentive programmes in the UK and other countries.

The crown of the Initiative is surely the opportunity for free technical assistance to low-income communities who wish to have Eco-homes built. Called the "Green Professionals Scheme," project resources have been set aside to cover the consulting fees of experts to spend a limited amount of time working on a project to ensure that their housing project incorporates at least the no-cost Eco-home measures.

Better Lighting

The Efficient Lighting Initiative (ELI) is a central component of power utility Eskom's residential demand side management programme. This programme has targeted 8800MW of cost-effective demand savings in the residential sector. Some 2500MW of this will come through energy efficiency, of which the lighting (at 770MW) is the largest single source of savings. IIEC-Africa is assisting Eskom in implementing the ELI. From a national perspective, implementation of the programme reduces the cost of residential lighting, increases security of electricity supply and reduces the environmental impacts from electricity generation. In particular, IIEC-Africa is examining how to stimulate the local manufacture of high-quality compact fluorescent lights, a step that could dramatically lower the cost of these products and thus make them more affordable to home owners. Establishing a local manufacturing facility would also be an ideal avenue for black economic empowerment both in terms of facility ownership and the creation of managerial and manufacturing jobs.

For more information, see Contacts.

harmful to the environment and surrounding communities than large dams. Small projects can also better serve the local economy, and help develop local skills and resources. However, scale alone does not determine whether a project will be socially or environmentally harmful. As with planning any hydro-

power project, small dams should be evaluated individually for their impacts on the catchment and communities, and for their fit in an overall catchment management plan. (See Resources for *Beyond Big Dams*, an IRN report on appropriate hydropower development.)

Geothermal

Geothermal energy is derived from the earth's core. It is the same source from which volcanoes and earthquakes get their energy. In some places, natural hot "reservoirs" below the surface of the earth provide large-scale sources of geothermal power. In 1993, these natural steam sources accounted for 9 percent of Kenya's energy supply, 28 percent of Nicaragua's power and 26 percent of the Philippines, to name a few nations that are making use of their geothermal reserves.

Geothermal reserves are not needed to take advantage of geothermal power on a small scale, however. Any place on earth can take advantage of geothermal heat-pump technology, which capitalizes on the stable temperature below the earth's surface. This uses heat-pump technology to extract heat from the earth in winter for heating buildings and to dissipate heat in summer for cooling. While the temperature of the soil to several feet below the surface varies with the seasons, below that depth the earth's temperature stays about the same year-round. This technology has made significant advances in the past few years. Installation costs have been reduced by 30 percent compared to earlier designs.

Biogas

The use of biological waste to generate energy has been proven to be a practical and economical means of recycling large volumes of organic wastes. Waste from domestic, agricultural, commercial and industrial sources is digested by microorganisms, which produces a mixture of methane and carbon dioxide, which is then turned into energy. Methane is non-toxic, smokeless and flammable. One cubic metre of biogas produces enough fuel to cook three meals for a family of five to six people, running one 60-watt electric light up to seven hours, or running a one-horse-power internal combustion engine for two hours.

Biogas technology has a number of benefits. It can digest human waste and decrease the spread of disease from pathogens in the waste, including organisms that cause infections such as typhoid, Guinea worm, cholera, dysentery, hookworm and bilharzia. While biogas has been widely used in China, Thailand, India and Nepal, it has yet to be encouraged in Southern Africa.

In many developing countries, most organic wastes such as dung and agricultural residue are burned directly for fuel (referred to as "biomass" energy production). The combustion of these wastes often creates air pollution and causes respiratory diseases. According to the World Health Organization (1992), 700 million women in developing countries are at risk for developing serious health problems from the burning of biomass. These problems would be reduced if a portion of these wastes were used in a biogas process.

