WORLD METEOROLOGICAL ORGANIZATION

# INFORMATION NEEDS FOR WATER QUALITY ASSESSMENT AND MANAGEMENT

## REPORT OF A WMO/WHO/UNEP EXPERT CONSULTATION (BRATISLAVA, 26 TO 30 AUGUST 1991)

## Contents

WMO/WHO/UNEP CONSULTATION
Bratislava, 26-30 August, 1991

The purpose of the consultation was to evaluate the information base required for the incorporation of sound water quality assessment into integrated water management taking into account the major concerns of agricultural, urban and industrial development and their environmental impacts. This called for the review of the entire process from data collection and monitoring to the assessment of water quality issues, on to the development of global strategies in water quality management.

This consultation constituted part of the preparatory process leading to the International Conference on Water and the Environment (ICWE) [Dublin 1992], which in itself will be the formal input on freshwater issues to the UN Conference on Environment and Development (Brazil, 1992). The consultation therefore was required to make recommendations for consideration at the Dublin conference.

# EXECUTIVE SUMMARY

## Introduction

The quality of water in rivers, lakes and reservoirs, as well as in aquifers has long been recognized as a key determinant in human health and more recently as a fundamental influence on ecosystem integrity. Now, however, water quality is increasingly being recognized as an important impediment to economic development and social progress involving the use of water. Human impacts on aquatic systems due to socio-economic development, including urbanization, industrial growth, agricultural expansion and their associated pollution, have reached a level where water quality has become a limiting factor for development. The exponential demand for water of adequate quality will exacerbate this problem by the turn of the century.

***Therefore, the assessment of water quality must proceed in step and be integrated with the assessment of water quantity so that effective water management policies can be promoted.***

There are increasing needs for the collection and assessment of water quality data to ensure sound water management and environmental protection and for the dissemination of these data to enhance public awareness on water quality issues. Without water quality information as a basis, evocative phrases such as "sustainable development" and "environmentally sound management of water resources" will be meaningless.

***Reliable and adequate information on water quality is of primary importance for both socio-economic development and environmental protection.***

To assess the information needs for quality assessments and management, and to formulate future strategies and actions for securing this information, the consultation addressed three sets of issues: firstly, those of a policy and institutional nature; secondly, water quality and other environmental issues; and thirdly, the scientific and technical base necessary to secure progress into the 21st century.

## Water quality assessment

Water quality assessment provides information for the protection of human health and ecological integrity, and for sustainable economic growth. However, in the global context, most existing monitoring programmes based on routine analysis of water samples provided by fixed station, fixed interval monitoring have not succeeded, by themselves, in providing the water quality information necessary for purposes such as: forecasting of future problems, surveillance of micro pollutants, assessment of pollutant loads in rivers, establishing the impacts of accidental pollution and, sometimes, defining water quality trends.

The primary reasons for such lack of success include: the absence of clearly defined objectives; greater emphasis on data collection rather than interpretation; separation of water quantity and quality assessments; inadequate sampling frequencies in rivers, particularly at high flow conditions; separation of surface water and groundwater monitoring; and the lack of consideration in most cases of sediment and biological characteristics.

In order to improve future water quality assessment it is recommended that:

***I Assessment of surface water and groundwater quality should be undertaken through purpose-oriented ((human health, ecosystem health, specific water uses), multi-media (water, sediment and biota), multi-compartment (surface water and groundwater) investigations which incorporate several approaches including routine monitoring, targeted and repetitive synoptic surveys, and detailed cause-effect studies.***

***II Future assessments should emphasize risk, both to human health and to the ecological integrity of aquatic and terrestrial systems.***

***III New monitoring systems should be established including an Early Warning System to detect the first signs of deteriorating water quality, from local to global scales, to give ample time for remedial actions to be taken, and appropriate emergency monitoring, particularly on large and/or international rivers, or sites of high potential risk of accidental catastrophic pollution.***

***IV The development and application of new assessment techniques should proceed in two directions: low-cost routine monitoring techniques, particularly using biological methods; and integration into water quality assessment of Geographical Information Systems, expert systems, remote sensing and modelling.***

**Information storage and dissemination**

All water information, including water quality data, should be considered as common information which should be stored in appropriate data banks at local, regional and global levels. Such data banks should be integrated with other data bases dealing with all other aspects of environmental quality.

In order to avoid as much as possible conflict situations related to water use at any level, but more particularly at the regional level,

where scarcity of appropriate quality of water might become a reason for international conflict, it is highly desirable that:

***V Free access to any water information, including water quality data, both within countries and between countries should be ensured on a non-profit basis.***

**Integrated water administration**

Improved water management requires an integrated approach at all geographical scales, including the integration of groundwater and surface water, quantity and quality, and the linking of all environmental components including air, soil, oceans, food, water and biota. To achieve this goal it is recommended that:

***VI An integrated water administration should exist or be established at the national level that will develop the nation's water quality assessment together with relevant technical, legislative and economic tools such as water quality criteria and enforcement policies. In those countries where water research facilities are still lacking it is strongly suggested that a National Water Institute dealing with both surface water and groundwater quantity and quality should be established to support the water administration.***

**Research needs**

There are still some major areas in the field of water quality, such as low cost monitoring methods, continuous monitoring, and the synergistic effects of pollutants which need investigation. However, two areas should be given urgent consideration:

***VII The development of appropriate methods to assess human and ecological risks.***

***VIII The development of water quality monitoring and assessment methods, particularly biological methods, adapted to tropical countries, in both dry and humid conditions.***

