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Water Resources Assessment and Integrated Management

Water Supply and Pollution Control

proceedings of the regional workshop
held in Hanoi, Viet Nam
8-11 November 1994

Viet Nam National Committee for the IHP
Hanoi
1995

Regional Workshop

on

Water Resources Assessment and Integrated Management

Water Supply and Pollution Control

Hanoi, Viet Nam
8-11 November 1994

Organised by:

Viet Nam National Committee for the IHP
Hydrometeorological Service of the Socialist Republic of Viet Nam
UNESCO Office Jakarta

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FOREWORD

The Regional Workshop on "Water Resources Assessment and Integrated Management - Water Supply and Pollution Control" organised in Hanoi from 8 to 11 November 1994, was a joint cooperation of the Vietnam National Committee for the International Hydrological Programme (IHP), the UNESCO Office Jakarta and UNEP (Nairobi) and supported by the Vietnam Hydrometeorological Service, Vietnam National Commission for UNESCO, Ministry of Water Resources, Ministry of Science, Technology and Environment. The initiative for the workshop was taken at the Regional Meeting of National Committees for the IHP in Kuala Lumpur in June 1990.

The Workshop was aimed at the exchange of experiences in the field of water resources assessment, integrated management, water supply and pollution control among countries in the region and international Organizations.

The Workshop highlighted the complexity of water issues, the strong variation of the water cycle and the impact of socio-economic activities on quality and quantity of water resources. Strong emphasis was put on the changing climate conditions leading to severe extreme values of floods and droughts in both frequency and intensity. This is an important concern in integrated water resources management in service of sustainable development in each country, as well as in the region and all over the world. The water shortage and variation/change in water budgets, water pollution, water supply and drainage for urban and rural areas require to be put into the planning of land use and water management.

This document presents the papers made in the Workshop. Besides, there were two sessions (the fourth and the fifth) discussing Pollution Control and Water Supply and the sixth session discussing the general outcome and recommendations of the Workshop. Out of these recommendations follow-up activities are being developed.

The proceedings have been prepared by the Vietnam National Committee for the IHP in collaboration with the UNESCO Office Jakarta.

Hanoi, July 1995
Prof. NGUYEN VIET PHO,
Chairman, Vietnam NC/IHP

OPENING SESSION

STATEMENT OF PROF. DR. NGUYEN DUC NGU, DIRECTOR GENERAL, HYDROMETEOROLOGICAL SERVICE OF S.R. OF VIETNAM

Dear Members of the Workshop Presidium,
Ladies and Gentlemen,

On behalf of the Hydrometeorological Service of S.R. of Viet Nam, the host Agency of the Viet Nam National Committee for the International Hydrological Programme, I would like to heartily welcome you, the delegates from UNESCO/ROSTSEA, UNEP, World Bank, the experts from international organisations, the representatives of ten countries in Southeast Asia and Vietnamese participants in the Workshop on "Water Resources Assessment and Integrated Management - Water Supply and Pollution Control".

Water resources assessment, water supply, integrated management of water resources and water pollution control are very important in the current conditions of climate change and to meet the increasing demands of water for human activities and sustainable development. The Hydrometeorological Service of Viet Nam with assigned responsibilities and duties, has been contributing to the purposes by observations, data collection, assessment of meteorological and hydrological resources and conditions, studies and forecasting in service of water resources exploitation, management and conservation. Being the host Agency of the Viet Nam National Committee for IHP, we actively cooperate with related national agencies to implement some programmes, projects under the IHP's framework like modelling studies, editing of Hydrometeorological Atlas, air and water environment investigation, reservoirs and their environment investigation, organisation of several workshops of this concern, etc.

We hope that during this Workshop the scientists and managers will have a chance to exchange experiences and technical progresses in the topics of the Workshop; this is very useful for us and you, all participants.

We wish you a good health and a successful Workshop.

Thank you.

STATEMENT OF PROF. NGUYEN VIET PHO, CHAIRMAN OF THE VIETNAM NATIONAL COMMITTEE FOR THE INTERNATIONAL HYDROLOGICAL PROGRAMME

Ladies and Gentlemen,

In the seventies the environment experts warned the world about the natural resources coming to limits. In the eighties they warned that the wastes in the environment surpassed the self purification limit of that environment. Recently, many environmentalists warned about climate changes that would lead to changes in water resources: in the lower latitudes rainfall might be reduced, the flood and drought extremes would be more severe in both intensity and frequency. In addition to increasing deforestation, water pollution and water hazards, water exhaustion in quantity and quality would be very substantial unless we have appropriate measures for protection and mitigation. In the last decades, Viet Nam underwent very high floods in the Red and Mekong rivers; mud floods and flash floods occurred in Son La, Lai Chau, Quang Binh, Thua Thien and Dak Lak. provinces; storms consecutively hit central Viet Nam and the Bac Bo (Northern Viet Nam) plains. All these events support the above mentioned observations.

Hence, the Viet Nam National Committee for the IHP warmly welcomes the decision made in the Kuala Lumpur meeting in June 1990 to carry out the Regional Workshop on "Water Resources Assessment and Integrated Management - Water Supply and Pollution Control" in Hanoi, Viet Nam. After the approval of the Viet Nam Government, the Viet Nam National Committee for the IHP in collaboration with the Viet Nam Hydrometeorological Service (HMS) and supported by the National Commission for UNESCO, the Ministry of Water Resources, the Ministry of Science, Technology and Environment made all arrangements for the organisation of the Workshop.

We warmly welcome the delegates representing 10 National Committees for the IHP in the region and the experts of international organisations who strongly support and take part in this Workshop in the exchange of scientific and technological experiences in this field. This will certainly be very useful to enhance our knowledge of water resources assessment, water supply, protection from and prevention of water pollution. We hope to gain more experience in the prevention of water pollution from various sources by a "green" design, industrial ecological production without or with limited waste and recycling. We hope that during the Workshop the cooperation among regional NCIHPs in the field of water resources with effective support from international organisations will be strengthened.

We wish you a very successful Workshop and all of you a good health.

Thank you.

WATER RESOURCES MANAGEMENT IN VIETNAM

Dr. TRAN NHON
Vice Minister of Water Resources

Distinguished guests,
Ladies and gentlemen,

Let me, on behalf of Ministry of Water Resources, give a warm welcome to all of the delegates participating in the Regional Workshop on Water Resources and on the occasion, I would like to extend to you a good health and happiness. We also wish our workshop good success.

We would like, hereafter, to present some problems of water resources management in Vietnam.

The water resources are rather abundant, including the surface and groundwater resources with the total annual amounts of about 860 and 100 billion m3 respectively, that are able to meet the needs of the socio-economical development in the country. Under the conditions of monsoon tropical climate, however, and the unequal rainfall distribution over space and time; storms, floods, inundations and droughts are common natural disasters and the typical characteristics of the climate and weather in Vietnam.

For the last forty years, the Vietnam water resources authority has overcome a lot of difficulties, made great efforts in development and great contributions to the implementation of the targets of production and its protection, as well as socio-economical targets: "making soil and water harmonise with each other constantly increasing the people's living level". The water resources development has freed Vietnam from constant shortage of food and annual import of its great amount in the past, provide water at present for 5.6 million ha of cultivated lands, 0.5 million ha of subsidiary and industrial crops areas, creating decisive prerequisite conditions for production of 25 million tons of food in excess of nutrient needs of the country and annual export of 1.5 - 2 million tons of rice.

Being assigned with responsibility for water resources management, the Ministry of Water Resources has made instructions in establishment of an economic water budget in every river basin in order to comprehensively exploit the water resources in the most reasonable, beneficial way for the national economic branches in the country including the exploitation of hydropower potential (theoretical, technical and economically feasible potentials) by means of reservoir cascades in large rivers.

Together with the industrial water users, the water resources agencies have participated in building reservoirs, weirs, pumping stations, canal networks, pipe lines, etc. to provide water for industrial, and domestic uses in the mountainous regions, rural areas and highly populated zones.

The Ministry of Water Resources is also responsible for the united management of a 7500km dike system including 5700km river dike and 1800km sea dike, which has been continuously consolidated and maintained, thus making active and significant contributions to the production protection and the stabilisation of the people's life in vast areas. At the same time, the water resources developments have also made a great active contributions to create the very decisive prerequisites in the environmental protection and development, to enrich the resources of soil, water, forest and to change the climate in some regions to create the fresh and brackish water environment in large areas, enriching the fresh and brackish aquaculture resources. The large canals and their banks, moreover, have been used as convenient communication roads and water ways and are the population and commercial sites with educational cultural centres for living improvement.

In the coming years, the water resources development has a very heavy workload. The national economy shifting to the market driven mechanism toward industrialisation, modernisation and new international cooperation. The water resources development stands before a lot of new, very new challenges:

1. The water resources development needs not to concentrate efforts mainly on rice and food crops production but should serve actively and efficiently the shifting of the agricultural economical structure, eliminating the monoculture, mere agriculture situation and should serve not only large food amount per capita but more important: higher goods value, a higher income value per ha or per worker.

2. As a result, the water resources development should not be concentrated only on the plain areas, flat areas in the midlands and mountainous regions, but should be expanded to irrigate steep lands also. The problems here are to find suitable water sources and conduct them to necessary cultivated areas, to select appropriate pump units, pipes and power sources so that the irrigation fees are not so high and acceptable for the water users.

3. The water resources development should also serve the agriculture and country sites for pushing up the industrialisation of villages, building a clean agriculture and building country sites developing on the advantages of agriculture in combination with related occupations and the processing industry.

4. The water resources development should satisfy the water needs of people and higher industrial development in the new stage.

5. An urgent requirement in the new situation is to strengthen the integrated state management in water resources from planning, investigation and design to construction and exploitation stages, to reinforce the united management of the hydraulic systems (instead of their separate management according to administrative territories) in order to ensure the structure and the whole system safety to serve highly effectively.

6. The management of technical standards, norms and quality from planning, investigation and design to construction, exploitation stages should be pushed up.

7. In management of the exploitation of the hydraulic structures, three of the following aspects should be paid much attention to: structure management, water management and economic management. The three aspects have the close interrelationship, a poor management of one aspect would influence and have a negative impact on the other two.

8. One extremely important function of the water resources development is storm prevention and flood control, the protection of production and the safety of the people's life and properties. In the coming years, this work should be gradually modernised, following the strategy guideline of the International Decade for Natural Disaster Reduction.

9. The international cooperation in water resources management on the border rivers and the rivers used and exploited by some countries should be well done to protect and use combined the water resources available on the basis of respecting the territorial sovereignty and integrity of each country. The close cooperation, therefore, with the International Organisation for the Mekong River with riparian countries of the Mekong and border rivers should be paid much attention to, in order to exploit the available water resources in service of the common development of river countries and to ensure the legitimate interests in the downstream regions in Vietnam.

10. The water resources conservation and pollution protection.

The data collected by the International Environmental Organisations and that of the Asian - Pacific Region has warned the mankind and our region of the reduction of the natural resources (soil, water, forest, etc) and the pollution of water, air and soil at the emergency level.

In Vietnam, the recorded data show that the water resources in many places have been seriously reduced and polluted. As a result, it is the time due attention should be paid on the water environment protection in water supply and water pollution control, gradual establishment of infrastructure for implementation of the management function of water environment exploitation and protection, especially concerning the accomplishment of legislative document for water resources management.

From the above mentioned situation and duties, the water resources management by law becomes an urgent requirement. Following the law promulgation program approved by the National Assembly in December 1993, the Ministry of Water Resources has been responsible for the preparation of the Water

From the above mentioned situation and duties, the water resources management by law becomes an urgent requirement. Following the law promulgation program approved by the National Assembly in December 1993, the Ministry of Water Resources has been responsible for the preparation of the Water Law. During the time of the law drafting, the departments under the Ministry of Water Resources have referred to and studied a lot of Vietnamese and foreign documents, organised several workshops, collected many comments from various agencies, authorities at different levels, Vietnamese and foreign experts in various fields and presently the fourteenth draft of the water law has been finalised.

THE BASIC VIEW POINTS EXPRESSED IN THE WATER LAW

The Water Law draft has been focused and based on the following basic viewpoints:

1. Water resources are people's property. The exploitation and utilisation of water resources are implemented in many relevant forms, such as the state licence or rents of water resources in long term or for limited periods to organisations or individuals to exploit and utilise, at the same time to preserve the water resources and to protect from harmful effects according to stipulations made by the law.

The contract of water exploitation and the trade registration for water utilisation, including joint ventures with the foreign counterparts should be closely attached to the rights, responsibilities and obligations of the organisations and individuals concerned.

2. To follow the market driven mechanism under the government's management in the water resources exploitation and utilisation.

The recognition of the value of water resources, the obligation to pay the taxes, the fees for waste water discharge and the contribution to the funds for protection from harmful effects caused by water should be observed.

3. The Water Law should be systematised and concurred with the existing law system of resources in order to increase the effectiveness of management of resources.

4. To ensure the state effective management, at the same time with the legal rights of the organisations and individuals in the water resources exploitation and utilisation.

5. To expand the international cooperation in the water resources exploitation and utilisation, to assure the legal rights of the foreign investors.

6. The water resources exploitation and utilisation should go along with the protection of water resources and hydraulic structures, the conservation of water sources, water pollution protection and the prevention from the harmful aspects caused by water.

7. The role of the inspection agencies specialised in water resources exploitation, utilisation and prevention should be clearly determined.

SOME APPROACHES IN WATER LAW DRAFTING

During the drafting of the water law, some important and complicated problems should be further discussed to get common agreement

1. Financial problems

In the law draft, some financial responsibilities and obligations of the organisations and individuals exploiting the water are stipulated:

- The beneficiaries (organisations and individuals) from the measures and structures for water supply, water drainage, protection from the harmful effects caused by water have to pay directly or indirectly the tax of resources and also to pay some fee for the operation, maintenance, upgrading and enlargement of the existing hydraulic facilities.
- The mineral producing agents have to contribute to the fund for water pollution and environment protection.
- The organisations and individuals should have to pay some fee for waste water discharge to eliminate the pollution harms caused by waste water.

- The regulations for international cooperation at the provincial level on border rivers aiming at production, commerce and tourism services.
- The distribution of functions for the state management of the water resources in national agencies and localities to heighten the responsibilities of the state management of water resources at central and local levels.

Above mentioned is a brief account on the situation of and responsibilities in water resources management in Vietnam. We do hope for the assistance and cooperation of agencies, the international organisations in attributing the knowledge and experience for water resources management in general and the water law drafting in particular. On the occasion, on behalf of Ministry of Water Resources we would like to extend our thanks to national agencies and the international organisations for the close cooperation and efficient assistance during last years in water resources development. Once more again, we wish our dear delegates and friends a good health and our cooperation in the water resources management new development steps.

Thank you very much.

OPENING STATEMENT UNESCO REPRESENTATIVE

M.J.G.BRUSSEL
UNESCO Office, Jakarta

Your Excellency,
Ladies and Gentlemen,

On behalf of UNESCO, the Regional Office for Science and Technology in South East Asia in Jakarta, I would like to welcome you all to this Regional Workshop on Water Resources Assessment and Integrated Management -Water Supply and Pollution Control-, here in Hanoi.
We are very honoured with the presence of H.E. Tran Nhon, the Deputy Minister of Water Resources. He will, apart from his opening address, open the technical sessions of Vietnam this afternoon with a special paper prepared for the meeting. I would particularly like to thank Dr. Nguyen Duc Ngu, director of the Vietnam Hydrometeorological Service, Prof. Nguyen Viet Pho, chairman of the National Committee for the IHP, Mr. Le Van Sanh secretary and Mr. Vu Van Tuan, for their efforts in arranging this workshop and their very warm welcome to Vietnam. A word of welcome is extended to Mr. Schneider from UNEP (Nairobi), co-sponsoring agency of the workshop, Mr. LeMoigne from the World Bank (Washington), Mr. Pollard form the UNDP/World Bank Regional Water Supply and Sanitation Programme in Jakarta, Mr. Hemo from UNDP Hanoi and Mr. Verboom, consultant from the Netherlands. We hope the workshop will in this way further contribute to increase inter-agency cooperation. We are glad to have all our regional participants here from Australia, China, Indonesia, Japan, Malaysia, the Philippines and Thailand and of course all Vietnamese professionals whose input will be decisive for the success of the workshop.