Ocean Power

Creating energy from ocean waves may never become a major source for power, but it continues to become more economically and technically viable. According to *New Scientist* magazine (May 16, 1998), the average cost of wave power is now 10 times lower than it was in 1982. The magazine reports that three of the six wave-power devices now available can produce power that is economically competitive, and one device produces power that is one-third cheaper than coal in the UK. *New Scientist* reports that the British government is now seriously considering including wave power as part of its goal to reduce carbon emissions by 10 percent by the year 2010.

Another experimental energy source is being researched in the US island of Hawaii, Japan, Bali and elsewhere. The technology uses the difference in temperature between ocean surface water and water up to 1,000 metres deep to create energy.



Glossary

aquifer: A layer of the earth that contains fresh water. It is a significant source of groundwater.

basin irrigation: technique where fields are irrigated by trapping floodwaters behind embankments, small earthen weirs and pits.

biomes: the interaction between water resources, climate, geology, soil types, and geographic coordinates which determine the type of biology with the region can sustain.

brackish water: water with a high dissolved salt content. Can refer to sea water, estuary environments or agricultural wastewater.

catchment: the entire area drained by a river (also called catchment area, basin, drainage basin or watershed). A single large catchment includes many smaller tributaries.

delta: flat area of alluvium formed at the mouth of some rivers where the main stream divides into several distributaries before reaching a sea or lake.

demand management (also known as “demand-side management”): The systematic conservation of water or power resources. Includes a number of changes to the demand side of the equation, including efficiency innovations, the reduction of waste through policy or pricing, retrofitting buildings to conserve energy, fixing leaking water pipes, etc.

desalination: removing the salt from water (especially that from the sea) to create fresh water.

drip irrigation (also known as micro-irrigation): efficient irrigation systems that deliver water directly to the roots of plants, e.g., through perforated or porous pipes.

estuary: semi-enclosed coastal body of water where freshwater from a river mixes with sea water.

evapotranspiration: the loss of water by a combination of evaporation from the soil and transpiration from plants.

floodplain: area of a valley floor that would be under water during a major flood.

greywater: water that has been used for washing dishes, laundering clothes, or bathing. Essentially, any water, other than toilet wastes, draining from a household is greywater. Although this water may contain grease, food particles, hair, and any number of other impurities, it may still be suitable for reuse if properly handled, especially for irrigation.

groundwater: water within the earth that is contained in soils and rocks.

groundwater dams: a sub-surface dam which obstructs the flow of groundwater, storing water within the water table. Also used to recharge aquifers and surrounding wells.

hydrological cycle (also called the water cycle): the natural cycle by which water evaporates from oceans and other water bodies, accumulates as water vapor in clouds, and returns to the land as precipitation. Although water is constantly in circulation, the amount available on the planet is finite.

hydropolitics: the political world of water management and allocation, as determined by those in power. Influences include multinational companies, international development banks and regional political strife in addition to the national political landscape.

indicator species: an animal or plant species whose numbers and presence in a catchment indicate the health of the catchment.

instream flow requirements: in the case of a dammed or diverted river, the water that is allowed to remain in a river to protect fisheries, water quality, navigation or recreational uses.

integrated catchment management: an approach to catchment management that integrates the views and demands of all affected parties, as well as all components of the catchment, e.g. land and aquatic resources.

integrated resource planning (IRP): a public planning process to examine the costs and benefits of both demand- and supply-side resources, to develop the least-total-cost mix of utility resource options. Includes a means to weigh environmental damages caused by new infrastructure and identifying cost-effective alternatives.

interbasin transfer: Water projects that take water from one watershed to another. Sometimes these projects can introduce species from one river to another, thus upsetting ecological balances. Also reduces flow in the river from which the water is taken.

large dam: defined by the dam-building industry as a dam measuring 15 metres or more in height.

megawatt: a unit of power equal to 1000 kilowatts, or enough to power 10,000 100-watt light bulbs.

nonrenewable water: water in aquifers and other natural reservoirs that are not recharged by the hydrological cycle or are recharged so slowly that significant withdrawal for human use causes depletion.