**International co-operation**

As water is by nature a transboundary resource, water quality problems should be treated at the basin level. However, our present knowledge of water quality issues is restricted to the very few countries where financial resources have been made available for this purpose. Water quality assessments are now high-tech and high-cost exercises and their benefits generally go far beyond the country where they have been undertaken. In many cases, the cost of water quality assessment should be shared among all nations as in other key environmental fields, such as climate, ocean, and water quantity. To remedy this general lack of information it is recommended that:

***IX The establishment of international basin commissions, for both surface waters and groundwaters should be promoted. Collaboration among UN agencies with specific mandates in the field of water quality (e.g. WHO, WMO, UNESCO,UNEP, FAO) should be increased and co-ordination strengthened.***

***X Technical capabilities of developing countries can also be developed by various means such as the promotion of twinning arrangements between existing laboratories and those under development and the establishment of regional/national centres for technology transfer and training.***

***XI All donors and implementing agencies should be urged to implement environmental impact assessment, including regular monitoring of water quality before, during and after major development schemes, and to incorporate the necessary funding for this purpose, into project budgets. This information should be widely disseminated and integrated into national, regional and global environmental data banks.***

***XII The major water bodies such as aquifers and large lakes with long residence time to be considered as "water reserves" of global importance, particularly groundwaters, should be identified and studied so as to ensure a safe and sufficient water supply for the future.***

**Training**

As knowledge of water quality is still very limited in about 100 countries and insufficient in about 50 others, a tremendous effort is required during the next decade to improve this situation. Two actions are particularly recommended:

***XIII In view of the increasing complexity of water quality assessment for sound water resources management, training needs have to be urgently met through specific training programmes for technicians and managers at local, national, and regional levels.***

***XIV Regional Water Quality Centres should be established as soon as possible, in regions where financial and analytical capabilities are insufficient, and serve as a focus for training, data collection and interpretation, and water analyses when needed, and as centres for specific research, particularly in the tropical zone. These Centres will be more efficient if***

***established on the basis of international hydrological basins of rivers, lakes and groundwater.***

WMO/WHO/UNEP Consultation on Information Needs for Water Quality Assessment and Management
Bratislava, 26-30 August 1991

Background

The purpose of this expert consultation was to assess the information needs for water quality assessment and management, and to formulate future strategies and actions to secure this information. This called for the review of the entire process from data collection and monitoring to the assessment of water quality issues. To this end, the consultation addressed three sets of issues: the first was the integrated management associated with the policy and institutional framework; the second was water quality and other environmental issues, particularly at a regional and global scales; the third was concerned with the scientific and technical base for water quality assessment. For each of the above the consultation defined major problem areas and gaps and formulated general recommendations and proposed actions and targets for their implementation, addressed to countries and relevant international organizations.

Scientists present in Bratislava also took the opportunity to voice their concern over the possible misuse of freshwater resources in conflict situations, and draw to the attention of the international community the possibility that freshwater scarcity might become a reason for international conflict and urge the international community to take adequate preventative action. More particularly concerning water quality, it is stressed that during conflict situations the environment and particularly freshwater resources should not be deliberately polluted or threatened to be polluted by any of the conflicting parties.

## I THE POLICY AND INSTITUTIONAL FRAMEWORK FOR INTEGRATED MANAGEMENT

Integrated water resources information provides the fundamental basis for effectively advising decision-makers on resource management policy matters and for creating the essential public awareness of the status of freshwater quality issues. Therefore, national and international action programmes should be geared to provide the data and information required for such goals as:

(a) establishment of policies for sustainable development;

(b) establishment of the basis for risk assessment for human health and ecosystem integrity to be used for prioritization of preventive and remedial actions;

(c) provision of an integrated framework for the environmental impact assessment of development projects including present and proposed hydraulic structures;

(d) development of policies for cost effective decisions on integrated water management programmes for the control of sectoral pollution and the enhancement of surface and groundwater quality;

(e) development of balanced national programmes of sewage and waste control as an integral part of national development programmes;

(f) establishment of an appropriate legal framework in which water quantity and quality management can be integrated;

(g) establishment of appropriate legal and enforceable standards for point source and high risk non-point source pollution management and control.

### Recommendations for sound integrated water management

In order to attain the above objectives the following recommendations are made:

**Integration of networks and programmes**

A. Sound water management at national and international levels cannot be achieved without a high degree of integration of: networks of observation stations for surface water and groundwater quantity and quality; water resources assessment programmes; and training programmes in quantity and quality aspects of water resources.

**Integration of water data with other environmental and socio-economic data**

B. Cost-effective management of water resources requires significant changes in the nature and availability of resource information. Specifically, the ability to integrate water data with other natural resource information such as land use and soil chemistry, together with social and economic data, is essential for rational resource management decisions. Data banks must also include inventories of surface and groundwater use, and the quantity and quality of effluent discharges to surface water courses. Data integration is particularly required at the drainage basin scale.

**Data and information systems**

C. The ability to synthesize and use water resource information is an essential requirement for integrated water resource management. Nevertheless, many parts of the world have little or no such capability. Effective water resource management requires new procedures and techniques that can link data to policy needs. Advances can be made by using existing tools such as modelling and prediction that combine data analysis with policy development and by applying technologies such as Geographic Information Systems (GIS) and expert systems which permit regional integration of data and production of a wide range of visual aids such as water quality maps, water quality trends, etc... The application of water quality criteria for various uses permits the evaluation of the resource and the determination of the effectiveness of point and non-point source pollution control programmes.

**Free flow of information**

D. All water quality information should be considered as common information. Many national development programmes are seriously constrained by institutional separation of data. For example, in many countries the relevant agencies responsible for environmental matters have less available information on water quality that others (health, rural development, natural resources). A free flow of data and information, on a non profit basis, at national, intra-basin and global levels will facilitate analysis and interpretation by a greater number of experts and agencies. Therefore, all information obtained, particularly with public funds, should be well documented and made easily available.