The concept for this Workshop originates from a meeting of National IHP Committees in 1993 in Manila. Following the presentation of a concise and comprehensive National Report on Water Resources in Vietnam, prepared by Prof. Nguyen Viet Pho, it was proposed by the Japanese Delegate that all nations would prepare and present such a report. This is one of the reasons we are here today.

If one flies in from the west to Hanoi, just a simple look out of the window gives you an overview of the importance and difficulties of water management and the use of water resources in Vietnam. Endless stretching rivers, dikes, man made canals and lakes and thousands of irrigated plots as far as the eye can see. Water with functions ranging from irrigation, to fisheries, power generation, water supply, transport and drainage. These various functions call for an integrated management, a need that grows every day as ever increasing human activities pose increasing threats to our water resources.

The humid tropics in Southeast Asia may hydrologically mainly be characterised by the occurrence of floods in the rainy season and droughts during the dry season. These floods and droughts seem to be intensifying in some areas as a result of climate change, further posing difficulties to the proper management of our precious resources.

To us the formidable task to try and understand the underlying principles, mechanisms and interactions. Hopefully this workshop will contribute to this goal in any way.

I wish you all an interesting workshop and a pleasant stay in Hanoi.

OPENING STATEMENT OF THE UNEP REPRESENTATIVE

G. SCHNEIDER
Programme Officer,
UNEP Nairobi

1. UNEP's unique Mandate, and major achievements

UNEP, around 20 years ago, was set up as an agency having a catalytic role in tackling major environmental problems. Rather than executing field / development projects, UNEP's task is to initiate action of other major players (f.i. UN - Agencies, Governments, the Public) to act on emerging environmental issues. Our focus is on environmental problems of global, or at least regional matters, major successes were: Montreal Protocol (Ozone), Climate Change and Biodiversity Conventions. I should also mention the Global Environment Monitoring System (GEMS), under which, at a global scale, Air and Water Data are collected and compiled. In order to make it a bit clearer what UNEP is doing, I brought some brochures and books which are exhibited here.

2. Activities in the field of Water Resources Assessment and Management

a) I already mentioned the GEMS/Water Activities. GEMS is a UN-wide activity, involving also WHO and UNESCO. Under GEMS, not only collecting (background and trend) data at global level is done. We also have those data treated statistically, interpreted and made available in understandable form to many institutions around the world.

Institutions operating GEMS/Water stations in developing countries are receiving various forms of support aimed at strengthening their capabilities, such as:

- Training courses to strengthen analytical and field skills;
- At very limited scale, receive necessary equipment (like computers);
- Receive advise on institutional matters

b) In the field of "Integrated Management of Freshwater Resources", we have been involved in the following:

- Assisting riparian countries in the management of shared water bodies, by: Preparation of Diagnostic Studies and Action Plans (Example exhibited here: Lake Chad, Aral Sea). I would like to explain this approach a bit:

In our Diagnostic Studies, we try to identify major water-related environmental problems in a certain basin, as well as major conflicting uses of water resources between sectors and countries. After its completion, the Diagnostic Study is submitted to concerned governments and agencies for adoption. Ideally, an Action Plan would then be commissioned, where "priority projects" based on the findings of the Diagnostic Study are outlined. This Action Plan then is again submitted to governments and agencies for adoption. Hopefully, "concrete actions" then can be started.

- Various training and "capability building" activities, production of publications on the subject;

- Participating in the "International Waters" portfolio of the Global Environment Facility: Lake Victoria Basin, East Africa;

- Various activities on "water pollution caused by mining", focusing on copper mining in Zambia, Malaysia, Papua-New Guinea, and Ecuador.

3. Our interest in this UNESCO-organised training course

a) We work quite closely with UNESCO in the field of water resources management. This training course is of special interest to us because it not only gives us the opportunity to lecture, but also to introduce UNEP to Vietnam (and possibly other countries in Indochina). We are really interested in learning also during this course what the specific water-related environmental problems of Vietnam and the wider Indochina region are, and how we can assist in tackling them.

We can offer to hold a 2-week training course on practical control of eutrophication in lakes and reservoirs, specifically for this region. This training course is well established, and has been very successfully held over the years. For your information, I brought a detailed program of the last training course held at our headquarters in Nairobi. I hope that we will get some feedback from you on that.

Therefore, we welcome the opportunity to hold discuss with officials from Vietnam, and from our sister agencies UNESCO and World Bank.

I hope that I can report back to our Regional Office in Bangkok, and to our management at headquarters very clearly what the needs of this region in the field of freshwater resources management are, and what our role could be in addressing them.

In this sense, I wish you and all of us a very fruitful training course.

WATER RESOURCES POLICIES AND STRATEGIES

GUY LE MOIGNE
Senior Water Resources Advisor,
The World Bank

I would like to thank Mr. Brussel and UNESCO for the invitation to join you and to speak about water resources policies and strategies, particularly about the activities of the World Bank in this area. I know that throughout the course of this seminar you will be making and listening to presentations by a number of international organizations and by country experts on many specific water resources assessments and on the problems of integrated management that are unique to various countries. I would like to take this opportunity to look at the "big picture", that is, at some of the issues that have renewed the commitment of the World Bank and UN agencies to water resources management. That commitment has taken the form, at least in the World Bank's case, of developing a policy that will guide World Bank activities in water resources. Following publication of that policy, a number of regions of the World Bank, including the Asia Region, have produced strategies for water resources management. These are strategies intended to put the principles articulated in the Bank's water policy into action, but of course they are strategies from the Bank's perspective. Also, the Bank, with the substantial influence of the UNDP, has produced a short generic guide to the process of formulating water resources strategy. This focus on policy and strategy of course has bearing on ongoing water resources management projects supported by the Bank, particularly in Asia. I would like to speak about the genesis and content of the World Bank's water policy and some of the issues surrounding strategies for water resources management.

As water resources professionals, many of you are already aware of the global challenges organizations such as the World Bank and the United Nations must face.. About one-third of the world's 5.4 billion people lack clean water or adequate sanitation (or both), and there are some 900 million cases each year of diarrhea linked to unclean water or poor sanitation. By median UN population projections, the number of people on the planet is expected to nearly double in the next 35 years; most of the growth will occur in urban areas in developing countries. This growth will substantially increase the demand for food, which will mean a greater demand for water for agriculture. Economic growth will also mean a rising demand for water for households and industry. Globally, fresh water appears to be abundant, but water scarcity in terms of annual renewable water resources per capita is a major problem in some 40 countries in the world. Even where, on a national level, water does not appear to be scarce, local and regional scarcity is a problem, for example in northern China and western and southern India. When water is scarce, countries may sometimes have to make awkward choices between quantity and quality. The engineering and environmental costs of procuring new supplies of clean water are escalating dramatically.

In Asia, however, particularly in South Asia, water scarcity is not as much of an issue as water quality and other questions of natural resources management. Let us pause just for a moment to look at the overall picture of resource availability and use for the region.

Woven into issues of supply and demand for water is of course the question of water quality, which provides the direct link to larger questions of natural resources management, such as questions of land use and planning. I know I need not elaborate for this audience the many interdependencies between water resources and other important factors in economic growth and the quality of human and other life. Maintaining a country's ability to grow, to "meet the needs of the present generation without compromising the needs of future generations" is at the heart of the catch phrase "sustainable development". It is also the principle that guides the integrated management of water resources.

The World Bank has long supported work on the water sector and has supported investments in water resources areas such as irrigation, water supply, sanitation, flood control, and hydropower. The Bank has already lent some $40 billion in support of water resources development, and plans to lend an additional $20 billion before the end of the century, which will probably be about 50% of all support for water resources that comes from external support agencies. Yet internal World Bank reports have suggested that the water resources investments supported by the Bank often encountered implementation, operational, and social problems in the past. On a practical level, underlying these problems was a cycle of poor - quality services, such as for water supply and sanitation, that resulted in the unwillingness of consumers to pay for these services, which meant inadequate operating funds and further deterioration in services. Moreover, the Bank perceived that environmental concerns were not being given sufficient attention by governments or by the Bank. In developing its water resources policy, which was published last year, the Bank was concerned about three problems in particular:

The first of these problems is the fragmented management of water resources. Many governments face growing problems in managing water resources because they have failed to address water resources management in a comprehensive manner. Government activities are generally organized so that each type of water use is managed by a separate and independent department or agency for example, irrigation, municipal water supply, power, and transportation. This fragmentation has often resulted in a failure to consider the cross sectoral effects of water activities, leading to waste and poor allocation of resources.

The second problem has been overextended government agencies. When water is scarce, governments tend to base allocations on political and social considerations rather than on purely economic criteria. Moreover, they have an understandable concern that relying exclusively on unregulated markets would not generate the best allocation. In many countries, the result has been a tradition of heavy dependence on government agencies for developing, operating, and maintaining water systems - with the noticeable absence of incentives for profitability and efficiency that typically motivate market participants. In addition, in most cases, water users have not been consulted or involved in the planning and managing of water resources.

The third major problem that needs to be addressed is the neglect of water quality, health, and environmental concerns. Countries have in general paid too little attention to water quality and pollution control. Many countries do not have standards to control water pollution or the ability to enforce existing legislation. Evaluations of water resource projects have often overlooked the cumulative environmental degradation caused by several projects, and interactions within the ecosystems have not been adequately considered. For example, because many irrigation projects in the past lacked a drainage component, the results have been serious waterlogging and salination of the soil.

In order to address these three major concerns, as well as many attendant areas, the Bank has proposed a new policy for water resources management. This policy, which has many aspects will guide the Bank's activities; the Bank will seek to encourage potential borrowers to adopt as much of its approach as possible, bearing in mind that individual country circumstances are different. There are two aspects of the policy ,which I would characterize as fundamental. These are, first, adoption of a comprehensive or integrated approach to water resources management, and second, taking actions that will strengthen the capacity of governments to carry out their essential roles.

The comprehensive or integrated approach was endorsed by the UN members at the 1992 Conference on Environment and Development in Rio de Janeiro. To quote from the results of that Conference, integrated water resources management is "based on the perception of water as an integral part of the ecosystem, a natural resource, and a social and economic good". The Conference also stressed "implementation of allocation decisions through demand management, pricing mechanisms, and regulatory measures". I add this to emphasize that the worldwide consensus has moved away from past approaches tending toward a "supply" focus that tended to center on new sources of water. The new focus is on "demand" policies that emphasize economic behavior, policies to overcome market and government failures, and technologies for increasing the efficiency of water use..

Building a country's capacity to manage its water resources is, both a means and an objective, and is crucial for long term, sustainable water resources management. Capacity building is not only building the formal institutions, such as successful municipal water supply agencies, but involving the end users of water, whether farmers, the urban poor, or industries, in the planning and execution of water policies, strategies and projects. The UN has put a great deal of emphasis on building human resources in its concept of "capacity building". The Delft Declaration issued in 1991 identified the three basic elements of capacity building as:

- Creating an enabling environment with appropriate policy and legal frameworks
- Institutional development, including community participation
- Human resources development and strengthening of managerial systems

I think the concept as envisioned at the World Bank is somewhat broader, but the goal is the same: to encourage countries to develop the ability to manage their water resources with minimal assistance from the outside..

I have spoken so far about the chief motivation for the World Bank's water resources policy and I have spoken about two of the key ideas, a comprehensive approach and capacity building that are behind the policy. I would now like to spend some time on the substance of that policy before I discuss strategies to put these ideas into place. I would say that there are eight main points to the Bank's policy.

The first four of these are:

- A comprehensive analytical framework that incorporates cross sectoral and environmental considerations.
- A greater emphasis on incentives for efficiency and financial accountability
- Establishing strong laws and regulations
- Decentralizing water service deliveries

Regarding a comprehensive analytical framework, the World Bank's policy states that water resources should be managed in the context of a national water strategy that reflects the nation's social, economic, and environmental objectives and that is based on an assessment of water resources. A comprehensive framework can help ensure that cross sectoral and environmental implications of water investments and use are taken into account and can overcome the problems caused by fragmented management. Often, the most appropriate management unit under a comprehensive framework is a river basin, since it is a reasonably self - contained hydrological system.

Establishment of proper incentives can induce better performance by providers of water services and efficient use by consumers, leading ultimately to a better allocation of water among different uses. A key component of an appropriate incentive system is the pricing of water. For example, when the city of Bogor, Indonesia increased water fees by 30 percent, the consumption of water declined by a similar rate, and expensive investments in new supply sources were postponed. A good starting point for incentives is to ensure that charges cover the cost of water service entities. Such charges ensure the sustainability of financially autonomous entities, where incentives for efficient operations are closer to those of businesses. Privatization of water services and transfer of ownership or operational responsibility to the community are reforms that improve incentives. Guinea provides a striking example: some 18 months after responsibility for supplying urban areas with water was turned over to a private supplier, the fee collection rate had increased from 15 percent to 70 percent, and services had improved markedly.

Laws and regulations covering monopoly organisations, environmental protection and other aspects of water management that are not adequately handled by unregulated market forces can be a foundation for effective water resources management. Many countries are examining their legal and regulatory structures with special attention to water ownership and rights. Chile, for example, has a very interesting regime for tradable water rights. The area of water rights is too closely tied to cultural norms that many experts are not optimistic about the possibility of such popular ideas as tradable water markets succeeding everywhere. In Asia, for example, where paddy irrigation is an important use of water, tradable water rights may be a dubious proposition. However, enforceable laws and regulations are very necessary in environmental protection, especially for such measures as protection of coastal and inland ecosystems that support vital fisheries and aquatic ecosystems.

With a foundation of appropriate legal and regulatory procedures, and with an appropriate coordinating framework, the management and delivery of water services can be decentralized, increasing local and community control and improving efficiency. Many countries are encouraging user associations to take more control of water management. In an effort to both decentralize and involve beneficiaries, Mexico has transferred management of 78 irrigation districts (covering more than 1.8 million hectares) to water users associations, which will be responsible for operating and maintaining all canals and the water distribution system.

The next four points:

- Stakeholder Participation
- Protecting, enhancing, and restoring water quality and ecosystems
- Greater priority on services for the poor
- Research, development and adoption of low- cost technologies

Experiences have shown that the participation of "stakeholders"-- individuals and institutions that would be affected by decisions about water resources management-- in formulating strategies and in planning, designing, implementing, and managing water activities is not only good management practice but also helps to build necessary political and social consensus. Water users are willing to pay for services that are designed to cater to their needs, which improves the ability to sustain water services financially. In projects in Bangladesh and Kenya, water users not only participate in establishing rural water and sanitation systems but also manage them.

B. Protecting existing ecosystems is typically less costly than attempting to restore water quality or to restore valuable ecosystems once damage has been done. For example, until the 1960s, the Aral Sea was environmentally stable and had a large commercial fishing industry. The massive diversion of water sources to expand irrigated cotton production eventually shrank the Aral sea by 66 percent, with consequences that were simply disastrous. Had authorities considered those consequences, a different scale of diversion might have resulted, and costly efforts to save the Aral Sea now would not be necessary.

C Providing adequate services to the poor will help to stop the spread of disease. Regarding cost for water delivery to the poor, fee schedules can be structured so that consumers receive a limited amount of water at low cost and pay a higher fee for additional water. The Istanbul Water and Sewerage authority has institutionalised block volumetric water charges, where water charges up to a minimum to meet basic health requirements are kept particularly low. This system requires that individual consumers be metered, however.

D Finally, some of the most noteworthy successes in "demand management" of water resources have come from low cost technologies to conserve water and enhance its quality. Mexico City has replaced some 350,000 toilets with small, efficient models, and saved enough water to meet the household needs of a quarter of a million residents.