rainwater harvesting: farming technique which conserves water by collecting rainwater run-off behind earth or rock weirs or in small basins.

regulated river: river of which the natural flow pattern is altered by damming.

renewable water: Fresh water that is continuously replenished by the hydrological cycle for withdrawal within reasonable time limits, such as water in rivers, lakes, or reservoirs that fill from precipitation or from runoff. The renewability of a water source depends both on its natural rate of replenishment and the rate at which the water is withdrawn for human use.

riparian: of or relating to the banks of a river or stream. For example, ‘riparian vegetation’.

riverine ecosystem: zone of biological and environmental influence of a river and its floodplain.

river restoration: the practice of repairing ecological damage to riverine ecosystems. Practices may include replanting forests and streamside plants, removing dams, restoring the amount of water for instream flows, restoring natural floodplain functions by removing levees and buildings, and reducing sources of pollution.

run-of-river dam: dam which raises upstream water level but creates only a small reservoir and cannot effectively regulate downstream flows. Although such dams are often thought to have smaller environmental impacts than dams with large reservoirs, run-of-river dams have done serious harm to fisheries in various places.

run-off: rain which drains into a watercourse rather than being absorbed by soil.

run-off farming: dryland farming which maximizes available moisture by directing water running off slopes onto fields below.

salinization: the accumulation of salts in soil to a harmful level. It is caused by the evaporation of water that sits on the soil surface of irrigated fields.

sedimentation: settling of small particles in water. Can reduce the effectiveness of dams.

small dam: a dam measuring less than 15 metres from foundation to crest.

small hydro: usually defined as a hydroplant with an installed capacity of up to 10 megawatts.

sustainable water use: the use of water that supports the ability of human society to endure and flourish into the indefinite future without undermining the integrity of the hydrological cycle or the ecological systems that depend on it.

tributaries: smaller rivers and streams which join the main river in the same watershed.

waste water: water that has been used by industries or households and is unfit for use without treatment; sewage.

water cycle: see hydrological cycle.

water harvesting: various methods of catching rainwater, as an alternative or supplement to tying into local water delivery systems.

waterlogged: the saturation of soil with water.

water scarcity: According to a growing consensus among hydrologists, a country faces water scarcity when its annual supply of renewable freshwater is less than 1,000 cubic metres per person. Such countries can expect to experience chronic and widespread shortages of water that hinder their development.

watershed: see catchment.

water stress: A country faces water stress when its annual supply of renewable freshwater is between 1,000 and 1,700 cubic metres per person. Such countries can expect to experience temporary or limited water shortages.

water table: the surface of groundwater. Can drop if water is used faster than it is replaced, and is therefore one indicator of unsustainable water use patterns.

wetland: area of land which is seasonally or permanently waterlogged. These areas are usually very high in animal life. They also act as “natural filters” by immobilizing pollutants so they cannot contaminate other bodies of water, and help reduce flooding by intercepting large amounts of runoff. The world’s wetlands have been greatly reduced by people trying to create more arable or buildable land.



Resources

The following is a limited list of good publications on river, water and energy issues.

Beyond Big Dams: A New Approach to Energy Sector and Watershed Planning (1997), edited by Juliette Majot. Published by International Rivers Network. This report “sets out to consider a world in which new large-scale hydropower is not a preferred option for electricity generation.” The report describes the world energy situation, current planning processes and why they favor projects like large dams, how to improve energy-planning priorities, and alternatives to large-scale dams. Small-scale hydropower offers a less destructive energy option to meet growing energy demand, though it has its own set of potential problems. The report explores the pros and cons of this approach, in part through valuable case studies from countries that have experience with small-scale hydro, including Norway, Nepal, China, Sri Lanka and Peru. For more information: International Rivers Network, 1847 Berkeley Way, Berkeley, CA 94703; Email: irn@irn.org; web: www.irn.org.