**Promotion of public awareness**

E. Countries must recognize that public awareness and good practice are more cost-effective than enforcement and remedial action. National programmes promoting public awareness, codes of good practice, and education, together with access to data, are essential components of an effective national water quality management programme.

**Proposed actions for sound integrated water management**

National Action Programmes

Target year: 1995 - Countries should:

**Integrated data collection programme**

(1) Formulate and implement plans for the integration of programmes for data collection of surface water and groundwater quantity and quality and for the assessment and management of water resources.

These programmes should include data necessary for sound aquifer management taking into account such important groundwater issues as characterization of the resource, establishment of protection zones, and determination of residence times relative to pollution control, and monitoring in the saturated and unsaturated zones in priority areas.

**Data dissemination**

(2) Adopt, and commit themselves to, the principle of free access to and free flow of water and related resource data and information amongst national resource and development agencies, and demonstrate progress in implementing this principle.

**Water legislation**

(3) Develop or review existing water legislation to ensure that these incorporate the principles of environmental protection, integrated basin management, pollution prevention, economic tools for water resources management, and free access to information.

**International information exchange**

(4) Participate in a global information network comprised of national information systems or, where appropriate, regional and/or multi-national basin centres, for the purpose of assessment and management of hydrological basins at the national, regional and global scales.

**Public awareness**

(5) Implement a programme of public awareness and education with technical assistance, as required, from appropriate UN agencies.

Target year: 2000 - Countries should:

**Water and socio-economic data banks**

(6) Develop and implement a comprehensive programme for integrating surface and groundwater quantity and quality data with other social, environmental and economic data required for resource management and policy development. This programme will provide for common use of these data banks by national agencies.

International technical assistance

Target year: 1995 - Relevant UN agencies should:

**Guidelines for data collection**

(7) Provide specific guidelines on the composition and minimum data needs for sound water resource management.

Particularly concerning impact assessments, objectives of water quality assessments, development of integrated data banks, harmonization of water quality terminology, etc...

**Capacity building**

(8) Develop and implement, together with donor countries, a programme of capacity-building for national water quality management.

This programme should include the following:

- provision of minimum capability to collect and interpret the most basic water quantity and quality data;

- guarantee of a minimum acceptable level of data quality assurance in all countries;

- provision of data storage and information synthesis capabilities, with a focus on national and/or regional centres;

- development of analytical and technical capacities for assessing levels and trends of organic and inorganic toxic substances in water, sediment and biological substrates, with a focus on national and/or regional centres;

- implementation of training programmes on low cost biological assessment techniques that can reduce reliance on expensive chemical analytical technology.

**Training and technical assistance**

(9) Provide an appropriate technical and training framework and, with donor countries, develop an assistance programme for the national implementation of data and assessment programmes in developing countries. In some regions this task may require the establishment of Regional Water Institutes that could be used for training, data collection and assessments and, possibly, for specific research. Other possibilities include the twinning of existing and planned water quality and water management institutions.

The following urgently required training activities in the water quality field should be implemented:

a) Development in all countries of at least one scientific university programme in environmental science which should include courses on the assessment, protection and management of natural resources and more particularly of water resources.

b) Development of a package of training modules, including provision for distance learning on all aspects of water quality assessment including definition of objectives, study designs, implementation, assessment of groundwater and surface water monitoring programmes, data interpretation and use of derived information to evaluate resource management alternatives.

c) Introduction of technician training programmes at national or regional levels using the newly developed training materials, to be coordinated and validated by designated national or regional organizations.

d) Establishment of regional or national workshop programmes for middle level management on conceptual approaches to water quality assessment.

e) Development of work agreements on a continuing basis between developed and developing countries for postgraduate training and bilateral exchanges.

## II WATER QUALITY AND OTHER ENVIRONMENTAL ISSUES

Integrated development and management of water resource systems require information which is broad-based and multi-disciplinary. Issues related to land resources, such as desertification and deforestation; to the atmosphere such as acidification, climate change and long-range transport of pollutants; to human health, such as drinking water, food and fisheries and livestock water; to ecosystem integrity and pollutant inputs to oceans, all affect, or are affected by, water quality. Thus, water quality must be considered as an integrated indicator of environmental quality.

The primary sources of water quality degradation include agricultural practices, mining and industrial activities, and urban development, all accentuated by the exponential increase in the demands for water of suitable quality to meet the needs of a rapidly growing world population.

### Recommendations to link water quality to other environmental issues

A number of previous recommendations [see (A) to (E)] are also applicable here in order to obtain multi-disciplinary information. In addition, the following recommendations should also be considered.

**Early warning of future problems**

F. Most existing water quality networks have failed to forecast several current critical issues such as nitrate pollution or water acidification. Considering the predicted global changes and the ever growing list of chemicals used in support of human activities, an early warning system is required to provide timely assessments of the emerging environmental issues related to water quality.

**Long-term impact assessments**

G. There is an important need to incorporate environmental impact assessments into development projects, such as river channelization, dams and diversion schemes, mines and major urban, agricultural and industrial developments. Most of these water development schemes could have a life time of hundreds of years and may affect the quality of water and the aquatic ecosystem for an even longer period.

Therefore, environmental impact assessments should be undertaken before and during construction, and throughout the lifetime of the installation. The findings of the environmental impact assessments should guide project design and operation to minimize the negative environmental impacts of these developments. These permanent assessments should be widely distributed and should be checked by independent experts not connected with the contractor.

**International water bodies**

H. All major shared surface water and groundwater bodies should be managed by a basin-wide commission in order to assess and manage the resources in an integrated manner and water quality should be addressed at this level. This might require the strengthening of existing commissions as for large rivers, or their establishment , particularly for lakes and groundwater, and should involve the integration of water quality concerns into all commissions.