Each of the measures I have discussed above is worthwhile in itself, but their full potential will be realized only if they are all integrated in a country s water resources management practices. Many countries have already put some of these elements into place, while others are just beginning. France is one country whose water resources management regime incorporates most of the elements of the comprehensive approach.

Basically, the French system is organized around six major hydrographic basins with national policy oversight. Each of the six basins has a basin committee and a corresponding executing agency called a water board. The basin committee is a sort of "water parliament" that reflects regional control. The water boards are responsible to the central government for certain technical maters, such as upholding national quality standards. Water and sewerage services are provided by public or private firms chosen by communities. Finally, the system is fairly autonomous financially. I do not cite this system merely because I am French; In fact, the French system has served as a model for other countries. But it has taken years for this system of river basin management and water parliaments to evolve.

As I mentioned before, the best policies are of little use unless they are implemented. I would like to turn now to how the comprehensive approach to water resources can be put into place, which means the formulation of *strategies* to manage the resource. Before strategies can be formulated, however, a country, region, or locale should have goals and policies in place. The general process I am going to describe is something of a template, that is, a process that could be applied in many situations, but I shall refer to it on a national level. Many countries, regions, or localities have used processes similar to this in developing a water resources strategy; there is even an academic name attached to it, it is a "rational"- type model. However, we all know that the world and its governments are not totally rational, which makes for a great deal of innovation!

What is the difference between an objective, a policy and a strategy? These words and others are used frequently and I want to be clear now about what they mean to me in the context of water resources management. An *objective,* is of course a goal, an end point. A country may have, for example, a development goal of food self sufficiency. A *policy* is generally defined as a course or method of action to guide and determine decisions. In the example I just gave, the goal of food self- sufficiency may generate a general policy of support for farmers and agricultural industries. Now, a *strategy* is how the policies are to be put into place. The classic definition of strategy is "the science and art of employing the political, economic, psychological, and military forces of a nation or group of nations to afford the maximum support to adopted policies in peace or war".

How often we water resources professionals wish we would have the political, economic, psychological and military forces of the nation behind us! In short, a strategy is a plan or method that is employed to obtain a goal; it is the means of translating policy into action. Specifically, a water resources management strategy is a set of medium- to long- term action programs to support the achievement of development goals and to implement water- related policies. As I conceive it, a national water resources management strategy does not include project identification, ranking, or financing; in this sense, a strategy is between policies and projects.

One question that is often asked is how a water resources strategy differs from master plans, "quick" or "rapid" assessments, and the like. A master plan is usually investment or project- oriented; the product of a master plan is often a specific set of investments to be made or projects to be undertaken. Master plans have a role to play in water resources management if they are viewed as an investment plan that follows the accepted policies and strategies. In the past, however, many master plans have not adequately considered the institutional and human resources frameworks that are important to water management. Master plans have often neglected the long term issue of building a country's water management capacity. Also, many such plans have been developed with considerable expatriate involvement, and some have not considered national development objectives or the acceptability of plans to government decision makers or water resources stakeholders.

In contrast to master plans, which often take a long time to develop, "quick assessments" or "rapid assessments have been used to justify immediate investments. The objective of these assessments is to determine critical issues for prompt consideration while longer term needs are being examined. Quick assessments may be necessary in the short term; they have the merit of rapidly bringing the major issues that need to be addressed to the attention of decision makers. However, they, too, often do not address the long term issue of building a country s ability to manage its resources in a sustainable manner. Building capacity is a medium- to long term affair.

I wish to concentrate on strategy because it is the first means of putting some of the principles of comprehensive water resources management into practice. Most importantly, however, the process of formulating a strategy can help countries to develop the capacity to manage their water resources. In this way we can say that the process of formulating a strategy, as long as it is with minimum outside assistance, can be just as or more valuable than agreeing to the principles of a comprehensive approach, for it is a practical exercise in capacity building. Water resources assessments are an important part of strategy formulation.

Before describing the general process, I would like to emphasize one aspect of the type of strategy formulation that takes the comprehensive approach. That aspect is participation of stakeholders in the strategy formulation process. The concept of such participation will be familiar to many of you from project work. It basically involves those with an interest in water resources in the assessments and decision making-- and often in the execution of strategy as well. It is a way of ensuring a consensus, of enhancing creativity, and of building people's awareness of water and capacity to manage it. This participation can take many forms. Stakeholders may be involved as observers, listeners, reviewers, advisors, or actual decision makers. It should be up to the country and the team formulating strategy to decide how one of its greatest resources, the users of water, will be involved.

There are several critical elements that should be in place before the actual strategy process begins.

Development Objectives and key water related policies should be articulated as clearly as possible

As the highest levels, the government should make a commitment to the process of formulating a water strategy and to water management using a comprehensive approach. This commitment can take various forms.

The government should recruit a team of national experts responsible for the process and content of strategy formulation.

The expert team should determine the partners and the process for strategy formulation and agree with its oversight body on terms of reference for strategy formulation

I think it is especially important to emphasize that the strategy formulation exercise must remain above all a *manageable* process. For some countries it may take months, for others a year or two, but it must have appropriate deadlines.

Phase 1 of strategy formulation is an actual water resources assessment. In many countries, previous national or regional assessments may help to abbreviate this phase. It involves first, a review of development objectives and policies, taking an inventory of key resources (including institutional resources), and identifying, selecting, analyzing and ranking key issues. The inventory will, I hope, be largely self- explanatory; it includes not only the physical supply of water but its quality, and covers also the fields of information about water resources, and institutional and human resources. Key issues may include such things as pollution of groundwater, lack of sanitation facilities, or difficulties with water allocation among neighboring nations. On that issue, it is important to consider that, since, many water resources are international, it may be useless to proceed without further discussion with neighboring nations or perhaps an effort to form joint international assessments.

An interim would allow the expert team to review the process thus far and make decisions about proceeding.

Finally, Phase 2 of strategy formulation is developing and evaluating options and making recommendations to government decision makers. Formulating a strategy is not quite complete until the government has chosen among various options for its strategy.

Among the many facets that could be examined in this process, some of which I have mentioned before, are:

- Institutional and Human Resources
- Information
- The Role of Economics (including water pricing and allocation)
- Ecological and Public Health Issues
- International Issues

Thus far, I have presented the challenges that motivated the World Bank's water resources policy and talked about many of the aspects of comprehensive water resources management. The World Bank is committed in the policy paper to assisting countries that wish to tackle individual problems using elements of the comprehensive approach.

Formulating a water resources strategy is an important step in beginning to implement such an approach. The outline I presented of strategy formulation offers a general process for countries, regions, or locales. I would like to turn to policies and strategies in Asia. Water resources development in Asian countries typically accounts for 20 to 25 percent of total public investment. Irrigation projects in particular have fueled regional and national development. Almost every country in Asia has some sort of water policy or plan, and several governments have published statements of national policy, for example, India and Thailand.

The extent to which national water policies go through strategy or legislation varies. China, for example, is systematic in this regard; plans that were formed on the basic of hydrological basins have been combined into a national water plan. Basin plans are also used in Korea and the Philippines, although I do not believe these have yet been consolidated into national plans. Many international treaties and statements establish the river or hydrological basin as the unit of analysis or planning. I do not think this approach is incompatible with the sort of "top down" strategy formulation exercise I have described. Each country will of course take their own route, but I believe that a successful effort to integrate many aspects of water resources planning and management called for in the comprehensive approach requires a national level effort. Many countries in Asia take what is essentially a "sectoral" approach to water resources, for example, planning for water supply and sanitation, or planning for the hydro-electric sector. These are certainly beneficial, but again, they for the most part do not take into account the uses of water across sectors.

The comprehensive or integrated approach to water resources management is first and foremost a multidisciplinary approach. If specialists in various sectors are to influence water resources policies and strategies in future, they must at minimum have an appreciation of other disciplines. This means irrigation engineers who consider ecological matters, dam experts who consider public health, and ecologists who understand water supply issues. This is what the new policies and strategies will mean to us as representatives of institutions and as individuals.

Thank you all for your attention.

SESSION ONE

PRESENTATIONS BY EXPERTS FROM INTERNATIONAL ORGANISATIONS

RATIONALE AND POSSIBLE STRATEGIES FOR COMBATTING AQUATIC WEEDS

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ABSTRACT

By using the case of Lake Victoria's infestation with Water Hyacinth (Eichhornia crassipes) as an example, its detrimental effects (especially on fisheries), and possible control methods for aquatic weeds are explored. Whether mechanical, chemical or biological methods, or combinations thereof should be chosen, partly depends on the institutional set-up in a given country. Also, introduction of biological agents in international waters requires agreement between riparian states. If any taken measures are to be successful, sources of re-infestation must be controlled properly.

INTRODUCTION

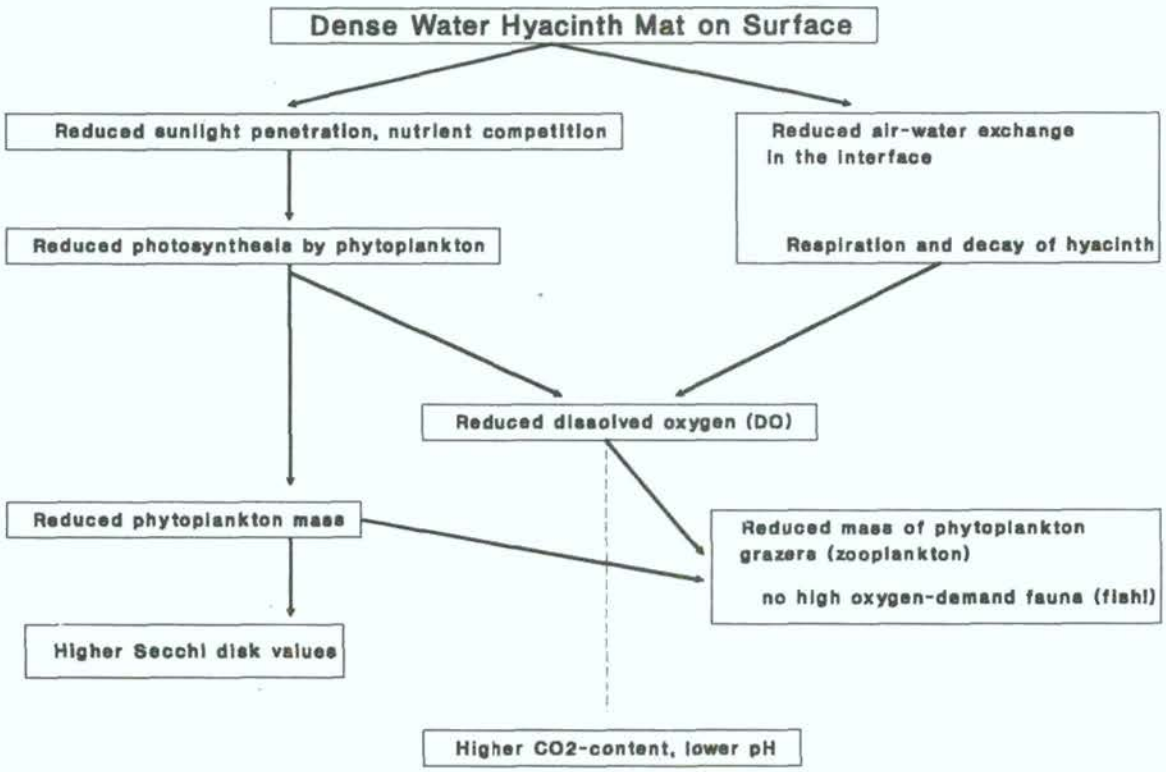
The exact date of introduction of water hyacinth (Eichhornia crassipes) in Lake Victoria is unknown, and various theories how this happened were brought forward. It is assumed by some that water hyacinth escaped from an ornamental pond in Rwanda into river Kagera, which is the major tributary of Lake Victoria. Since end of the 80s, it has spread tremendously, and various negative repercussions, especially on the Ugandan side of the lake (where it spread most) are encountered (Table 1).

Table 1: Overview of negative consequences of water hyacinth mats in lakes on beneficial human uses

1)	On Fisheries:	Fish landing sites' accessibility problematic, more time of fishermen needed to reach fishing grounds; breeding sites for fishes (near the shores) through covering negatively affected
2)	Water Supply:	Intake points of waterworks being clogged (additional costs to keep water hyacinths away)
3)	Hydroenergy generation:	Clogging of turbines if plants are not kept away (Owen Falls Dam, Uganda)
4)	Human health:	Near-shore mats suitable habitats for certain snails (schisostomia vectors) and mosquitos (malaria)
5)	Agriculture:	Clogging of irrigation channels (flooding, human health)
6)	Transport:	Same as 1)
7)	Others:	Due to high evaporation, water losses; Biodiversity in wetlands (?)

Apart from those effects on beneficial human uses, various changes in water quality beneath those mats are being observed (Fig. 1):

Fig. 1: Effects of Water Hyacinth Mats on Water Quality (of a water column covered by a mat!)



Conditions for Spreading of Water Hyacinth

Once introduced, water hyacinth thrives in bays and inlets under following conditions:

(a) Shelter from strong wind and wave action;
(b) Gently-sloping shores that are relatively shallow (< 6 meters);
(c) A muddy bottom, rich in organic matter;
(d) Nutrients (especially available N and P): According to the literature, water hyacinth is very adaptive to different nutrient conditions. It is widely reported that water hyacinth is spreading far more rapidly in eutrophic waters.

Efforts towards positive uses of water hyacinth

Since water hyacinth is encountered all over the tropics, and due to the vast amounts of biomass it produces in affected water bodies, there were (and are!) numerous efforts and projects to make positive use of water hyacinth. Amongst other ideas, it was proposed to use water hyacinth as feed for livestock (pigs), for producing potash, fertilizer, or compost/mulch, and paper. Also, it was suggested to use it as a source of energy (briquettes, or biogas), and in wastewater treatment (removal of heavy metals).
However, looking at the chemical composition of water hyacinth, things look more sober:

Chemical Composition of Water Hyacinth:

95% water, 5% dry matter
Dry Matter (ash residue): 50% silica, 30% potassium, 1.5% Nitrogen
Protein Content: Less than 0.5% of fresh plant

Consequences of this composition for uses proposed are:

- As a livestock feed: It contains too much silica, calcium oxalate, potassium, and too little protein. Thus, it would be necessary to mix it with other feed materials.
- As a fertilizer or mulch: It has a high C:N ratio, thus making addition of N-fertilizer necessary.
- As raw material for paper: Since its fibre length is short, only low-quality paper can be produced.
- For biogas: Technically feasible without major problem. However, this use alone is also uneconomical. It could be possible to recover some costs incurred while practicing mechanical eradication.
- In wastewater treatment (removal of heavy metals): Although shown to be effective, a problem would be the large amount of plant material (and thus sludge) obtained, containing low concentrations of heavy metals. This would make use of the sludge, for instance in agriculture, difficult.

Even if some beneficial uses of the water hyacinth itself are envisaged (until now none of those proposed could be shown to be economical!), negative impacts as shown in Table 1 normally render control measures imperative. An overview of various methods, their advantages and disadvantages, is given in table 2.

Table 2: Possible Control Methods for Water Hyacinth

METHODS	ADVANTAGES	DISADVANTAGES
Mechanical (evtl. use of plant material)	No risks to ecosystem; no sophisticated means necessary (can be done by local communities); Fast success at limited locations; possible use of plant material for biogas generation	Harvesters expensive (foreign exchange); if done with hand tools, time-consuming, especially if large areas are infested; continuous + permanent effort necessary; institutional problems
Chemical (Herbicides)	easy to apply; quick results on limited scale (f.i. important transport/irrigation channels)	expensive; high contamination risks to local population; effective?; O_2-deficiency due to rotting mats, evtl. fish-kills
Biological (applications of weevils and/or moths)	long-term efficiency(?); no direct risks for population; simple 'project' approach possible	Time-lag before efficient; unknown long-term effects on ecosystems; infrastructure for propagation of agents necessary; in international waters: agreement between riparian states necessary

Whatever method or sets of methods are selected, may also depend on the institutional framework in place in a certain country, which is explored in following paragraph.