Comprehensive Assessment of the Freshwater Resources of the World (series), produced by the Stockholm Environment Institute. A series of 8 reports on a number of problems in the world’s freshwater resources, including sustainable urban sanitation and water availability, policy issues, gender issues around water, and patterns and problems in freshwater management. For more information: Stockholm Environment Institute, Communications, Box 2142, S-103 14 Stockholm, Sweden. Email: orders@sei.se; Web: www.sei.se/

Dams as Aid: A Political Anatomy of Nordic Development Thinking (1997), edited by Ann Danaiya Usher. Published by Routledge, London, UK. The introduction states, “This collection of essays starts from three premises: that large dams cause serious environmental and social impacts; that public opposition to dams exists in virtually every country where there is the democratic space to express dissent; and that because the negative effects of dams are borne disproportionately by the poor, Western donors face an intractable dilemma when they give dams as aid. This book is about how aid agencies handle that dilemma.” One of its three case studies is on Tanzania’s Pagan Dam.

Last Oasis: Facing Water Scarcity (1992), by Sandra Postel. Part of the Worldwatch Environmental Alert Series. W.W. Norton & Company, New York & London. As the world enters an era of water scarcity, new solutions are needed to avoid water wars. This excellent book examines the ecological, economic and political limits of water, and describes how water use can be cut without reducing economic output or quality of life.

Lifelines of Western Namibia: Ephemeral Rivers and their Catchments (1995). A video about water management issues in one of southern Africa’s driest places. The 40-minute color video reveals how upstream communities threaten the livelihoods and ecosystems of downstream communities by over-pumping aquifers and creating small dams to hold back the seasonal floods. The overall message: “Catchment awareness must be the guiding principal” in the region’s water management, taking into account all users – including the environment. For more information: Doxa Productions, 10 Camp Street, Gardens, South Africa. A book of the same name is available from The Desert Research Foundation of Namibia (see address above).

Watersheds of the World: Ecological Value and Vulnerability (1998), by Janet Abramovitz et al. A joint publication by the World Resources Institute and WorldWatch Institute. Includes detailed watershed maps of southern African river systems, including the Okavango, Limpopo, Jubba, Congo, Lake Chad, Nile, Niger, Okavango, Orange, Volta and others. The maps describe changes to watersheds with statistics about threatened fish species, loss of forest cover, erosion and urban growth, among other things. For more information: WRI Publications, P.O. Box 4852, Hampden Station, Baltimore, MD 21211, USA.

Sharing Water in Southern Africa (1997), by the Desert Research Foundation of Namibia, Windhoek, Namibia. This well-illustrated, thorough book describes the severe water constraints that affect most of the region’s 11 nations and evaluates water-management methods. It also lays out the difficult choices that will need to be made in coming years if the region is to avert a water-management crisis while also addressing growth and economic development in a sustainable way. A valuable resource. For more information: DRFN, P.O. Box 20232, Windhoek, Namibia.

The Status of Freshwater Resources in Namibia (1997) by J.A. Day, and *An Approach to Sustainable Water Management Using Natural Resource Accounts* (1997), by G.M. Lange. Directorate of Environmental Affairs, Ministry of Environment and Tourism, Namibia. Two good official reports on the status of water resources in Namibia. Available from DEA Publications Dept., Directorate of Environmental Affairs, Ministry of Environment and Tourism, Private Bag 133306, Windhoek, Namibia.

Silenced Rivers: The Ecology and Politics of Large Dams (1996) by Patrick McCully. Zed Books, London. This book describes in a clear and concise manner the environmental effects, human consequences, technical failures and elusive benefits of large dams. Includes a critical analysis of the history and politics of dam building worldwide, and the rapid growth of the international anti-dam people's movement. (See *Beyond Big Dams*, above, for address)