**Water quality criteria**

I. Acceptable water quality criteria for all major water uses and for safeguarding aquatic ecosystem integrity should be established where they are not already available. This might require further scientific research, particularly in tropical environments.

**International co-ordination**

J. In order to optimize the integrated approach to water resources assessment and management, the establishment of permanent coordination mechanisms should be considered at basin level and at the international level. This mechanism should facilitate the exchange of information, programme integration, the efficient use of financial and human resources, and cover such issues as training, public awareness, and technical support for developing countries.

**Groundwater and lake reserves**

K. Many groundwater resources and a few large lakes have very long residence times (> 10 years). These water bodies may be important in the future supply of safe water. Considering their vulnerability to pollution and the almost impossible task of remedial action within an economic time scale, the establishment of national, regional and global water reserves should be promoted, particularly for groundwater, in order to ensure the security of safe and sufficient water supply in the coming decades.

**Actions to identify, forecast and control water quality issues**

National Action Programmes

Target year 1995 - Countries should:

**Early warning programme**

(10) Set up a national early warning programme consisting of:

- background assessment at selected stations not subjected to any direct (point or non-point) pollution.
- in-depth analysis of pollutants at selected impact stations.
- monitoring of new chemicals (inventories and quantitites), in domestic, industrial, and agricultural uses.

For groundwater, such early warning stations should be located so as to sample unsaturated and saturated zones beneath typical land-uses in the recharge areas of major aquifers.

**Review of past impacts**

(11) Establish a programme to document the actual environmental impacts of past major development schemes affecting the hydrological cycle (e.g., large dams, river channelization, flood plain reclamation, irrigation schemes) on both the quality of water and aquatic ecosystems.

**New impact assessments**

(12) Develop or establish new impact assessment procedures for future development schemes affecting water, so that water quality and aquatic ecosystem integrity are fully taken into account in the design and operations of these schemes.

In particular impact assessment should include permanent water quality assessment before and during construction and throughout the lifetime of the installation. Appropriate financial resources should be allocated for this purpose from the beginning and on an annual basis. The total impact assessment cost could be of the order of 1% of the construction cost. Conclusions and recommendations of the environmental impact assessment should be regularly made public. Results of regular monitoring activities should be incorporated within national environmental data bases.

**Groundwater protection**

(13) When appropriate, particularly in regions of water scarcity, programmes should be set up to identify, assess the quality of, and protect, their water bodies with a residence time in excess of 10 years (groundwater and some large lakes), which may be their major safe water resources in the future.

International Action Programme

Target year 1995

**Global Early Warning system**

(14) An Early Warning System in the field of water quality should be established at a global scale. It should provide timely assessment of emerging environmental problems related to water quality so that remedial actions can be taken before the issues become critical.

For this purpose a number of monitoring stations capable of providing background and impact information at the global level should be selected. Both background and impact stations might require the strengthening of selected existing monitoring stations and the establishment of new stations as required. National early warning systems are also proposed [see (10)]. The cost of such systems will be very high, despite the relatively small number of stations, in view of the high technology needed for analyses (e.g. micropollutant inventories). It is therefore proposed that the global network should have at least one early warning station in the smaller countries and proportionately more in the larger countries. The cost of establishing and operating these relatively expensive stations should be borne by all countries, irrespective of their location.

This Early Warning System (which relates to rivers, lakes and groundwater) could be incorporated into ongoing programmes such as the background monitoring in the UNESCO-Man and Biosphere and the UNEP/WHO/UNESCO/WMO-GEMS/WATER programmes. It could also be considered as part of the freshwater component of the Global Climatic Observing Systems (GCOS) planned by IOC, WMO and ICSU. The new UNDP/UNEP/World Bank Global Environmental Facility (GEF) could perhaps be used to promote such stations and systems of data collection, as well as analysis of the quantity and quality of river flows.

**Impact assessment of existing and new structures**

(15) International and bilateral donors should re-evaluate the impacts of existing major water development projects on water quality and aquatic ecosystems, particularly on the long term scale, and compare them with the impacts forecasted at the time the structures were designed.

(16) International and bilateral donors should ensure that in planned water development schemes water quality and aquatic ecosystem integrity are fully appraised before and during the construction of the scheme and throughout the lifetime of the installation. Preliminary impact assessments should guide the design and operation of these development schemes. The results of these regular water quality monitoring activities, particularly in developing countries where these activities are still very difficult to establish, should be transferred to the national and, if appropriate, regional and global data bases.

It is highly desirable that donors use consultants, not associated with the contractors for these impact assessments, and that their conclusions and recommendations could, if needed, be examined by independent experts nominated by the donors.

The results and recommendations of these assessments should be made public.

**Commissions on shared water bodies**

(17) International commissions should be established for all major shared water bodies (rivers, lakes and groundwater) to ensure sound management of water resources, taking into account the various needs of the countries and the quantity and quality of the available water resources.

This requires the establishment of water quality monitoring stations at national boundaries to check such as issues as the level and loads of pollutants. Data from such networks should be collected, processed, assessed and disseminated among all countries by Regional Water Quality Centres. When necessary, UN programmes such as the UNEP/WHO/UNESCO/WMO GEMS-WATER, and the UNEP EMINWA (Environmentally Sound Management of Inland Waters) project could help to set up such networks and regional centres.

**Clean technology transfer**

(18) UN agencies, such as UNIDO, UNEP, FAO and WHO should co-ordinate the establishment of regional dissemination centres for clean technology transfer which is appropriate to maintaining water quality and the integrity of aquatic ecosystems. These centres should also establish the necessary legal and economic instruments to support this transfer.