Institutional Implications of Eradication Methods

Looking at governmental structures, eradication of aquatic weeds in most tropical countries would involve different departments/ministries: Since they are weeds, often departments/ministries of agriculture are in charge. However, since fisheries often are worst affected, those in charge of administering fisheries have a strong interest in being involved. Also, water (due to negative effects on water intake points), as well as environment departments (wetlands' management) have interests at stake. In case foreign donor support is anticipated, those various interests may become conflicting, even within one national government only. This has happened in the case of Lake Victoria, and has led to delays in taking action. Therefore, clear structures and modes of co-operation between various governmental departments seem to be of importance.

Since normally user groups such as fishermen (and drawers of drinking water) are most directly affected, their views and involvement have to be sought also. Those 'user groups' are needed in order to define priorities. This again is crucial, since combatting water weeds normally is a long-term effort. Table 3 summarizes necessary considerations to be given to institutional arrangements, depending on method, or combinations of methods selected.

Table 3: Institutional Implications of Eradication Methods

1) Mechanical:	Unless big harvesters are bought (foreign exchange?), strong involvement of riparian and fisheries communities is necessary. Naturally, remuneration and disbursing of funds, either to individuals or communities for work accomplished, is difficult. Communities' involvement is also to be sought for building infrastructure for use of plant material (biogas, or mulch), and for avoiding re-infection from dumps and other sources.
2) Chemical:	Apart from an 'information component' to avoid accidents, no community involvement necessary; governmental departments, or other organizations would do the job; a problem is fish toxicity of chemicals used, and possibly oxygen deficiency through rotting mats also inducing fish kills. This may require compensation to fishermen.
3) Biological:	Little involvement of local communities necessary. Field research stations, or other scientific institutions would propagate and release weevils. Often, it is controversial who takes the risk, e.g. who should make decisions on that (especially in international waters).
4) Combining 1+3:	This would call for broad involvement of both local communities, governmental departments, and scientific institutions.

CONCLUSION

By using the case of water hyacinth infestation of Lake Victoria, East Africa, various control methods for aquatic weeds have been discussed. It has been shown that in this case possibly a combination of mechanical and biological methods would be promising. Mechanical methods, be it removal of plants with sophisticated harvesters or simple hand-tools, allow short-term measures at priority sites such as drinking water intake points, harbors, and prime fish landing sites. Biological methods such as the introduction of highly specific weevils or moths, are more appropriate in achieving a long-term stabilization of the weed population.
Application of herbicides in the African context seems problematic, due to the many (and scattered) water users around a lake. It may be justified only in exceptional situations.

Depending on the local circumstances, the conclusions on which methods to chose may differ. However, always a combination of methods should be considered (with a 'mechanical component' for priority sites), and a reasonable infrastructure for the work undertaken should be established. It is noted that resource users such as riparian and fishermen communities should be involved closely, if a lasting success is to be obtained.

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ASSESSING RISKS OF EUTROPHICATION OF A LAKE BY CALCULATING ORGANIC AND NUTRIENT LOADS FROM ITS CATCHMENT

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ABSTRACT

To assess whether a lake is approaching eutrophic status, often is not easy to determine, especially when its original trophic structure has been changed. Lake Victoria is given as such a case, where the introduction of the Nile Perch (Lates niloticus) has depleted stocks of detritus- and plankton-feeders, due to its heavy predation on haplochromine cichlids. Therefore, periodic algae blooms and associated hypolimnetic anoxia may not be solely attributed to the increased nutrient load entering such a lake.

Methods are presented on how to calculate the loads of highly-degradable organic pollutants (measured as Biological Oxygen Demand, BOD_5), and of Nitrogen and Phosphorus, both from point and non-point sources of pollution. For assessing point-sources of pollution, the WHO Rapid Assessment Methodology is presented. For calculating estimates of loads from non-point sources of pollution (such as agriculture), the unit area load concept is discussed, as it had been applied in the management of the North American Great Lakes. By inputting calculated loads into a Vollenweider Model, expected Phosphorus and Nitrogen concentrations in a given lake can be calculated, and thus its risks of eutrophication be determined.

This information allows prioritizing of pollution control measures in a catchment, and thus is of vital importance for management of water quality.

INTRODUCTION

In many lakes, the introduction of exotic species for increased fish production has changed the original foodweb. At the same time, land use in their catchments is being intensified, leading to increased loads of organic pollutants, sediments, and nutrients. Therefore, symptoms like periodic algae blooms, and hypolimnetic anoxia (sometimes leading to fish killings during mixing events), may not be only symptoms of eutrophication, but also of a changed foodweb, where plankton- and detritus-feeders have been depleted by introduced predators (see Fig. 1). In those cases, apart from monitoring water quality, calculating the loads of nutrients, both from point as well as from non-point sources, may be helpful. By inputting those data into 'Vollenweider Model' equations, expected concentrations in the lake's water can be estimated, as can its risk to accelerated eutrophication.

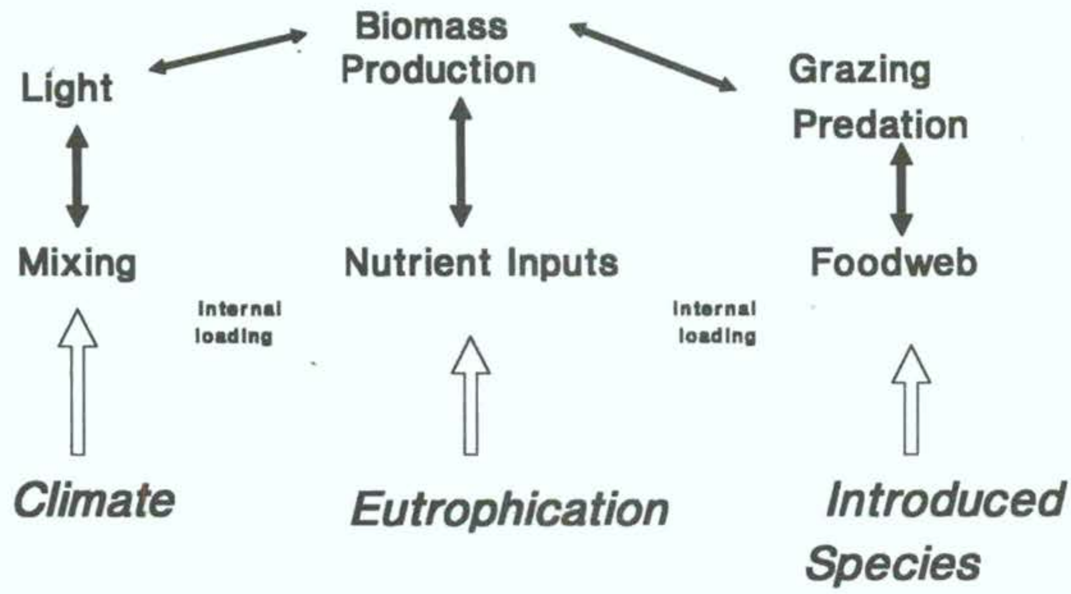

Fig. 1: Factors affecting a lake ecosystem

Such an exercise has been done for the Kenyan part of Lake Victoria in East Africa, the so-called Winam Gulf (Calamari et al., 1994). For calculating loads of highly-degradable organic matter (measured as Biological Oxygen Demand, BOD_5) from point-sources such as factories, the WHO Rapid Assessment Methodology (Economopoulos 1993) is presented. For estimating loads of P and N from non-point sources, especially from crop production and animal husbandry, as well as from urban run-off, the unit area load concept is discussed (Ryding and Rast 1989).

The Case of Lake Victoria

Lake Victoria in East Africa, with a surface area of 68,800 km^2, is the second largest lake in the world. Introduction of exotic species (Fish species: Lates niloticus, Oreochromis niloticus; Aquatic weed: Eichhornia crassipes), and intensified industrial and agricultural activities in its catchment have changed the original foodweb structure (Fig. 2), and possibly its trophic status. Threats to water quality in nearshore areas, and to sustainable use of its various resources exist (Vidaeus and Schneider, 1992).

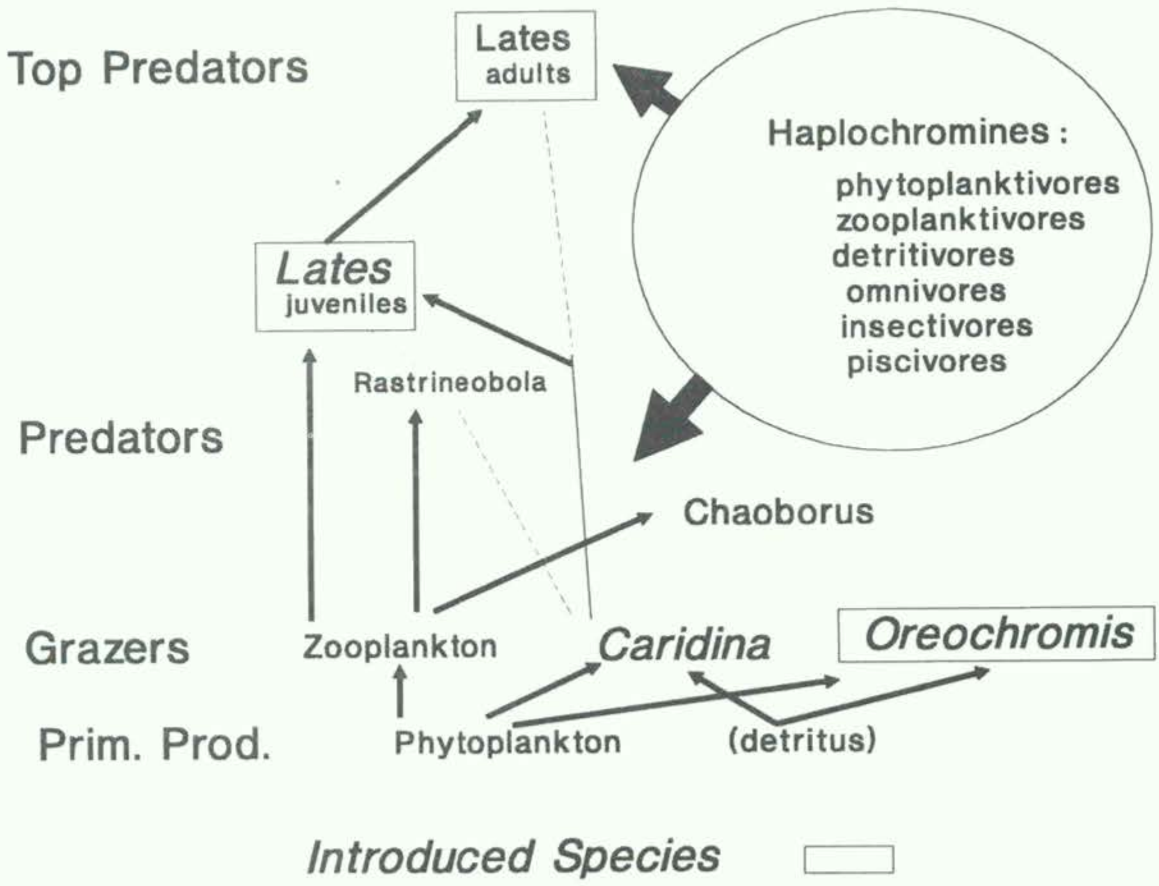

Fig. 2: Simplified Lake Victoria food web. The left side represents the current trophic structure, while the cloud of Haplochromines represents a diverse assemblage existing at a variety of tropic levels.

In following paragraphs, a short example is given how loads of BOD_5 have been calculated for the Kenyan part of that lake (Calamari et al., 1994), and how a rapid risk assessment has been done[1]

Quantification of Urban Loads

As an example, the calculation for the town of Kisumu is presented (Kisumu is the largest town in the Kenyan catchment of Lake Victoria). Naturally, figures on population connected to various sanitary systems are difficult to come by in Africa. Therefore, the authors made the assumption that one third each of the population was connected to sewers (e.g. to a municipal sewage treatment plant), to septic tanks, and to pit latrines.

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[1] It should be noted that the surface of the Winam Gulf accounts just for 6% of Lake Victoria's whole surface. Mixing of waters of the gulf with that of the 'open waters' of Lake Victoria is partly impeded due to the Rusinga Island off the Winam Gulf, but mixing still occurs (see maps of the area on page 7). Therefore, to deal with the Winam Gulf, and its Kenyan catchment as a separate lake basin, is methodologically problematic. However, from a management perspective at country level (e.g. Kenya), it appears justified in this case.

Baseline data of Kisumu town (estimates)

Population	185,000
Population connected to sewers	(1/3) 61,667
Population with septic tanks	(1/3) 61,667
Population with pit latrines	(1/3) 61,666

The BOD_5-calculation for 'human waste' now is running as follows:

(a) Septic tanks:

A conservative estimate for the BOD_5 load of inhabitants connected to septic tanks is 30 g/capita*day.

Population using septic tanks	61,667
Total BOD_5 from septic tanks	61,667 x 30g = 1,850,010 (equivalent to 1,850 kg/day)

(b) Pit latrines:

An estimated BOD_5 value for people using latrines is 19-22 g/capita*day. The value used here is 20g/capita*day.

Estimated Population using latrines	61,666
Total BOD_5 from latrines	61,666 x 20g = 1,233,320 g/day (equivalent to 1,233 kg/day)

(c) Domestic sewerage (eg. connected to municipal treatment plant):

Estimated daily BOD_5 of domestic sewage in Kenya	23 g/capita*day
Estimated Population sewered	66,667
Total BOD_5 from treatment plant	66,667 x 23g = 1,533,341 g/day (equivalent to 1,533.3 kg/day)

(d) Estimate of Refuse/Solid Waste Leachate

In Africa, urban/municipal solid waste is often dumped on heaps (either centrally, near the roadside, or on individual compounds), where it is burnt periodically. Under these conditions substantive quantities of leachate must be expected. An estimate of this BOD_5-contribution is given below:

Solid waste generation rates Population Waste generated (185,000 x 0.4kg)	0.4 kg/capita*day 185,000 74,000 kg/day (74 tons/day)

Again, it is difficult to estimate the leachate emanating from this 'daily waste'. As a 'literature value', an estimated daily leachate of BOD_5 from the solid waste, 9.5 g/capita*day was used in cited paper (Calamari et al., 1994). Thus, the daily leached BOD_5 from solid waste is: 185,000 * 9.5g = 1,757.5 kg/day or 1.7 tons/day.

The box below shows the total BOD-load assumed to enter Lake Victoria from the municipality of Kisumu:

(e) <u>Total BOD_5 Load</u> (reaching the lake from Kisumu town, estimated)

Leachate from refuse	1,757.5 kg/day
Septic tanks	1,850.0 kg/day
Latrines	1,233.3 kg/day
Domestic sewage	1,533.3 kg/day
TOTAL	**6,374.1 kg/day**

It is possible to translate this BOD_5 load into equivalents of kg P and N per year. For doing this, one would have to know more in detail the chemical composition of the 'BOD_5-load' (or to use figures from the literature), which is beyond the scope of this paper.

Quantification of Industrial Loads

Since many industries in the developing world do not apply a precise monitoring of their effluent and wastes, to obtain precise figures on those is difficult. A possible solution is to make 'reasonable estimates' of those industrial pollution loads.

A possibility for a preliminary calculation of industrial loads is to use the WHO Rapid Assessment Methodology (Economopoulos 1993). For each type of industry, a 'waste load factor' per unit of product is assumed. Also a 'penetration factor' for various types and efficiencies of sewage treatment applied is proposed. This allows calculation of the BOD_5-load emitted as:

Daily production [Unit] * waste load factor * penetration factor = BOD_5 [kg/day].

This means, that for achieving reasonably good figures, some production figures, and technical arrangements for sewage treatment of the industries in a given catchment must be known. If it is not possible to visit industrial plants and to inquire personally, those figures may also be obtained from statistical materials such as production figures from chambers of commerce.

An example for such a calculation is given below, calculating the BOD_5 load of the Chemelil Sugar Company in Kenya, processing sugar cane into sugar.