Vanishing Waters (1998) by Bryan Davies and Jenny Day. University of Cape Town, South Africa. This book covers the crisis facing inland waters in the dryland regions of southern Africa, from the Zambezi Valley southwards. The book details southern Africa's water-supply crisis, distribution of water, and the misuse and abuse of water through over-engineering for water supply projects and over-abstraction by farming communities and urban populations of the region. Separate chapters cover the ecological functioning, conservation and management of coastal lakes, wetlands, estuaries, reservoirs, and perennial and intermittent rivers, and their distribution, uses and abuses. The book also contains extensive chapters on the many kinds of water pollution and their control, water-borne diseases, invasive organisms, and the ecological impacts of dams and inter-basin water transfers on river ecosystems throughout the region. There is an extensive review of water-supply versus water-demand management, alternate sources of water supply, water-savings devices as well as agricultural, industrial and domestic uses of water in the context of the revolutionary new South African Water Law. Aimed at the interested lay public, teachers, scientists, conservationists, managers and students. For more information: UCT Press: uctpress@hiddingh.uct.ac.za.

Water Audit: How your school can be water-wise (1997), published by Jacana Education and by Department of Water Affairs and Forestry / National Water Conservation Campaign, Cape Town. An good curriculum guide for teachers, to help raise awareness about water wastage in schoolchildren (Std. 4-8). Uses comics and activity sheets to help children perform water audits at their schools and homes. Gives teachers ideas for linking the programme to other parts of the curriculum. One problem: although the booklet is thorough on the need to conserve water, it is very weak on the impacts of dams and water diversions on catchments and rivers. For more information: Jacana Education, PO Box 2004, Houghton 2041, South Africa; Tel: (011) 648.1157. OR Department of Water Affairs National Water Conservation Campaign, Private Bag X9052, Cape Town 8000; Tel: (021) 462.1460.

World Rivers Review, a bimonthly publication by International Rivers Network, reports on major threats to the world's rivers and catchments, the growing movement of dam activists fighting to save their rivers, information about the financial institutions funding bad projects, and feature stories on alternative energy and water projects. A number of issues are available on-line: see www.irn.org. Back issues are available from IRN (see *Beyond Big Dams*, above, for address). Annual subscription is US\$35.

The World's Water 1998-99 The Biennial Report on Freshwater Resources (1998), by Peter Gleick. Island Press, Washington, DC. A thorough, well-documented and fascinating look at a broad range of water issues, from water-borne disease to large dams. Includes a chronology of water conflicts from 1500 to the present; charts showing each nation's percent of population with access to fresh water over time, and freshwater withdrawals by country and sector, and the full text of key new water laws. The Water Briefs section includes updates on scientific discoveries or new technologies pertaining to fresh water. For more information: Island Press, 1718 Connecticut Avenue, Suite 300, Washington, DC 20009; or The Pacific Institute for Studies in Development, Environment & Security; 654 13th Street, Preservation Park, Oakland, CA 94612; Tel: 510.251.1600; Fax: 510.251.2203; Web: www.pacinst.org/pacinst.



Contacts

This includes just a few of the groups in the region working on water, river or energy issues. Please let us know if you know of a group that should be included in future editions of this booklet.

Southern African Nongovernmental Organizations
Alliance to Save Energy-Ghana is working on energy efficiency measures for Ghana.

ASE
P.O. Box C1671, Cantonments
Accra, Ghana

Tel: 233.21.771.507; Fax: 233.21.771.508
Email: energyfn@africaonline.com.gh, OR sganguli@ase.org

Association for Water and Rural Development (AWARD) serves dozens of rural communities in South Africa which must compete for limited water access with large plantations and the Kruger National Park. The group works with communities to help them identify water needs and develop their own committees and initiatives to solve those needs.

AWARD
Private Bag x483
Acornhoek 1360
Republic of South Africa
Tel: 2715.793.3991; Fax: 2715.793.3992; email:
research.award@emg.co.za,

Conservation Wildlife & Environment Society of
South Africa
100 Brand Road
Durban 4001, South Africa
Tel: 27.31.21.3126; Fax: 27.31.21.9525; email:
wlskzn@saol.com

The Desert Research Foundation of Namibia works to further awareness and understanding of arid environments and developing the capacity, skills and knowledge to manage arid environments appropriately.