## III THE SCIENTIFIC AND TECHNICAL BASE FOR WATER QUALITY ASSESSMENT

***The goal of water quality assessment should be the provision of information for resource management, for the protection of human health and ecological integrity, and for the supply of water of adequate quality for sustainable economic growth.***

The sound management of water quality requires the development of adequate monitoring and assessment strategies and tools to obtain a thorough knowledge of the interaction between biological composition, chemical processes and physical features.

Most existing water quality monitoring programmes have failed to forecast water quality trends and new problems and therefore to warn of the widespread incidence of such matters as nitrate pollution, acidification, and eutrophication. In many cases remedial action has been taken only after the critical condition has been reached.

Water quality assessment involves a sequence of activities beginning with definition of objectives and ending with data interpretation to evaluate resource management options. Each step is fairly well defined, but often certain steps are omitted or are given inadequate consideration. In order to achieve a sound assessment, especially to define risks to human health and ecological integrity, a water quality assessment programme should include the following components:

(a) Definition of objectives and data use .

(b) Study designs, based on the objectives, which establish strategies for sample collection and analysis, and data interpretation, and which incorporate quality assurance procedures.

(c) Data quality assurance at every stage of the assessment procedure.

(d) Harmonization of field and laboratory activities.

(e) Strengthening of monitoring and assessment networks.

(f) Data collection verification, interpretation and dissemination.

(g) Information evaluation for resource management alternatives.

(h) An appropriate feed-back mechanism.

Water quality assessments should now be seen as complex activities which largely encompass the classic approach of regular determination of specific variables at fixed sites. However, many knowledge gaps still exist in addition to the many problems already mentioned in this document (e.g. early warning, integrated assessments, information on water resources and uses, socio-economic indicators linked to water quality). These gaps include:

(a) The synergistic effects of chemicals and microbiological contamination on both human and ecosystem health;

(b) Factors affecting water quality;

(c) The use of risk assessment techniques and integrated environmental data in identifying priorities for the protection and management of water resources;

(d) Aquatic ecosystem response to physical, chemical and biological perturbations; and

(e) The basic behaviour of pollutants within aquatic systems in tropical conditions.

## Recommendations for improvement of water quality assessments

**General goals and means**

L. Water quality assessment should be purpose-oriented (human health, ecosystem health, specific water uses), use all aquatic media (water, sediment, biota), and consider all aquatic compartments (atmospheric deposition, surface water, groundwater).

**Integrated monitoring**

M. Water quality assessment requires quality assured data. To this end, all water quality monitoring and assessment programmes must:

- be objective/question-oriented and dedicated to producing information for direct use in water resource management;
- fully integrate surface water and groundwater;
- fully integrate information on water use, quantity, quality, chemistry, and biology; and
- be a multi-approach process that includes: i) routine monitoring; ii) targetted and repetitive synoptic surveys; and iii) detailed cause and effect studies.

For this purpose laboratory studies should be conducted together with field studies to help clarify interactions and processes . The implementation of both field and laboratory studies at regional level requires technical and management coordination encompassing a wide variety of aquatic environments (rivers, lakes, marshes, wetlands, estuaries, etc.), species diversity and, sometimes, climatic conditions.

**New methods and techniques**

N. The development of new approaches to water quality monitoring will necessitate a whole set of specific manuals, training courses, research topics (particularly for the tropical zones), and development of new low cost techniques (continuous sampling, continuous surveillance, biological indicators, biotests of water quality, etc....)

**Actions to improve water quality monitoring**

National Action Programmes

Target year: 1995 - Countries should:

**Water quality coordination**

(19) Designate one organization to coordinate integrated water quality assessments. It is essential that all components of a water quality assessment system be equally developed, from the definition of objectives, through network design, to interpretation and information utilization. Initially, Regional Water Quality Centres might co-ordinate and conduct such assessment for the least developed countries (LDCs).

**Water quality assessment implementation**

(20) Establish their water use priorities and implement at least one purpose-oriented water quality assessment based on priorities and available resources, on selected river basin or aquifer systems.

**Training courses**

(21) Training programmes related to the design and implementation of integrated environmental assessment should be established at local and national levels. The training programmes should address all aspects of programme design, data collection, analysis and interpretation in relation to specific water quality problems.

Particular emphasis should be given to training in:

a. New monitoring and assessment technologies.
b. Quality assurance.
c. Low costs assessment methods.
d. Biomonitoring.
e. Environmental impact and risk assessment.
f. Data and information analysis.

Extensive use of micro computer based information systems to store and analyze the data is recommended.

Target year: 2000

**National laboratory**

(22) Each developed or rapidly developing country should have at least one National Laboratory capable of conducting the full range of analytical work required for water quality assessment. This laboratory should participate in international quality assurance programmes. Before these National Laboratories are established the Regional Water Quality Centres could be used for these purposes.

**Quality assurance programmes**

(23) In each country all laboratories contributing to water quality assessments should participate in a systematic quality assurance programme.

International Technical Assistance

Target year: 1995 - Relevant UN agencies should:

**Water quality and human health**

(24) Conduct a research programme and develop guidance on health risks related to water quality.

These programmes/guidance should include::

- Human health risk associated with mixtures of chemical substances typical of degraded water quality.

- Cost-benefit analysis of combating water related diseases caused by typical chemical pollutants versus remedial action.

**Water quality and ecosystem integrity**

(25) Develop a research programme on risk of ecosystem degradation related to water quality.

This programme should include:

- Simple methods for reconnaissance surveys to identify potential ecological impacts.
- In-situ toxicological tests and development of biological indicators to evaluate ecological conditions.