Chemelil Sugar Company

Production	3,000 tons/day
Waste load factor per ton	2.9 kg
Penetration factor[2]	0.23
Waste load	0.667 kg BOD_5/ton
Waste load per day	0.677 x 3,000 = 2,001 kg/day
Industrial BOD_5-load	2,001 kg/day

With no treatment facility: 8,700 kg BOD_5/day

3,000 x 2.9 x 1 (Penetration factor)

Results of those calculations are depicted below in maps of the area (after Calamari et al., 1994, amended).

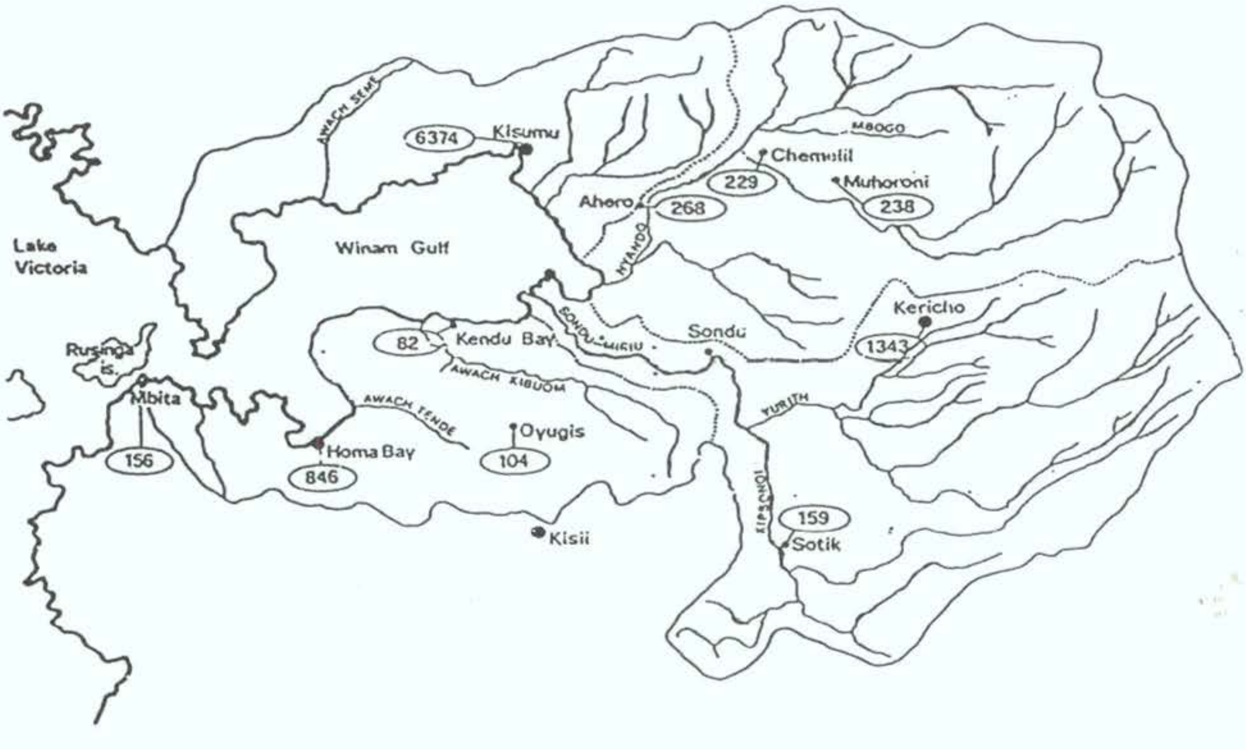

Fig. 3: Urban Loads in [kg/day] of BOD_5 into the Winam Gulf, Kenya, emanating from the catchment

[2] **The 'penetration factor' ranges from 0 to 1. While a factor of 1 means that 100 percent of the sewage generated at a factory is released untreated, the factor 0.23 means that 77% of the BOD-load is removed through treatment facilities at the plant. In the Kenyan case, often mechanical treatment (especially through settlement ponds), is practiced.**

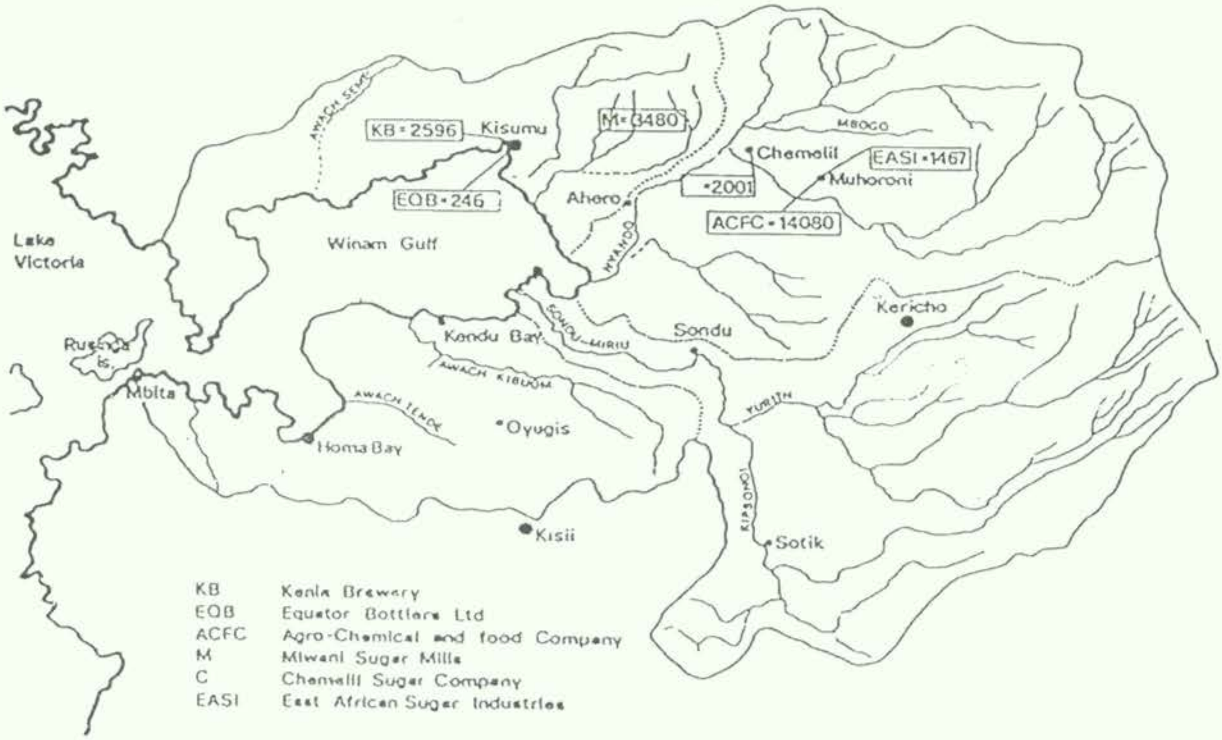

Fig. 4: Industrial Loads in [kg/day] of BOD_5 into the Winam Gulf, Kenya, emanating from the Catchment

<u>The Unit Area Load Concept</u>

Above calculations of urban and industrial loads have to be complemented by figures on agricultural land use (crop production, and animal husbandry), which often are large sources of nutrients and sediments to water bodies. Following are some tables on P and N loads from various agricultural and livestock raising activities. Those figures have been arrived at empirically, largely through studies in countries of the temperate zones, and should be used cautiously while applying for tropical and subtropical countries. Also, quite wide ranges even within certain land-uses occur. Nevertheless, in the absence of direct field measurements, they can be of use.

As an alternative to above calculation of urban/municipal loads using an average figure for each inhabitant, urban loads can also be calculated on an areal basis, e.g. in the unit [kg P or N per ha and year], on which some examples and tables are given further below.

Agricultural Loads

Following tables 1 and 2 show Phosphorus unit area loads for land under various agricultural uses. The texture of the topsoil, e.g. its clay content is a strong determinant of those loads, due to the fact that rainfall infiltration is much lower in clayey soils than in sandy soils (and thus the run-off much higher).

Table 1: Total Phosphorus unit area loads (kg/ha*yr) for rural cropland (after Ryding and Rast, 1989)

Land use	Surface Soil Texture				
	Sand	Coarse loam	Medium loam	Fine loam	Clay
Cultivated fields - row crops (low animal density)	0.25	0.65	0.85	1.05	1.25[a]
Cultivated fields - mixed farming (medium animal density)	0.10	0.20	0.30	0.55	0.85

[a]Unit area loads can be higher for soils with very high clay content.

As depicted, areas under row crops like potatoes and sugar beet, where a substantive percentage of soil surface is not covered by plant material in the early phases of the vegetative cycles, experience substantive P-losses.

Table 2: Total Phosphorus unit area loads (kg/ha*yr) for rural non-cropland (after Ryding and Rast, 1989)

Land use and intensity	Surface soil texture					
	Sand	Coarse loam	Medium loam	Fine loam	Clay	Organic
Pasture/range - dairy	0.05	0.05	0.10	0.40	0.60	-
Grassland/idle land	0.05	0.05	0.10	0.15	0.25	-
Forest/wooded	0.05	-	-	-	0.10[a]	-
Wetlands	-	-	-	-	-	0.20

[a]Unit area loads may be higher in certain unique forested areas with clay soils.

Animal Husbandry

(a) Animals with direct access/contact to the water body

Livestock (and human beings also!) having direct access to a water body, and fish cultivation have considerable BOD_5 and nutrient inputs. Some figures are shown in table 3.

Table 3: Nutrient load characteristics based on direct utilization of a waterbody (after Ryding and Rast, 1989; amended)

Type of load	Annual population equivalents[a] in terms of		
	BOD_5	Total N	Total P
1. Duck breeding with free access to the water (100 ducks/day)	14	8-12	16
2. Duck farming on slatted floors with swimming troughs (100 ducks/day)	11	7	10
3. Geese breeding with free access to the water (100 geese/day)	42	24-36	48
4a. Trout cultivation in channels per 1000 kg true rate of stocking/day[b]	85	110	110
4b. Average load per day at an annual production of 1000 kg fresh weight of fish in net cages in channels	30	30	30
5. Recreation loads caused by primary body contact (100 bathing persons/day; seasonal mean)	2	2	2

[a]One (daily!) population equivalent (P.E.) = 54g BOD_5; 13g N; and 2g P. Use P and N values for P- and N-limited waterbodies, respectively. For non-nutrient-limited waterbodies, use P.E. values of BOD_5.

[b]Since approximately 50% of the nutrients are bound to particles, it should be possible to reduce the load by almost 50% using settling basins.

(b) Animals kept in feedlots, and land receiving manure

Table 4: Unit area load values for land used for feedlots and manure disposal (after Ryding and Rast, 1989)

Land use	Unit area load (kg/ha*yr)	
	Total Nitrogen	Total Phosphorus
Land receiving manure[a]	4-13	0.8-2.9
Feedlots[b]	100-1600	10-620

[a]Crop or unused land used for manure disposal.

[b]Runoff from confined, non-enclosed animal holding and feeding areas.

While in Africa this source is only exceptionally of importance, in other parts of the world, notably Europe and Asia, this is a major source for nutrients entering waterbodies

Different Calculation of Urban Loads

As an alternative to above calculation of urban loads using average figures for per capita emissions depending on sanitary arrangements, one can also use the unit area concept for urban areas. Differentiating factors then are sewer systems, and the degree of industrialization (see table 5). Also, precipitation and percentage of impermeable surface are important determinants.

Table 5: Total Phosphorus unit area loads (kg/ha*yr) for urban land[a] (after Ryding and Rast, 1989)

	Degree of industrialization		
Type of urban area	Low	Medium	High
Combined sewered areas	9	10	11
Separate sewered areas	1.25	2.5	3.0
Unsewered areas	1.25	-	-
Small urban areas (sewer systems not differentiated	2.5	2.5	2.5
Urbanizing land (e.g. construction sites)	25	25	25

[a]Based on data from the North American Great Lakes Basin

The high figure for 'urbanizing land', e.g. construction sites, should be noted. Various measures (for instance covering the open surface) can be taken.

Again, all those figures in above tables can be used only with caution, and a lot of specific knowledge of the local situation.

Using the data obtained as input to a 'Vollenweider Model'

After having concluded calculating the load from a catchment to a lake, it is then possible to calculate expected values (for instance of P content) in the lake's water, using a Vollenweider Model. An example, a calculation on the Kenyan part of Lake Victoria (the Winam Gulf) inputting the P load estimated, is given below:

Empirical formula for a model calculation of P-concentration in a lake (after Calamari et al. 1994, amended)

$$[P] = \frac{L(P)}{\bar{Z}/\tau_w \cdot (1 + \sqrt{\tau_w})}$$

[P] = Conc P total in µg/l

L(P) = P load in mg/m².year (lake surface)

$\bar{Z}$ = Lake mean depth in m

τ_w = Time of recharge in years (residential time)

$$\tau_w = \frac{V}{Q}$$

V = Volume of the lake (i.e. Winam Gulf only!)

Q = Annual tributary in-flow(affluents)

Baseline data for the Winam Gulf, and P unit area loads assumed (after Calamari et al., 1994)

CATCHMENT AREA	Km²	12000
SURFACE AREA	Km²	1400
AVERAGE DEPTH	m	6
VOLUME	m³	8.4x10[illegible]
ANNUAL IN-FLOW	m³	1.6x10[illegible]
(ANNUAL IN-FLOW)	m³	2.5x10[illegible]
MEAN ANNUAL RAINFALL (1.3M)	m³	15.6x10[illegible]
MEAN CONC. P[illegible] RIVERS (earlier reports)	mg/l	0.030
1991 CONC. P[illegible] RIVERS (measured 1992)	mg/l	0.055
	P-Loads/Unit Area Factors	
2x10[illegible] INHABITANTS	0.2 kg/y	
0.5x10[illegible] CATTLE	0.95 kg/y	
0.15x10[illegible] SHEEP/GOATS	0.15 kg/y	
36% CULTIVATED LAND	0.4 kg/ha.year	
64% NON-CULTIVATED LAND	0.1 kg/ha.year	

Results of the calculation of the model Phosphorus load from the Kenyan catchment into the Winam Gulf (after Calamari et al., 1994)

Catchment area: 1.200.000 ha

36% cultivated	$432 \times 10^3 \times 0.4$ kg/y	=	216 t/y
64% non cultivated	$768 \times 10^3 \times 0.1$ kg/y	=	77 t/y
Inhabitants	$2000 \times 10^3 \times 0.2$ kg/y	=	400 t/y
Cattle	$500 \times 10^3 \times 0.95$ kg/y	=	475 t/y
Sheep/goats	$150 \times 10^3 \times 0.15$ kg/y	=	22 t/y
Total			**1190 t/y**

$$L[P] = \frac{load/y}{lake\ surface} = \frac{1190x10^9 mg/y}{1.4x10^9} = 850 mg/m^2$$

$$\tau_w = \frac{1.4x10^9 x6}{2.5x10^9} = 3.36\ years$$

$$[P] = \frac{L[P]}{\bar{z}/\tau w \cdot [1+(\tau_w)^{1/2}]} = \frac{850}{5} = 170 \mu g\ P\text{-}Tot/l$$

The model overestimated the actual P_{tot}-concentration in the Winam Gulf considerably (the bulk of measured data from the Winam Gulf was in the range of 3-40 mgP_{tot}/l), probably for following reasons: By using the formula of a 'Vollenweider Model', a separate lake was to be modelled. However, the Winam Gulf is only a sub-basin of the large Lake Victoria, and mixing of the (quite polluted) waters of the Winam Gulf with the relatively unpolluted waters of the larger lake occur (see also Footnote 1 on page 3). Also, the calculations of the nutrient loads are done with uncertainties, especially with regard to the unit area loads of Phosphorus and Nitrogen to be applied under the specific local conditions, as only few of such figures have been measured empirically in the tropics.