Desert Research Foundation of Namibia
PO Box 20232
Windhoek, Namibia
Tel: 264.61.229.855, Fax: 264.61.230.172; Email:
drfn@iwwn.com.na, Web:
<http://www.iwwn.com.na/drfn/index.html>

Earthlife Africa is an all-volunteer group with a number of branches in the region. It is a broad-based group with a number of projects it focusses on. Below are some specific branches working on river or water issues.

The group's overall web site: <http://www.earthlife.org.za/>
Earthlife Africa - Johannesburg

P.O. Box 11383
Johannesburg 2000
Tel/fax: 2711.482.9445

Richard Worthington, email: activist2@earthlife.org.za
Earthlife Capetown (working on a regional network for river and water activists):

P.O. Box 176
Observatory 7935
Lisa Foale, email: lfoale@mweb.co.za
Earthlife Namibia (working on the Epupa Dam issue):
Earthlife Namibia
P.O. Box 24892
Windhoek, Namibia
Ulli Eins, email: eins@namib.com

Environmental Justice Networking Forum (EJNF) is a national alliance of 180 South African NGOs who share a common set of values and concerns regarding environmental issues. This network works towards achieving a just and ecologically sustainable social order at provincial, national and international levels.

EJNF
P.O. Box 100029
Scottsville 3209
Pietermaritzburg
South Africa
Tel: 0331.949073; International 27-331-949-073
Fax: 0331 - 455841 - International 27-331-455-841
E-mail: ejnf@wn.apc.org

Environmental Monitoring Group is acting as Southern Africa's liaison to the World Commission on Dams. EMGs primary role which is to assist communities and groups to assert their environmental rights in policy and decision-making and in cases of environmental injustice, and of building bridges between decision-makers and those most affected by their decisions. In addition to their role with the WCD, EMG is also becoming increasingly involved in regional water initiatives and the promotion of alternatives to dam building.

Environmental Monitoring Group
P.O. Box 18977
Wynberg, South Africa
Tel: 27.21.761.0549 / 788.2473 Fax: 2721.762.2238
Contact: Liane Greeff
E-mail: liane@kingsley.co.za

GREEN
P.O. Box 3515
Pietermaritzburg 3200, South Africa
Tel: 27.331.452.045/6; Fax: 27.331.452.044
E-mail: sandile.green@pixie.co.za; Web: www.greensa.co.za

The Group for Environmental Monitoring works to bring together communities affected by environmental policy and policy makers to ensure that people's needs are not ignored. GEM's resource centre has materials on water resource management, water quality, transboundary water issues and water policies.

Group for Environmental Monitoring
P.O. Box 30684
Braamfontein 2017
Johannesburg, South Africa
Tel: 27.11-403-7666
Fax: 27.11-403-7563
Email: gem@gem.org.za; Web:<http://www.oneworld.org/gem/>

The International Institute for Energy Conservation - Africa is working with a network of South African organisations on renewable energy, low-cost sustainable housing, greenhouse gas mitigation and sustainable transport.

IIEC-Africa
62A Fifth Avenue
Melville
Johannesburg 2092
South Africa
Tel: 27.11.482.5990
Fax: 27.11.482.4723
email: iiec@iafrica.com

Okavango Liaison Group is working to bring communities living along the Okavango Delta into the official planning process for the Delta.

Okavango Liaison Group
Private Bag 164
Maun, Botswana
Tel/Fax: 267.662.351
e-mail: noxolo.s@info.bw

The Rennies Wetlands Project works on South African wetlands issues. The project promotes the rehabilitation, wise use and sustainable management of wetlands, and aims to influence political decision makers. The group published Wetland Fix, South Africa's first illustrated set of field guides on the assessment, management and rehabilitation of wetlands. The series contains practical information, mostly in illustrated, step-by-step format.