- Establishment of an Aquatic Ecosystem Typology based on environmental condition, biological composition, and biological diversity - that will permit results of typical studies to be extrapolated to similar ecosystems.
- Definition of uncertainties of current sampling and biological procedures in relation to the tolerances of specific organisms, and communities, and systems.

**International consultation**

(26) Convene and publish the results from international meetings on emerging concepts for water quality assessment. These conferences should emphasize risk assessment, relative vulnerability of different water resources and ecological integrity with particular focus on approaches, methods and techniques for developing countries.

**Technical and teaching manuals**

(27) Establish a plan for preparing a series of water quality manuals for teaching and training purposes.

These manuals could include:

- Approaches and methods for water quality assessment for sound water management.
- Methods for incorporating the assessment of the vulnerability of water resources, ecological integrity and risk, and human risk into water quality assessment.
- Groundwater quality assessment.
- Early warning techniques.
- Laboratory analytical methods for the complete range of physical, chemical and biological variables.
- Strategies and methods for emergency monitoring and assessment of accidental pollution in water bodies.
- Biological methods of water quality assessment.

# REPORT OF THE CONSULTATION

## 1. OPENING

1.1 At the kind invitation of the Government of the Czech and Slovak Federal Republic (CSFR) an expert consultation on information needs for water quality assessment and management took place in Bratislava from 26 to 30 August 1991. The meeting, convened by WMO in association with WHO and UNEP, was held at the Slovak Hydrometeorological Institute (SHMI).

1.2 Opening addresses were presented by: Dr. I. Kunsch, Deputy Director for Hydrology of the SHMI, Dr. F. Samaj, Director of SHMI and Permanent Representative of the CSFR with WMO, Ing. J. Smrek, Vice-Minister of the Environment, Ministry of the Environment of the Slovak Republic, and Dr. L. Molnar, Institute of Hydrology and Hydraulics (Bratislava). Words of welcome were expressed, an overview of the hydrometeorological activities in the CSFR was presented and problems relating to water quality were highlighted. The representatives of the three sponsoring agencies Messrs D. Kraemer (WMO), M. Meybeck (WHO) and P. Peterson (UNEP) thanked the government of the CSFR and in particular the Slovak Hydrometeorological Institute for the excellent support and facilities provided. They also briefly outlined the activities of their respective organizations in the field of water quality.

## 2. OBJECTIVES

2.1 The purpose of the consultation was to evaluate the information base required for the incorporation of sound water quality assessment into integrated water management taking into account the major concerns of agricultural, urban and industrial development and their environmental impacts. This called for the review of the entire process from data collection and monitoring to the assessment of water quality issues, on to the development of global strategies in water quality management.

2.2 This consultation constituted part of the preparatory process leading to the International Conference on Water and the Environment (ICWE) [Dublin 1992] and therefore was required to make recommendations for consideration at that conference.

## 3. PARTICIPATION

Thirty five participants from eleven countries and four international organizations attended the consultation. The list of participants is given in Annex 2 to this report.

## 4. ORGANIZATION OF THE MEETING

4.1 Under the chairmanship of Prof. D. E. Walling (UK), the consultation was conducted in accordance with the programme set out in Annex 3 to this report. The working papers presented to the meeting addressed a number of specific problems relating to water quality and environmental issues. The consultation also considered the reports prepared by the UN agencies concerned on the evaluation of the progress achieved under the Mar-del-Plata Action Plan and the proposed integrated strategy for the 1990s relating to: water resources assessment (WMO/UNESCO), water quality (WHO/UNEP), and water for agricultural development (FAO). Information was provided on the preparations for the ICWE which forms part of the preparatory process leading to the United Nations Conference on Environment and Development (UNCED) [Rio de Janeiro, 1992]. In this connection it considered the draft report of the Secretary-General of UNCED on

the "Protection of the Quality and Supply of Freshwater Resources: Application of Integrated Approaches to the Development, Management and Use of Water Resources-Options for Agenda 21 (A/CONF. 151/PC/42/ADD.7/REV.I).

4.2 The consultation established four sub-groups, each to consider in detail, on the basis of the information provided, one of the following issues:

(i) water quality and ecosystem integrity and health;

(ii) water quantity and quality aspects of water use and management;

(iii) water quality and environmental impacts; and

(iv) water quality assessment and monitoring programmes.

These groups defined major problem areas and knowledge gaps and formulated recommendations with proposed actions for their implementation.

## 5. CONCLUSIONS AND RECOMMENDATIONS

5.1 The consultation reviewed a draft report of its deliberations, containing the main conclusions and recommendations as well as an executive summary, to be submitted to ICWE. It requested the Secretariats of WMO, WHO and UNEP to finalize the report in the light of amendments and additional material proposed.

5.2 The consultation recommended that the report of its meeting together with the technical papers presented possibly be published as a WMO technical report.

## 6. FIELD TRIP

A one-day trip was organized to study the Gabcikovo site of the Gabcikovo-Nagymaros water scheme on the river Danube, with the view of considering the water quantity-quality linkage and the many water-quality problems posed by such a large development project. Both the technical and environmental background information on the project were introduced before and during the field trip by specialists from the SMHI.

## 7. ADOPTION OF REPORT AND CLOSURE

7.1 The consultation adopted the report of its session. It requested the Secretariats of WMO, WHO, and UNEP to make any editorial changes deemed necessary.

7.2 At the closure of the meeting a brief address was presented by Dr. F. Samaj. He expressed the hope that the efforts of the past week and the recommendations of the consultation will contribute towards the protection of the earth's freshwater resources. Mr. D. Kraemer, on behalf of the agencies, thanked the participants for their valuable contributions, the chairman for the fine manner in which he had conducted the proceedings and the host Institute for the excellent facilities and support which had been provided.