CONCLUSION

While errors of calculations described above may be substantial, it could be shown that those calculations yield useful results, more from a management than a scientific perspective, though. 'Hot spots' of pollution, and problematic land uses (f.i. certain agricultural practices) can be identified, and environmental management programs and priority investment schemes be designed accordingly. Wherever possible, field measurements should accompany those calculations, in order to receive figures for the specific local conditions. This would also increase credibility and legitimacy of pollution control measures taken by concerned authorities.

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INTEGRATED WATER RESOURCES MANAGEMENT IN RELATION TO IHP-V

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1. BACKGROUND ON THE IHP PROGRAMME

The purpose of this meeting is to discuss the topic of Water Resources Management, to look into the National Reports prepared by a number of nations in the region of Southeast Asia and to think about possible activities in regional cooperation in these fields.

The IHP programme will be used to clarify the presently available UNESCO plans for the future in guiding the discussion on the development of new initiatives in Southeast Asia.

The IHP is an Intergovernmental Programme, which operates through a network of National Committees and project working groups, extending upwards to a Bureau and a Council. The IHP addresses itself to the long- term goal of advancing our understanding of the processes occurring in the water cycle and integrating this knowledge into water resources management. Originating from the International Hydrological Decade (1965-1975), as one of the first "global" programmes in environmental sciences, the first phase of IHP commenced in 1975. Within the present fourth phase, the programme has three principal aims:

- to improve scientific and technical knowledge of freshwater processes;
- to stimulate conservation and responsible management of water resources by decisionmakers and the public;
- to train the necessary personnel and build up research and training institutions;

We are now approaching the final year of this fourth phase of IHP and preparations for a fifth phase (1996- 2001) are underway. The origins of the Humid Tropics Programme date back to April 1987. It was recognised that the socio- economic problems of the humid tropics and the urgency of the need to address associated water management issues, warranted a separate programme under the auspices of the IHP. An International meeting was held in partnership with UNEP and several other co- sponsoring agencies at the James Cook University of North Queensland, Townsville, Australia in July 1989, under the title of the "International Colloquium on the development of Hydrological and Water Management Strategies in the Humid Tropics". A series of recommendations on follow- up actions emanated from that Colloquium which are currently being implemented in stages.

2. THE PROPOSED IHP- V PROGRAMME

The fifth phase of UNESCO s International Hydrological Programme has been given the general theme: "Hydrology and Water Resources Development in a Vulnerable Environment". Particular emphasis will be laid on scale problems, issues related to eco-hydrology, connections between hydrology and climate and the vulnerability of increasingly scarce water resources. The final programme will be discussed at the IHP council meeting in Paris in January 1995, after comments have been received from all players, most importantly the IHP National Committees/focal points as well as co-operating governmental and intergovernmental agencies.

Key objectives in the programmes are to improve knowledge of the hydrological sciences, to transfer results effectively across borders, to foster cooperation among members and to enable nations to tackle shared problems more effectively. The results of the applied research need to be incorporated as promptly as possible into established education and training programmes.

The IHP- V programme is largely based on concepts related to freshwater issues, that have been developed at recent international conventions, the International Conference on Water and Environment which was held in Dublin in January 1992, and the UNCED conference in Rio de Janeiro. Also reflected are the recommendations of the UNESCO/ WMO/ICSU International Conference on Hydrology towards the 21st Century: Research and Operational Needs, held in Paris in March 1993.

3. A POLICY FRAMEWORK ON WATER RESOURCES ASSESSMENT AND INTEGRATED MANAGEMENT, COUPLED TO THE IHP INITIATIVE

Important principles have arisen out of the Dublin conference that touch the key of the integrated use of water resources:

1. *Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment.*
2. *Water development and management should be based on a participatory approach, involving users, planners and policy makers at all levels.*
3. *Water has an economic value in all its competing uses and should be recognised as an economic good.*

In order to be effective, Integrated Water Resources Management must accommodate a number of important physical, economical and social linkages and interactions:

- Linkages between the systems of groundwater and surface water relating to both quality and quantity.
- Interactions between land and water ecosystems.
- The complex context in which human activities take place in terms of managing the multiple demands purposes, means and actors.
- An integrated approach should include and emphasize environmental and social consequences in both the short and long terms.
- Allocation of water among competing uses and users.

The following principal areas of concern are deemed to be most important to address at the regional level in the near future within the area of Integrated Water Resources Management:

1. The role of scale in hydrological processes
2. Vulnerability of the environment
3. Education, Training and Transfer of technology (KIT)

1 . Different regions require different approaches to water management. The zone of the humid tropics is considered especially vulnerable in light of the fact that 40% of the worlds population will inhabit this belt by the year 2000.

Scale problems may be tackled amongst others by comparative hydrological studies; which will be promoted by UNESCO. This will lead to improved knowledge on Hydrological and Biochemical processes and their relationships at different scales.

2. The buffering capacity of the environment against unexpected shocks or long term trends needs to be preserved or enhanced. Appropriate criteria must be assessed to address the vulnerability of water resources.

3. Education, training and the transfer of knowledge are key elements in trying to achieve sustainable long term development, even the more so, since todays complexity of water resource development calls for most efficient usage of our human resources capital.

Within IHP- V, eight themes have been identified out of which the following are relevant to the subject of Water Resources Management and South East Asia: (numbers refer to the numbers used in IHP- V)

3. Groundwater resources at risk
4. Strategies for Water Resources Management in emergency and conflicting situations.

6. Humid tropics hydrology and water management

7. Integrated urban water management

8. The overall theme of transfer of Knowledge, Information and Technology.

In the attached appendices A and B, some topics for project proposals are listed. Those in appendix B have been developed within the IHP- V framework. All topics have been selected to serve as ideas for discussion in this workshop and possible projects to be carried out in the region.

3. One of the most serious problems worldwide and especially in the Humid Tropics is the degradation of groundwater. Groundwater is a vulnerable resource, since it can be exposed easily to pollution through its contact with surface water as well as through direct seepage of pollutants. Furthermore, the risks of depletion of groundwater, leading to a number of adverse effects is significant in already a large number of areas, especially in the densely populated coastal strips in Southeast Asia. These are due to extreme depletion of resources, grave pollution (mainly due to modern chemical compounds stemming from industrialisation and agricultural practices) and the penetration of salt tongues into sweet water aquifers.

4. Water may become the subject/cause of conflicts. These may range from conflicts of use between local users up to the international level. Important would be the cultural component stemming from the different perceptions of the value of water.

6. Rapid economic growth has further aggravated the environmentally unsound development of water resources. The complex social structures, combined with a lack of knowledge on hydro-ecological relationships of natural systems, show that the tropics are a vulnerable environment. The continued analysis of humid tropics hydrological phenomena at different scales is still considered to be of the utmost importance.

7. As 50% of the worlds population will be living in urban areas by the year 2000, an increasing demand for domestic and industrial water use will arise. As a result of this, the environmental stress that can already be observed in a number of Southeast Asian metropoles will only grow. The sustaining of the quality and quantity of the water resources in urban areas calls for an integrated approach, addressing all aspects of urban water management, such as drainage, water supply, sewerage, possible pollution stemming from solid waste and industries, as well as legal, institutional and political aspects. More emphasis needs to be laid on qualitative research.

8. The transfer of hydrological and water resources KIT should be incorporated in all mentioned activities, not as a separate entity but rather as an umbrella to cover resources, process and management studies as well as regional studies on Integrated Water Resources Management in different climatic zones. The generation of KIT is to be considered as an indispensable and strong component of any project to be undertaken.

Important goals of KIT are:

- To speed up of the adequate transfer of research and technological development on water resources development and management,
- To further the professional and managerial skills at all levels to apply the techniques for solving multidisciplinary water resources problems,
- To foster co- operation among nations and regional or international programmes for education and training facilities, for appropriate learning technologies, for the exchange of information and experts in the field of Hydrology and Water Resources.

4. OUTLINE OF THE SESSION ON REGIONAL COOPERATION

The purpose of this session is to prepare a small number of project outline documents for hydrological study that are of immediate concern to the region. These can be based upon the topics presented here and/or other relevant topics coming up during the meeting.

Working procedures:

Establishing of a working group that will meet before the meeting and discuss the required inputs from various people, as well as the framework of the discussions.

An executive summary of the meeting results will need to be made available on the spot, taking into account the various recommendations that have been made, including possible draft outlines of projects.

Results of this session will immediately be brought forward to the regional IHP meeting which will be held in Cambodia, from 28 Nov- 3 Dec.1994, where the framework for cooperation of the entire IHP programme in the region will be discussed.

The following factors are proposed to be addressed in the preparation of agreed topics for projects: (relate to appendix C).

- Broad requirements of project outline documents: (length, format and key items)
- Host governments priority for proposals
- The element of technology transfer
- Selection of a host country or base out of which a project will be run, determine inputs from host countries in the form of personnel, facilities, transport etc.
- Inputs from other countries in the region to a specific project.
- The possibilities of attracting donor funds
- Estimates for the required funds.
- The Knowledge and Information Transfer component and training.
- The timing and duration of projects
- As it may be envisaged that an amount of funding attracted for particular projects will be insufficient, it is advisable that each project be reduced to a number of discrete sub-projects that can be carried out with available funds.

For operational projects, other factors need to be added:

- To take into account in each project outline the importance of socio- cultural, economic, environmental and legislative factors
- To discuss means to identify proper information and how to disseminate it to all countries in the region.

Strong intellectual and financial cooperation is required from funding of national and international donor agencies, since regular programme funds of UNESCO are limited. It is expected that the national efforts be channelled into the international effort.

Within UNESCO's funding competence are international workshops, symposia, training activities, data facilities and small operational projects.

APPENDICES

A. PROJECT PROPOSALS FOR REGIONAL COOPERATION IN THE FRAMEWORK OF WATER RESOURCES ASSESSMENT AND INTEGRATED MANAGEMENT

The following list of possible topics has been provided for discussion and reflection.

Emphasis should be laid on practical study, technology transfer and the promotion of pilot and demonstration projects.

A reference is given to the earlier explained themes within IHP V, whenever applicable.

Project Area I: *Setting up a regional information network for hydrological and hydrogeological data as well as water quality data relevant to assist in policy decisions.*

- Making an inventory of the existing networks.
- Evaluating quantity and quality of the data that are being collected by the various countries in the region .
- Suggesting physical updates of data gathering networks based on common guidelines and strategies.

IHP- V reference: 6.4

Project Area II: *A study into the principles of looking at water as an economic good. Pricing and accounting of water.*

Water pricing can be viewed as an instrument to decrease the exaggerated usage of water and to be able to control allocations to the various users. When trying to implement pricing systems for commodities such as water for agricultural use as well as domestic and industrial supply, the mechanics of water is pricing, when implemented, have usually been based on the principle that no price for the resource "water" is determined, but the cost of the required infrastructure and additional investments required, in terms of the following components:

- Investment costs
- Operation and Maintenance Costs
- Re- investment costs
- Short and long term depreciation
- Costs of removing pollutants
- Costs of sustaining aquifers and basins

Aim is to promote the perception of water as an economic good and attach a price based on the principles of water accounting and hydrological study. Components of the project will include: sociological and cultural backgrounds, effective management strategies, Environmental Health Education, information dissemination on the proper use of water.

Within this study, strong emphasis should be put on the principles of demand management.

IHP- V reference: 4.3

Project Area III: *Transfer of knowledge on the use of Geographical Information Systems in Water Resources Management.*

Being dubbed as the humid tropics, it could not be imagined until recently that water scarcity would actually become a major problem. A regional monitoring network providing a global view of the hydrological systems through remote sensing and GIS, would provide the means to assess relevant factors in the creation of an integrated management of water resources and the safeguarding of the quality thereof. Information serving as basis for the inventory may include: rainfall, evapotranspiration, surface water runoff, slope, geological characteristics, catchment data, morphological data.

IHP- V reference:

Project Area IV: *Comprehensive techniques for Environmental Impact Assessment of water resource usage*

Principles and knowledge of the Environmental Impact Assessment of local interventions on the regional hydrological cycle may be developed, as well as studies on the impacts to transboundary basins and hydrological systems. This would lead to increased capabilities to monitor transboundary fresh water resources in quality and quantity and the development of sustainable policies to counter water related problems and create integrated approaches to the various objectives of water use. The apparent data scarcity in a number of developing countries needs to be enhanced to arrive at a set of minimum conditions to be able to usefully carry out an Environmental Impact Assessment.

Special elements may be incorporated such as the Environmental Impact Assessment of resources for water supply for large urban centres.

IHP- V reference: 4.2 and 7.2

Project Area V: *Establishing an inventory of national water resources in terms of water quality.*

- Groundwater quality inventory
- Surface water quality inventory

IHP- V reference: 3.1

B. PROPOSED PROJECTS WITHIN THE IHP- V FRAMEWORK RELATING TO WATER RESOURCES MANAGEMENT

In the following projects, the Jakarta Regional Office for Science and Technology might coordinate the efforts for the region in coordination with the national IHP committees.

Theme 3: Groundwater resources at risk

Project 3.1. Groundwater contamination inventory.

Regional workshops may be organised to harmonise methodologies, interpretation and boundary conditions, as well as to prepare regional maps and databases and standardised methodological guidelines.

Project 3.4. Groundwater contamination caused by urban development.

To be incorporated in a nation s national water quality resources report, to document the likeliness of groundwater contamination in present and future urbanisation trends.

Project 3.5. Agricultural threats to groundwater resources.

Identification of the vulnerability of groundwater to agricultural practices concerning regional scale groundwater resources.

Theme 4. Strategies for water Resources Management in emergency and conflicting situations.

Project 4.2. Comprehensive environmental risk and impact assessment.

To develop and improve risk and impact assessment methodologies to be able to cope with rare events and emergency situations (toxic material release, oil spills, droughts, radionuclide contamination).

Project 4.3. Non structural measures for water management problems.

Development of laws, regulations, standards, priorities, and water pricing mechanisms to enhance water saving in the agricultural, industrial and domestic sectors.

Theme 6. Humid tropics hydrology and water management

Project 6.3. Integrated water management for sustainable development in the humid tropics. The incorporation of the hydro- ecological component into water resources projects in the humid tropics. Development and promotion of demand management instead of supply management.

Project 6.4. The technology transfer of hydrological research and experiences in water management across the humid tropics. Creation of a media for mutual understanding of the hydro-climatological, geographical and/or sociological similar neighbouring countries, publication of river catalogues in the region, establishment of a regional hydrological data bank, training courses for data bank and data handling;

To be implemented by the Regional Steering Committee composed of representatives of each country of the region;

Theme 7. Integrated urban water management

Project 7.2. Surface and groundwater management in urban environments. Providing a comprehensive analysis of the needs for integrated water management in the urban and surrounding areas encompassing technological developments, environmental constraints, socio- economic aspects and institutional arrangements;

Analysing the impact of urbanisation on surface and groundwater quality through point and non- point pollution;

Examining pollution loads in receiving water courses.

Establishing a regional centre of UNESCO on Water Resources Management studies in urbanised areas, and of a bibliographic data base.

C. PROJECT PROPOSALS FOR REGIONAL COOPERATION PROJECTS IN THE FRAMEWORK OF WATER RESOURCES ASSESSMENT AND INTEGRATED MANAGEMENT

Standard form for the preparation of a project outline

The following structure of project outlines may be adhered to:

1. Project Description.
2. Background / Justification
3. Objectives.
4. Location.
5. Country / Organisation to take initiative.
6. Involved Organisations / Persons.
7. Methods of Implementation.
8. Existing data and initiatives of governments, other donor agencies and regional organisations that might be interesting to link up to. Overview of what has been done in the field on this particular subject.
9. Inputs.
10. Outputs.
11. Envisaged Duration.
12. Possibilities to attract funds from donor agencies.
13. Actions to be taken.

UNDP ACTIVITIES IN WATER MANAGEMENT

ROLF HERNO
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Dear Mr. Vice - Minister,
Ladies and Gentlemen,

I am very pleased to be invited to participate in this workshop on "Water Resources Assessment and Integrated Management". The purpose of my speech will be to present those activities of the United Nations Development Programme that relate broadly to the safeguarding and management of water resources in Viet Nam.