Rennies Wetlands Project
David Lindley or Gayle Barichiev
Fax: 27.11.486.3369, e-mail wetfix@icon.co.za, web:
<http://psybergate.com/wetfix/home.htm>

Save the Vaal Environment has worked to stop a destructive open-pit mine on the banks of the Vaal River in South Africa. SAVE

Email: save@save.org.za; Web site: www.save.org.za

Sustainable Energy, Environment and Development aims to build capacity on sustainable energy in local authorities and service providers thorough training, information and demonstrations.

Urban SEED, Energy & Development Group
att. Project Manager Sarah Ward
P.O. Box 261
Noordhoek 7985, South Africa.
Ph: 27.21.789.2920, fax: 27.21.789.2954
e-mail: admin@edg.co.za, web: <http://www.edg.co.za>

Rural SEED, Energy for Development Research Centre
attn. Project Manager Bill Cowan

University of Cape Town,
Private Bag,
Rondebosch 7701, South Africa.
Ph: 27.21.650.3230, fax: 27.21.650.2830
e-mail: energy@energetic.uct.ac.za, web:
<http://www.edrc.uct.ac.za>

Southern Africa Rivers Association (SARA) is an association of river tourism interests, and has become a powerful force in the protection of South African rivers from large dams.

SARA
P.O. Box 645
Irene 0062, South Africa
Head Office: Ph/Fax: +27.12.667.1838
e-mail: sara@intekom.co.za

Solar Electric Light Fund (SELF) promotes rural area electrification in less-developed countries. The organization assists in community scale residential solar photovoltaic project design, development, and financing.

SELF
1775 K Street, NW, Suite 595,
Washington, DC 20006 USA
Phone: +202.234.7265; Fax: +202.328.9512
e-mail: solarlight@self.org; web: www.self.org

Solar Energy International's Renewable Energy Education Program provides training/education in solar, wind, and water power technologies, and provides technical assistance and training for projects in developing countries.

SEI
P.O. Box 715,
Carbondale, CO 81623-0715 USA
Phone: +970.963-8855; Fax: +970.963.8866; e-mail:
sei@solarenergy.org ; web: www.solarenergy.org

World Renewable Energy Network (WREN) is a non-profit network of organizations promoting environmentally safe and economically sustainable renewable energy. It organizes a biannual congress; has links with all UN-and most governmental as well as NGO organizations, and co-publishes the International Journal of Renewable Energy.

WREN

Attn: Prof Ali Sayigh, Director General,
147 Hilmanton, Lower Earley,
Reading, RG6 4HN, UK.
Phone: 44 1189 611364 ; Fax: 44 1189 611365; email:
asayigh@netcomuk.co.uk ; web: www.wrenuk.co.uk

Agencies and Companies Working on Alternatives

Energy Alternatives AFRICA

P.O. Box 76406

Nairobi, Kenya

Tel: 254.2.714.623; Fax: 254.2.720.909

e-mail: energyaf@iconnect.co.ke

This company works to develop renewable energy infrastructure in East Africa through training, demonstration, and pilot projects in the region.

National PV Rural Electrification Program of Botswana

P/Bag 0082

Gaborone, Botswana

Ph: 267.314.161

Fax: 267.374.677

Email: reinbo@info.bw

Contact person: Thapelo Nteta

National Water Conservation Campaign

Private Bag X9052,

Cape Town 8000, South Africa

Tel: 27.21.462.1480; Fax: 27.21.462.1719

email: conserve@mweb.co.za

Renewable Energy Information Network in Namibia

Coordinator: Ms. Renate Hans, Email: bsiepker@iafrica.com.na

Ph: 264.612.848.1111

Fax: 264.612.38643

Ministry of Mines and Energy

Private Bag 13297

Windhoek, Namibai

Rural Industries Promotions Company (Botswana)

Chief Executiv: Kitsiso V. Morei

P.O. Box 2088

Gaborone, Botswana

Ph: 267.314.431; Fax: 267.300.316

In addition to involvement in PV rural electrification, this group is also working in renewable energy (biogas, solar energy and wind pumping), and on a wetland technology program to recycle water.