7.3 The session closed on Friday 30 August 1991.

ANNEX 2

WMO/WHO/UNEP CONSULTATION
ON
INFORMATION NEEDS FOR WATER QUALITY ASSESSMENT
AND MANAGEMENT

# LIST OF PARTICIPANTS


Dr. Martine Allard
International Science
Liaison Co-ordinator
National Water Research Institute
867 Lakeshore Road
P.O. Box 5050
Burlington
Ontario L7R 4A6
Canada

Telex: 061 8296
Tel: (416) 336 6441
Fax: (416) 336 4989

Mr. John Chilton
Principal Hydrogeologist
British Geological Survey
Maclean Building
Wallingford
Oxfordshire OX10 8BB
United Kingdom

Telex: 849 365 HYDROL G
Tel: (0491) 38800
Ext. 2284
Fax: (0491) 25338

Dr. Adrian Demayo
Manager, Intern. Co-op.
Conservation and Protection
Technology Development Branch
Environment Canada
Ottawa
Ontario
Canada K1A OH3

Telex: 053 3608
Tel: (819) 953 3119
Fax: (819) 953 4705
953 9029

Prof. Dr. Jan Dojlido
Institute of Meteorology
and Water Management
Podlesna 61
01 673 Warsaw
Poland

Telex: 814 331 hm pl
Tel: (48 22) 341651/59
354926
Fax: (48 22) 345 466

Dr. Arthur Horowitz
U.S. Geological Survey
6481-B Peachtree
Industr. Blvd.
Doraville, GA 30360
USA

Tel: (404) 986 6860
Fax: (404) 986 6874

Dr. Vitaly Kimstach
Deputy Director
Hydrochemical Institute of the USSR
State Committee of Hydrometeorology
198 Stachki Avenue
Rostov-on-Don 344104
USSR

Telex: 123240 WODA SU
Tel: (863) -2-28 04 58
Fax: (863) -2-28 04 85

Mr. M. Abdelhadi Lahlou
Chief Engineer of Hydrology
Assistant Director of
Hydraulic Management
Charia Haouz
Zankat Rhamna
Rabat
Morocco

Tel: 516-26

Dr. Michel Meybeck
Laboratoire de Géologie Appliquée
Université de Pierre et Marie Curie
4, place Jussieu
Tour 26, 5ème etage
75252 Paris Cedex 05
France

Tel: (331) 4427 5148
Fax: (331) 4427 5125

Dr. Ed Ongley
Director
International Programmes Group
National Water Research Institute
867 Lakeshore Road
P.O. Box 5050
Burlington
Ontario L7R 4A6
Canada

Telex: 061 8296
Tel: (416) 336 6440
Fax: (416) 336 4989

Dr. David Rickert
US Geological Survey
414 National Center
Reston, VA 22092
USA

Tel: (703) 648 6862
Fax: (703) 648 5295

Dr. Daniel Ronen
Dept. of Environmental Sciences and
Energy Research
Weizmann Institute of Science
76100-Rehovot
Israel

Telex: 381 300
Tel: 972-8-342546
Fax: 972-8-344124

Mr. Swayne F. Scott
Chief
Water Resources Development and
Management Services
Land and Water Development Division
Food and Agriculture Organization (FAO)
Via delle Terme di Caracalla
00100 Rome
Italy

Telex: 610 181
Tel: (39-6) 579 71
Fax: (39-6) 5797-3152
578 26 10

Dr. Odon Starosolszky
Research Centre for Water
Resources Development (VITUKI)
P.O. Box 27
1453 Budapest
Republic of Hungary

Telex: 224959 hidro (h)
Tel: 00 361 1 142-617
00 361 1 338 160
Fax: 00 361-1-341-514

Dr. John D. Sutton
Agricultural Economist
Strategic Planning and Policy
Analysis Division
P.O. Box 2890
Room 6169-S
Soil Conservation Service
US Dept. of Agriculture
Washington, D.C. 20013
USA

Tel: 202 382 0122
Fax: 202 447 2646

Dr. Jan W. van der Made
Rijkswaterstaat
Tidal Water Division
P.O. Box 20907
2500 Ex the Hague
Netherlands

Telex: 33566 dgwkknl
Tel: 3170 374 5251
Fax: 3170 328 2059

Prof. Des E. Walling
Dept. of Geography
University of Exeter
Amory Building
Rennes Drive
Exeter EX4 4RJ
United Kingdom

Telex: 42894 EXUNIV G
Tel: (0392) 263 345
Fax: (0392) 263 305

Dr. W. Peter Williams
Monitoring and Assessment
Research Centre (MARC)
The Old Coach House
Campden Hill
London SW8 7AO
United Kingdom

Telex: 915407
Tel: 071-376 1577
Fax: 071-937-5396

## SECRETARIAT

Mr. John L. Bassier
Hydrology and Water Resources
Department
World Meteorological Organization
Case postale 2300
1211 Geneva 2
Switzerland

Telex: 414199 OMM CH
Tel: (41 22) 730 83 54
Fax: (41 22) 734 23 26

Mr. Dieter Kraemer
Hydrology and Water Resources
Department
World Meteorological Organization
Case postale 2300
1211 Geneva 2
Switzerland

Telex: 414199 OMM CH
Tel: (41 22) 730 83 38
Fax: (41 22) 734 23 26

Prof. Peter Peterson
United Nations Environment Programme
and Director
GEMS-Monitoring and Assessment
Research Centre (MARC)
The Old Coach House
Campden Hill
London SW8 7AD
United Kingdom

Telex: 915407
Tel: 071-376 1577
Fax: 071-937 5396

Dr. Veerle Vandeweerd
United Nations Environment Programme
P.O. Box 30552
Nairobi
Kenya