It should be made clear from the beginning that the United Nations Development Programme has at least two major functions. One function is, of course, to provide grant assistance to projects requested by the Government of Viet Nam. This enables us to carry out a number of interventions in the water resources area, sometimes in association with other multilateral and bilateral donors, although we often wish that more funds were available.

The other function of the United Nations Development Programme is to assist the Government in coordinating the external technical assistance and to mobilise additional funds for the country. In this field, we work closely with the State Planning Committee and the various line ministries to match the priorities of donors with those of the Government, and to explore new funding possibilities.

In terms of project assistance for water resources, the United Nations Development Programme has increasingly focused on disaster mitigation and disaster management. The largest and most severe natural disasters affecting Viet Nam are water disasters. Heavy rainfalls create river floods and flash floods in uplands areas. Floods often render freshwater supplies useless for a long period through infiltration and contamination. In some cases flood disasters claim more victims from the after-effects of lack of clean drinking water and adequate sanitation than from the actual flooding. The present severe floods in the Mekong Delta bear witness to the severity of the problem of rain - induced floods and the effects they have on the livelihood of the population and even the national economy.

On average 4 - 6 strong typhoons arrive on the coast of Viet Nam each year, bringing with them strong surges and wave action that inundate coastal areas. Crops are ruined and soil left unproductive for long periods by seawater intrusion. The insecurity and frequent losses inhibit investments and economic growth in many poor, coastal areas especially along Viet Nam's central coast.

For these reasons the Government and local communities have traditionally given high priority to improving and expanding the network of dikes. It is estimated that Viet Nam has approximately 5,000 km of river dikes and approximately 3,000 km of sea dikes. UNDP assistance has included a project to improve the capabilities of Government agencies to effectively repair deteriorating river dikes in time to avoid disaster. This project has introduced modern methods for dike design and risk analysis for existing dikes. New technologies have been introduced in Viet Nam for soil analysis, grouting, and emergency repairs. For example, the project successfully applied geotextiles to dike failures and sand boils during the rainy season of 1992 and effectively deterred the problems from turning into serious situations.

An ongoing UNDP project is concerned with the quality control and construction supervision of sea dike construction. This project provides essential engineering services to a World Food Programme project aimed at constructing and upgrading more than 400 km of dike in 7 central provinces, which are frequently hit by devastating typhoons. In the process, the provincial hydraulic engineering staff are receiving training and improved equipment to enable them to perform material testing and to monitor construction projects using modern methods and equipment. The improved sea dikes have already enabled farmers in many places protected by the structures to increase their agricultural productivity by using higher - yielding rice varieties and avoiding the regular salination of the soil.

River and sea dikes are typical structural measures against water disasters. In a recently started project, the United Nations Development Programme is hoping to improve on the institutional aspects of disaster mitigation. The Government has requested UNDP support for the establishment of the Disaster Management Unit to be located at the premises of the Ministry of Water Resources. The Disaster Management Unit will, on the one hand, be a reference centre for disaster related materials and data in Viet Nam. All agencies involved in disaster management and relief will be granted free access to the resources at the Disaster Management Unit. Staff of the Unit will collect and store relevant data and disseminate it to users with the help of computerised databases and electronic file transfer facilities.

On the other hand, the Disaster Management Unit will be the driving force in a review of existing disaster preparedness measures. The present procedures for responding to emergencies will undergo a critical review with the aim of streamlining them. For example, more accurate and timely flood warnings in the local communities could greatly reduce losses of property and lives. To this end, the Disaster Management Unit will make a study of how the communication systems for dissemination of disaster warnings can be improved. Finally the Disaster Management Unit will include a training component. The objective here is to benefit from the relatively large number of Government officials that have already received training overseas and in Viet Nam in various disaster management disciplines. These trained people constitute a valuable resource base if they are properly organised and used as trainers in disaster management workshops at the local level.

The Disaster Management Unit is in itself a rather small project. However, it is expected that it will create many new initiatives along the way and possibly attract further donor assistance for improvements in disaster management. As an example, a private firm has committed two mobile water purification units to be employed in disaster situations where drinking water supplies are not available.

There is in Viet Nam an increasing recognition that fresh water resources are a scarce commodity that must be preserved and used in the most economic way while taking into account social considerations. At the moment water seems to be an almost over abundant resource, but signs are already present of a future lack of water in some areas or at certain times of the year. The environmental degradation of catchment areas has contributed to increase runoff, thereby causing floods in the wet season and droughts in the dry season.

To improve the planning of water resources use at the national level, UNDP is enabling experts of the United Nations Food and Agriculture Organisation's to take part in a joint water resources sector study along with consultants from the World Bank and the Asian Development Bank. The water resources sector study team, which is working in Viet Nam at this moment, will look at the overall availability of water resources in the country, and analyse the present uses of water for agriculture, industry and consumers. It will estimate future demands in light of the present rapid economic development in Viet Nam. The outcome of the study will be tools for decision - makers for allocating scarce fresh water resources to the best uses in both economic and socio - economic terms.

The concept of water as an economic good to be optimally used is also underlying two river delta master plans supported by UNDP. The now completed Mekong Delta Master Plan project and the ongoing Red River Delta Master Plan look at developing the two great delta regions of Viet Nam with a mix of investments in agriculture, industry and services. Given the geographical nature of the river deltas, water plays a crucial role in both planning frameworks - water for irrigation, fisheries, industrial use, transportation, drinking water.

One of the general trends in the Vietnamese economy is a move towards the elimination of all Government subsidies and towards self - financing of all activities. A few months ago, the United Nations Development Programme fielded a consultant to examine the conditions for financing of operations and maintenance of a multi - purpose water scheme in Ninh Binh Province. The study highlighted some of the shortcomings of the present systems for assessment and collection of water fees, which originates in the former collective structures. It also reflected the situation characteristic of many parts of the northern provinces where farm land is very densely populated and where plots are too small to generate enough income to pay the actual costs of the schemes. In order to maintain these hydraulic structures, which will often be desirable from a social point of view, the Government must adopt an active attitude and set aside funds for their up - keeping. This may involve revising present policies requiring full self - sustainability of all projects.

In the fields of pollution prevention and environmental protection, UNDP is seeking to play a role at the policy level by providing decision - makers with planning tools and adequate knowledge of environmental regulation techniques. Although not directly focused at safeguarding water resources, our environmental activities are often touching upon that subject due to the great importance of water in Viet Nam. For example UNDP will be initiating a new project to introduce environmental concerns into all investment decisions at central and local levels. One obvious aspect is, of course, to limit the pollution of rivers and lakes. The project will train officials involved in investment evaluation in three provinces in environmental impact assessment and give them relevant tools for regulating the environmental damage of industry and agriculture projects. One main interest here is introducing the use of positive, economic incentives to improve environmental standards.

Coastal zone management has been singled out as a possible new activity for support from the Global Environmental Fund. Another new initiative is underway in the field of river basin management. Here water resources management will be linked to sustainable agriculture for ethnic minorities resulting in reduction of greenhouse gas emissions.

The last UNDP - activity I would like to mention is not really a project. It falls under that second role of UNDP I mentioned in the introduction, which is to help the Government mobilise and coordinate aid resources. In June 1992 Viet Nam hosted an International Workshop on Flood Mitigation, Emergency Preparedness and Flood Disaster Management. This workshop was attended by over 170 people from national and international agencies, including representatives of many provinces of Viet Nam. The participants reviewed the water hazards concerns to determine priorities and methods of mitigation.

Following the workshop in 1992, a team of experts combined the results of the workshop with a thorough background analysis in the "Strategy and Action Plan for Water Disaster Mitigation in Viet Nam". This document explains the existing, in some cases centuries old, measures against flood damage in Viet Nam. It shows how the economic benefits of investments in improved flood protection in most cases will greatly outweigh the costs. It also outlines an implementation strategy for the investments with the highest priority. This includes both so - called structural and non - structural interventions, that is, both projects for physical structures and institution building. Possible activities are outlined for three areas: forecasting and warning systems, preparedness and mitigation, and lastly emergency relief. Under each heading are a number of project to address that particular aspect. That way a matrix of projects was created to cover all important aspects of flood disaster mitigation. The matrix visually demonstrates that the problems caused by flood disasters are being approached by the Government in a comprehensive and consistent manner. The Government on its side has an efficient tool for managing and coordinating domestic and external investments in water disaster mitigation.

The Strategy and Action Plan included 18 priority project profiles designed to address the different concerns expressed in the project matrix and specific, local requirements. The purpose of these profiles was to promote specific interventions to interested donor agencies, whether multi - lateral or by - lateral. This approach has in fact generated a lot of interest and some donor commitments. For example, a flash flood forecasting project has been carried out in Ha Tinh Province. A large typhoon warning system project is close to the implementation stage at the moment. A flood warning system for the Red River is being developed with assistance from UNDP. Some donors have expressed interest in supporting institution building efforts and disaster awareness campaigns, and are about to field project formulation missions. The Disaster Management Unit project I mentioned before is itself a product of the Strategy and Action Plan.

Later this month, on 29 and 30 November, an International Consultation on the Strategy and Action Plan is scheduled to take place here in Hanoi. The purpose of this second international meeting will be to review the implementation of the Action Plan. The Consultation is also expected to indicate new directions for the Strategy and Action Plan made necessary by the rapid changes Viet Nam is undergoing these years. Besides supporting the arrangement of the International Consultation, the UNDP will provide consultants to review and update the Strategy and Action Plan document in light of the comments and recommendations made at the International Consultation. We hope that the Strategy and Action Plan will be regularly updated and continue to play its role as a tool for the Government's aid coordination and mobilisation.

I have brought a few copies of the Strategy and Action Plan for Water Disaster Mitigation in Viet Nam for those who may be interested. Allow me also to introduce to you a person who has played and continues to play a central role in many of UNDP's activities in the water sector, including the upcoming International Consultation. Mr. Marshall Silver is our foremost technical advisor to the Government in matters concerning dike safety and disaster management. He has graciously accepted to come here today and will be available to answer questions you may have regarding the activities of the United Nations Development Programme.

And with those words, I would like to conclude my presentation and invite you to make your comments.

Thank you

DRINKING WATER SUPPLY AND SANITATION IN THE CONTEXT OF WATER RESOURCES MANAGEMENT: PREPARING SECTOR STRATEGIES

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DRINKING WATER AND SANITATION AS A COMPONENT OF WATER RESOURCES DEMAND

Drinking water supply and human waste disposal constitute a relatively small component of overall water demand in most countries, far outshadowed in quantitative terms by uses for agriculture and industry. Water is, however, a critical need for human survival and access to safe water and adequate sanitation has a direct bearing on the quality of life. Hence, drinking water in particular, and management of human waste and its impact on water quality to a lesser extent, are major political issues. Drinking water supply invariably appears at or near the top of most nation's lists of priorities for water use, and most countries have in place a plan of some sort for provision of drinking water. This is less often the case for sanitation.

Experience has shown that in order to achieve sustained water and sanitation sector development, coordinated action over several years is needed in at least the following areas:

1. Sector studies and applied research leading to the adoption of sound sector policies as a framework for national sector plans and investment programs;
2. Pilot and demonstration projects to refine implementation strategies that can be replicated on a national scale for the delivery of water supply and sanitation services, particularly to low-income people;
3. Human resource development and training to strengthen institutions and provide the personnel (including community members and workers) needed for delivery of services;
4. Development of necessary supporting institutions and services in both public and private spheres, including promotion of local industries and consultants and support of non-governmental organizations;
5. Formulation of policy, particularly for financing and cost recovery, to support sustained expansion of services;
6. Support for development of investment projects ultimately leading to large scale improvements of services using a range of appropriate systems;
7. Continual dialogue between the government and other sector institutions (including external support agencies who are active in the sector) to integrate these elements into a coherent approach to sector development.

THE IMPORTANCE OF SECTOR PLANNING

However, the way in which drinking water and sanitation is managed does not always reflect national priorities for access to or equitable pricing of drinking water or sanitation services. The drinking water sector in developing countries is characterized by rapidly growing demand in the face of rising cost, resources development, use of expensive and unsuitable technologies, and high losses of water due to inefficient operation and inadequate maintenance. Water is often under-priced, cost recovery is poor, and central or provincial government are the source of financing of most new works. The institutional arrangements for the sector are often excessively complex, sectoral organizations tend to be poorly managed and driven by fragmented policies, and services are not responsive to the needs of those served.

The sanitation sector's performance has been even worse. Service coverage and quality are low and rapid urbanization has increased waste quantities far beyond the capacity of sector agencies. Pollution of the environment, poor public health and reduced labor productivity are the result. In both the water and sanitation sectors the poor are the worst affected. They often pay more for a lower quality of service and suffer disproportionately from the effects of unsafe water and inadequate sanitation.

In the past, large investments in the drinking water supply and sanitation sector have been made in projects that were designed more or less individually, in response to real or perceived needs, but without the benefit of adequate sector work or consideration of impacts related to other uses of water. These projects usually focused on the provision of water supply and/or sanitation facilities in an effort to raise service coverage levels. In the absence of significant improvement in the institutional and financial support to these facilities, and with the lack of adequate training of users to operate and maintain them properly, many projects have failed to deliver sustainable improvements.

A further problem has been that projects have been prepared and implemented in isolation - as "one off" initiatives of limited duration. These projects are characterized by high overhead costs, limited understanding of the lessons and experience gained from other projects, a failure to gain from the experience gained during implementation of the project because of a lack of continuity, and the adoption of technologies and delivery mechanisms that are not easily replicable and hence not suited to continuing sector development.

These problems can often be avoided if projects are formulated, planned and implemented within the framework of a clear sector development strategy. Such a strategy involves collecting available information about the sector, analyzing that data to determine the overall needs of the sector and the possible solutions to those needs, and finally developing a strategy and action plan to implement those solutions. The strategy should include all of the prerequisites for the development of sustainable national programs, which are the end product of sector work and the measure of its success.

THE EVOLUTION OF SECTOR PLANNING

The conventional wisdom about planning for drinking water supply and sanitation has evolved over the past twenty or so years from a prescriptive to an adaptive approach. Early sector planning efforts were large scale, highly centralized, supply driven, and inflexible. The result was sector master plans. These were often prepared by foreign consultants with little active involvement of recipient government agencies or other stakeholders. Hence, the sense of ownership of and adherence to these plans by sector institutions was limited and they rapidly became outdated as sector conditions changed over time. Another approach that was often taken was to carry out descriptive reviews of the sector to assist with the preparation of specific projects.

AN ADAPTIVE PLANNING PROCESS

More recently, there has been a shift to a staged approach to developing more adaptive sector strategies. This approach attempts to accommodate both the need for a rapid appraisal of the prevailing situation for immediate decision-making and the need for adapting strategies and action plans over a longer term as information and knowledge of the sector evolve in a country. The approach has four main stages:

1. A statement of position (or situation statement) that provides an initial description of the sector and the stage that has been reached in its development;
2. A statement of issues (or issues paper) that identifies and analyzes the key issues to be resolved;
3. Strategy formulation for addressing the issues and, if necessary, testing solutions by pilot projects;
4. An action plan for implementing the strategy and demonstrating its suitability.

In the first stage a study is undertaken to collect as much information as is available without additional investigation in depth. The purpose is to assess where the country is placed in the development spectrum and to identify problem areas. Then in the second stage these areas can become targets for studies or issues papers. From here it is possible, in the key third phase to make decisions about what is needed to further develop the sector. These decisions can be documented in a sector development strategy. An action plan to implement the strategy is the fourth and last stage, although subsequent evaluation and monitoring should provide the basis for revision and refinement of the strategy.

A fundamental issue in this process is the amount of information that needs to be collected, the time frame and the order in which it is collected, and finally the point in the process at which actual interventions (pilot projects, detailed studies, training programs, investment programs) are begun. The ideal situation is to have access to all the information pertaining to the water and sanitation sector before any decisions are made about financial or technical assistance. Unfortunately, all of this information (which includes economic and sociocultural data as well as an assessment of the current levels of service, institutional capacity, government policy, and available resources) is rarely available during a sector planning exercise.