SolarBank International is a planned new mechanism for global wholesale financing for solar energy end-use markets. There is growing consensus that the availability of low-cost financing is a key to the development of markets for PV and other renewables. The SolarBank network of funds will be a leading participant in the financing of PV projects, the capitalization of fee-for-service PV businesses, and on-lending through existing financial institutions. SolarBank intends to start a South Africa debt fund in 1999, directed and managed by local professionals.

Solar Bank Project

1825 I Street, N.W., Suite 400

Washington, D.C. 20006

Tel: +202.429.2030; Fax: +202.429.5532

South Africa Wind Energy Association

P.O.Box 43286

Salt River 7915, South Africa

Tel: 27.21.447.2454

sawea@icon.co.za

Funding Agencies

The World Bank

1818 H St., NW

Washington, D.C. 20433 USA

Tel: +202.477-1234

web: www.worldbank.org

Development Bank of Southern Africa

P.O. Box 1234

Halfway House,

Midrand 1685, South Africa

Tel: 27.11.313.3911; Fax: 27.11.313.3086

African Development Bank

Rue Joseph Anoma

01 BP 1387, Abidjan 01

Côte d'Ivoire

Tel: 225.20.44.44; Fax: 225.21.77.53

Mr. Giorgis, Division Chief, Industry and Infrastructure, South

Region: e-mail: g.giorgis@afdb.org

Other

World Commission on Dams

P.O. Box 16002 Vlaeberg

Cape Town 8018, South Africa

Tel: 27.21.426.4000

Fax: 27.21.426.0036

Web: www.dams.org



About IRN

International Rivers Network (IRN) is a nongovernmental organization which supports local communities working to protect their rivers and catchments. Since 1986, IRN has worked to halt destructive river development projects and to encourage equitable and sustainable methods of meeting needs for water, energy and flood management. We work to promote the wise management of the planet's freshwater resources, to link environmental protection with human rights, to create a worldwide understanding of river ecology, and to reveal the interdependence of rivers' biological, physical and cultural aspects. Through research into alternative energy generation, irrigation and flood management schemes, pressure for policy reform at international financial institutions such as the World Bank, and active media and educational campaigns around the world, IRN works to discourage investment in destructive large-scale river development while encouraging strategies that are more environmentally, socially and economically sound.

Our Southern Africa work includes a few major, ongoing campaigns and a number of projects that we monitor as needed. In Lesotho, IRN works with NGOs and communities to ensure that the Lesotho Highlands Water Project's impacts on communities and the environment are minimized, and that promised benefits reach affected communities. We also support South African activists' efforts to press for demand-management and conservation instead of more dams.

IRN is also a member of the Okavango Liaison Group, which is working to promote the sustainable management of the Okavango Delta through effective participation of riparian communities in the planning and management of the resource.

IRN's efforts in Namibia have focused on revealing the economic, environmental and social costs of the proposed Epupa hydroelectric project, as well as working with local NGOs to promote better alternatives.

IRN also maintains "watching briefs" on Bujagali Falls dam in Uganda, the Komati Basin water project in Swaziland, dams in the Senegal River Basin in Senegal and Mali, proposed dams in Kenya, and various projects on the Zambezi River.

This publication is just one of many available from IRN. Specific to Africa, IRN has campaign information packages on the proposed Epupa Dam and the Lesotho Highlands Water Project, and a report on alternatives to a proposed water pipeline that could harm the Okavango Delta. For more information, visit our web site.

International Rivers Network

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E-mail: irn@irn.org OR lori@irn.org (Africa programme)

Web: <http://www.irn.org>



International Rivers Network
Linking Human Rights and Environmental Protection