Telex: 22068 UNEP KE
Tel: 254(2) 3339 30
520600
Fax: 254(2) 520281

# LIST OF CZECH AND SLOVAK PARTICIPANTS


Tomas Bervinek, Mgr.
Czech Hydrometeorological Institute
Na Sabatce 17
Prague 4, 143 06
Czechoslovakia
Tel: (422) 40 95 308
Fax: (422) 40 10 800

Dr. Gabriela Babiakova
Institute of Hydrology and
Hydraulics SAS
Trnavska 32
Bratislava, 826 51
Czechoslovakia
Tel: (427) 61 226
Fax: (427) 62 419

Dr. Jaroslav Drako, CSc.
Slovak Hydrometeorological Institute
Jeseniova 17
Bratislava, 833 15
Czechoslovakia
Tel: (427) 37 12 47
Fax: (427) 37 49 27

Dr. Martin Guth
Czech Hydrometeorological Institute
Na Sabatce 17
Prague 4, 143 06
Czechoslovakia
Tel: (422) 40 95 310
Fax: (422) 40 10 800

Dr. Katarina Hajtasova
Slovak Hydrometeorological Institute
Jeseniova 17
Bratislava, 833 15
Czechoslovakia
Tel: (427) 37 11 92
(427) 37 43 31
Fax: (427) 42 181

Vit Kodes, Mgr.
Czech Hydrometeorological Institute
Na Sabatce 17
Prague 4, 143 06
Czechoslovakia
Tel: (422) 40 95 310
Fax: (422) 40 10 800

Ing. Stepan Krupicka, CSc.
The T.G. Masaryk
Water Research Institute
Podbabska 30
Prague 6, 160 62
Czechoslovakia
Telex: 122 517
Tel: (422) 3116741-9
Fax: (422) 311485

Dr. Ivan Kunsch, CSc.
Slovak Hydrometeorological Institute
Jeseniova 17
Bratislava, 833 15
Czechoslovakia
Telex: 922 08
Tel: (427) 47 546
Fax: (427) 42 181

Dr. Ludovit Molnar
Institute of Hydrology and
Hydraulics SAS
Trnavska 32
Bratislava, 826 51
Czechoslovakia

Tel: (427) 21 44 02
Fax: (427) 62 419

Dr. Darina Remenarova
Slovak Hydrometeorological Institute
Jeseniova 17
Bratislava, 833 15
Czechoslovakia

Telex: 932 65
922 08
Tel: (427) 37 38 07
Fax: (427) 21 75 73

Dr. Peter Roncak
Institute of Hydrology and
Hydraulics SAS
Trnavska 32
Bratislava, 826 51
Czechoslovakia

Tel: (427) 61 226
Fax: (427) 62 419

Dr. Ales Svoboda
Institute of Hydrology and
Hydraulics SAS
Trnavska 32
Bratislava, 826 51
Czechoslovakia

Tel: (427) 62419
Fax: (427) 62419

Ing. Tomas Trcka
Slovak Hydrometeorological Institute
Jeseniova 17
Bratislava, 833 15
Czechoslovakia

Telex: 93 265
992 208
Tel: (427) 37 38 07
Fax: (427) 21 75 73

Ing. Zdena Zeheova
Water Research Institute
Nabr. arm. gen. L. Svobodu 5
Bratislava, 812 49
Czechoslovakia

Tel: (427) 31 20 07

ANNEX 3

# PROGRAMME

| Date/Time | | |
|---|---|---|
| Sunday, 25 | Arrival of participants<br>Co-ordination meeting | |
| Monday, 26 | | |
| | Opening of consultation | Host country |
| | Introduction of questions to be addressed by the meeting (working document No. 9) | A. Demayo (Canada)<br>M. Meybeck (France) |
| | Introduction on the Dublin Conference and UNCED | D. Kraemer (WMO) |
| | Pollutant loadings and river flux assessment: a critical assessment (working document No. 2) | E. Ongley (Canada) |
| | Water quality assessment: a new concept for measuring the quality of surface water and groundwater (working document No. 1) | D. Rickert (USA) |
| | Evaluating the ability of USDA projects to protect water from non-point source agricultural pollution (addendum to working document No. 2) | D. Sutton (USA) |
| | Introduction on GEMS/WATER Operational Guide<br>Introduction of a draft chapter on quantitative hydrological measurement | M. Allard (Canada)<br>J.V. van der Made (Netherlands) |
| Tuesday, 27 | | |
| | Assessment of environmental impacts on human water uses and aquatic biota: a review of scientific requirements (working document No. 3) | W.P. Williams (UK) |
| | Water quality disease vectors and human health (working document No. 4) | R. Bos (WHO)<br>S.F. Scott (FAO) |
| | Use of the RAISON system in the GEMS/WATER programme | M. Allard |

| | | |
|---|---|---|
| | Evaluation of the progress achieved under the Mar del Plata Action Plan and the emergence of an integrated strategy for the 1990s: Information needs for- | |
| | (i) Water resource assessment (working document No. 5) | O. Starosolszky |
| | (ii) Water quality management (working document No. 6) | M. Meybeck |
| | (iii) Agricultural water management (working document No. 7) | S.F. Scott |
| | (iv) Introduction-Agenda 21 document | D. Kraemer |
| | Establishment of sub-groups | Chairman |
| Wednesday, 28 | | |
| | All day field trip, including presentation of a case study on integrated water quantity/quality assessment for the management of surface water and groundwater resources in the Danube river basin (working document No. 8) | Host country |
| Thursday, 29 | | |
| | Drafting of conclusions and recommendations by sub-groups | Participants |
| Friday, 30 | | |
| | General discussion and adoption of the conclusions and recommendations | Participants |
| | Closure of consultation | Host country |