Therefore, planners must decide what information is essential and what information can be collected later. They must determine whether there is a critical mass of information without which further studies, or perhaps pilot or demonstration projects, should not proceed.

Many individuals and donor agencies believe that the most feasible approach is to design strategies that incorporate pilot and demonstration projects early in the sector development process so that information can be gathered on a continuing basis. In this way a substantive program can be built up at whatever rate the availability of resources allows. The initial testing of strategies and community interest provides a solid foundation on which to expand with confidence to a national scale.

The maximum advantage from the learning by doing approach to sector development will be derived if the planners responsible for sector strategy adopt an open-minded, adaptive approach. In the past, it was common to see large quantities of information gathered, detailed analyses carried out, and a definitive national or regional program formulated; the master plans prepared for many countries are an example of this. The testing of implementation strategies first in small projects allows adaptation and there have been many instances where much time, money and effort would have been saved as a result. Thus, pilot projects should play an important role in testing and refining policy and strategy. Many unexpected results are produced, and sometimes quite different alternatives are found to the approach being tested. A high degree of experimentation should be encouraged so that innovative technologies and procedures can be tested prior to broader-scale application.

One important issue is that of who collects the information. The process of having an outside organization come into a country to examine practices, policies, and capabilities may be necessary where the local capacity is weak. An outside organization may serve as a positive stimulus to the government and may raise interest in issues formerly ignored. On the other hand, collecting information without sufficiently involving the local actors (at the government or at the community level) could lead to poor working relations with the government, inaccurate data, and inappropriate conclusions.

Thus, the process of formulating a sector development strategy should start with data gathering and defining of issues, the opening of a dialogue between the government and beneficiaries, and drawing up strategies and action plans that are fully receptive to the needs of the community at large. Technologies and delivery mechanisms should be tested through pilot and demonstration projects, and the results of those projects, together with other studies relating to financial and institutional improvements, should be used as inputs to the further development and refinement of the strategies and their implementation.

A sector strategy, if properly formulated, will enable a number of activities to occur simultaneously. Overemphasis on one aspect might produce more immediately measurable results but may not, in the longer term, be in the best interests of a sustained improvement in the health and well-being of the beneficiaries. An example of this situation is the desire to provide water supply services at levels well in excess of those needed to meet basic requirements. In the absence of parallel improvements in the facilities for disposal of human wastes and hygiene practices, little if any reduction is likely in the impact of diarrheal diseases, which are among the leading causes of morbidity and infant mortality in developing countries. Indeed, the increasing quantities of wastewater generated as a result of water supply improvements can have a negative effect on public health and can create other problems if there is not an adequate drainage system. Quite often, responsibility in each subsector for water supply and for wastewater drainage is fragmented, even to the extent that different institutions are responsible for each subsector, and there is little coordination.

Another area where improvements need to be made is in the parallel activities of different donors. The lessons gained from experience need to be shared with others, and yet it is not uncommon to see donors working independently of each other in the same country. In particular, sector work by large lending agencies should not only be available to other support agencies but should also meet the information requirements of those agencies. In the context of a collaborative framework, there is a need to agree on general guidelines for sector work so that the results can be utilized by governments to encourage investment in the sector by a range of financing agencies, including multilateral and bilateral donors.

RECENT DEVELOPMENTS IN SOUTHEAST ASIA

A number of countries in Asia have prepared or are in the process of developing drinking water and sanitation sector strategies along the lines described above. Nepal completed a sector strategy and action plan in 1991 that has helped to guide sector investments by the World Bank, ADB and other donors and laid the groundwork for a major reorganization of sector agencies. With advisory assistance from the UNDP/World Bank Water & Sanitation program, the Government of Lao PDR, Indonesia and Vietnam have all recently initiated sector strategy preparation. In Vietnam, the preparation process has evolved from an initial focus exclusively on urban water supply to a stepwise approach to the other elements in the DWSS (Drinking Water Supply and Sanitation) sector. This will result in a series of linked sub-sector strategies for urban sanitation and integrated rural water supply and sanitation along with the existing urban water supply plan.

The two more recent studies are both being prepared in a similar fashion, with the process being driven by a government steering committee chaired by the Ministry of Construction. Careful attention was given during the drafting of terms of reference for the strategy that the process be government led, with consultants and external agencies being limited to providing technical support under the direction of government personnel. The objective here is to ensure that the final document correctly reflects Government's intentions, expectations and capabilities and hence will be seen as a product that is produced and "owned" by the nation. A number of working groups will be established among the line agencies represented on the steering committee to review and analyze collected data and to formulate specific elements of the strategy and action plan. These working groups will be chaired by government personnel, and advisers attached to the study may be members along with government specialists. The working groups will be the key implementing bodies for producing the sector strategy and action plan. A number of countries in the region are also producing broader water resources management policy statements and strategies covering the full array of water resource uses. While these efforts also take into consideration drinking water and sanitation needs, the drinking water and sanitation sector strategies for these countries are not always fully coordinated with them. The focus has been on ensuring strategy compatibility rather than on identifying ways to more fully integrate the various uses of water.

WATER AS AN ECONOMIC GOOD AND INTEGRATED WATER RESOURCES MANAGEMENT

The World Bank has been supporting efforts in a number of countries including India, Malawi and Brazil to develop a comprehensive water resources management policy that incorporates a series of integrated strategies for key elements of the resource management process. Drinking water and sanitation are fully integrated within these strategies, thus ensuring that they are viewed and managed in a holistic way and in coordination with other water uses. The key elements of this approach are embodied in a World Bank Policy Paper on Water Resources Management.

Underpinning this integrated view of water resources management are concepts regarding the value of water and stakeholder involvement that have evolved and that have been articulated at recent international conventions. These are:

1. Water has an economic value in all of its competing uses and should be recognized as an economic as well as a social good, and;

2. Water development and management should be based on a participatory approach, involving users, planners and policy makers at all levels, with decisions and management occurring at the lowest appropriate level.

Understanding the value of water in its various uses for drinking, sanitation and other purposes provides a sound basis for improving water allocation, investment allocation, and pricing that can be described in separate strategies. The strategies that a nation's water resources policy encompasses might typically include the following:

Institutional capacity building and humans resources development: The effectiveness and efficiency of the water sector, that is, the degree to which it achieves the objectives set for it by the government, depend centrally on the institutional arrangements, particularly on the extent to which they create a structure of incentives which encourage good performance, cooperation between organizations to achieve shared objectives, and accountability to the government and the recipients of services. It depends also on the extent to which organizations of the sector develop their capacities, that is, undertake the set of tasks required to fulfill their charters, develop and maintain the skills of their people, and deploy them appropriately to undertake those tasks effectively and efficiently. It is necessary therefore to develop and propose a set of institutional arrangements and a strategy for capacity development that will best contribute to a high level of performance and achievement in the water sector.

Environmental protection: The environmental challenges which many countries face arise mainly from demands for natural resources, often arising from rapid population growth. As they affect water these demands may include some land use practices which lead to low productivity and resource degradation, the use of marginal or unsuitable land for agriculture and wood extraction for fuel or industry, mining, and other industrial development. The resulting soil erosion together with inappropriate waste disposal practices adversely affect water quality and the aquatic environment. The results can include increased turgidity and nutrient levels, the presence of toxic compounds in surface and groundwater, and reduced aquatic biodiversity.

Sanitation: In urban areas and dense rural communities where water borne sanitation is appropriate management practices have much in common with urban water supplies. An integrated approach combining institutional arrangements for water supply and sanitation management is called for. On-site sanitation practices in some areas can be major contributors to water pollution. Hence, a strategy for promoting safe on-site sanitation technologies and practices is required.

Allocation of investments: The funds available for investment in water and wastewater infrastructure are limited in all countries. Therefore, it is important that the greatest value be gained by deploying the investment funds and all other resources only on the set of options which yields the greatest benefit, the objective of the investment allocation strategy is therefore to maximize the net benefit to the nation by ensuring that investment programs are prepared which take into account all feasible investment options, can be undertaken with the resources available, and which optimize the achievement of development objectives.

Stakeholder involvement: A characteristic of water infrastructure projects and water resources management is that there are usually many stakeholders, that is people and organizations with varying interests in the project or program. In spite of efforts of planners and operators of water infrastructure to communicate effectively with those who can help them in their tasks, traditional approaches to planning and operations often result in systems that do not meet the needs and expectations of the communities they serve. This is not usually for reasons of technical efficiency, but simply that the communications processes used often do not result either in the planners and operators understanding the needs of the community, or in the community understanding what the planners and operators intend.

As a result, the world-wide experience is that infrastructure when completed is often less useful to the community then it could have been, and the community is therefore unwilling to use it, maintain it, or pay it.

Similarly, decisions on the management of water resources made without the involvement of stakeholders, run risks of being based on inadequate information or of being misunderstood. On the other hand, involvement of stakeholders in the management of water resources increases their sense of "ownership", improves decision-making, increases efficiency, and reduces the need for enforcement. Involvement and participation of stakeholders in the planning, operation and maintenance of water infrastructure is therefore regarded as vital.

Water allocation: Spatial and seasonal variations in the occurrence of water and growing competition for its use are leading in a number of areas towards full or over commitment of water resources at their present level of development. In arid or drought prone regions the problem is only worse. It is thus becoming increasingly important to put in place strategies and processes to ensure that water is allocated in a manner that creates the maximum achievable benefit for a nation. If such strategies and processes are not implemented, the result is likely to be that in some areas water resources will become fully committed.

Pricing strategy: A pricing strategy has multiple objectives including:

1. *Investment* - Providing incentives to encourage selection of cost-effective investments in schemes which are responsive to the demand of the users;
2. *Efficient management* - Providing incentives to managers of schemes to operate and maintain efficiently;
3. *Efficient water use* - Providing incentives to the users to use water efficiently;
4. *Financial sustainability* - generating sufficient income from a scheme to cover costs.

As is true of other strategy objectives, it is possible to design approaches to water pricing that work in a mutually reinforcing way to achieve high levels of accomplishment of all the objectives at the same time. World wide experience has shown that such approaches emphasize a high degree of local autonomy in commercially oriented water schemes, responsibility at the local level for payment of most costs from user charges, a corresponding reduction in subventions by government and a redirection of government, financial support to carefully targeted groups, such as those who really cannot pay in kind or cash and have no viable alternative source of water, and to targeted aspects of service like advanced treatment of sewage, which is very costly and provides benefits to much larger groups than the users of the schemes.

CONCLUSION

Effective planning for drinking water supply and sanitation is best carried out through an adaptive, holistic approach that takes into consideration a wide range of factors as well as their dynamic, changing nature. The process of sector planning has evolved over recent decades from a rigid "master planning" approach to the stepwise preparation of flexible sector strategies and action plans that is increasingly common today. Vietnam, Lao PDR, and Indonesia, among other countries, are now developing drinking water and sanitation sector strategies following a phased approach. These strategies will be modified over time to respond to changing conditions and needs and to ensure that they continue to accurately reflect the nation's sector development priorities.

Most recently efforts are being made to look at water resources management from a perspective of integration, providing plans for the development of drinking water and sanitation under a broad water resources management policy that incorporates strategies for key aspects of water management that are common to all water uses. Fundamental to this integrated approach is the concept that water is an economic good and should be managed as such.

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MAJOR PROBLEMS IN INTEGRATED WATER RESOURCES MANAGEMENT

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Introduction

In this paper the main problems causing failure of water resources development and management projects will be discussed. The study is based on documents dealing with integrated water resources management.

Water resources management can be defined as a set of actions taken to use and control natural resources inputs such as water to obtain outputs and natural system conditions useful to society.

Integrated water resources management means a set of actions that takes appropriate account of the important physical, economic, social, and cultural linkages within the system being managed.

Without an integrated approach only the technical feasibility and economical benefits are considered.

The term integration is often used nowadays in different sectors.

The World Meteorological Organisation (WMO) and the United Nations Education, Science and Cultural Organisation (UNESCO) both have hydrological programmes, WMO the Operational Hydrological Programme (OHP), and UNESCO the International Hydrological Programme (IHP) which deals with the scientific aspects of hydrology. The member countries are asking for more cooperation and a stronger integration of these two programmes. It has even been suggested that the two should melt together into one programme.

UNESCO is running other scientific programmes, such as the Marine Science Programme and the Ecological Programme, which have interfaces or overlap with IHP. More and more UNESCO is requested to integrate these programmes and to consider establishment of one scientific environmental programme.

In Agenda 21, the environmental action plan for the twenty-first century prepared at the United Nations Conference on Environment and Development (UNCED) in 1992 in Rio de Janeiro, integrated water resources management is one of the main proposed programmes in Chapter 18, which deals with freshwater resources.

Integrated water resources management is more of an issue today than 30 years ago. Until recently the available water resources in the humid tropics were abundant and there was not much reason to consider it as a finite resource. Also the negative impacts for the environment were not as serious as they are today. Growing population and industrial development are the main causes for the stress on the water resources. A growing population goes parallel with higher consumption of water, more need for food (especially rice in the humid tropics), and higher water demand for irrigation. Industrial development results in a greater demand for water as well as a higher risk for contamination of the existing water resources, surface and groundwater.

Nowadays it is no longer possible to develop or manage water resources in a non-integrated way. Integration should cover all types of interrelated freshwater bodies, surface as well as groundwater. Not only the technical and economical aspects have to be taken into account as was the case until recently, but also the social, cultural and environmental aspects. The purposes for which water resources are developed can be manifold: hydropower, flood protection, irrigation, sanitation, transportation, water supply, recreation, etc.

Another issue is the supply of water obtained from rainfall. Tropical areas are known for their high intensity precipitation and uneven distribution in time and space. In the humid monsoon regions, 70 to 80 percent of precipitation occurs within a three month period. Also from year to year precipitation may vary considerably. In this respect the El Nino Southern Oscillation (ENSO) is an important factor. The El Nino phenomenon is a flow of warm water moving from the West of the Pacific Ocean to the East, which influences the wind and rain patterns. In an ENSO year Indonesia and the Philippines receive much less precipitation than in an average year, while Central America has more rain than usual. Next to these short term variabilities in rainfall, trends can be observed over longer periods of time. In Indonesia on Java for example it has been found that the average duration of the dry season (months with rainfall less than 100 mm) has increased since 1951 from about 4 1/2 to 6 months, see figure 1.

Before a proper development or management plan can be developed the available water resources have to be assessed. This is often minimised because it is rather costly. Still the experience of several countries indicates that where a benefit/cost ratio can be estimated, this ratio is generally much higher than one.

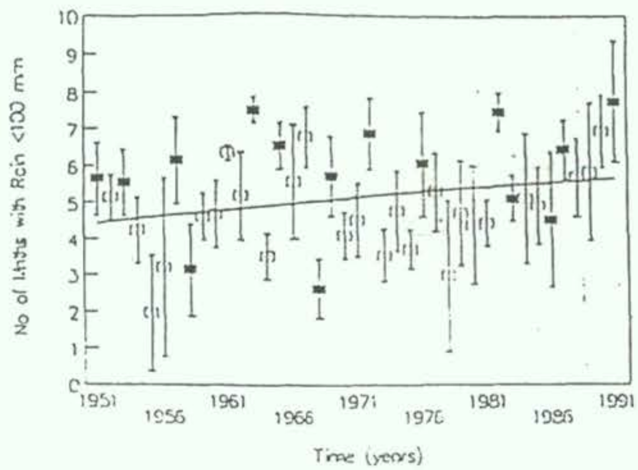

Figure 1. Duration of dry season (1951-1991), 4 stations on Java: Jakarta, Tegal, Yokyakarta, Surabaya.
Source: Wasser H.J., 1992 (unpublished).

Problem Areas

When natural resources are used for economic, social or cultural purposes, it will have an impact on the environment. Ecological values are extracted and transformed into economic goods leaving a disturbed nature behind. In an ideal situation there would be full economic use of the resources and no impact on the environment. In reality some combination of economic and social benefit, as well as environmental impact always occurs as illustrated in figure 2.

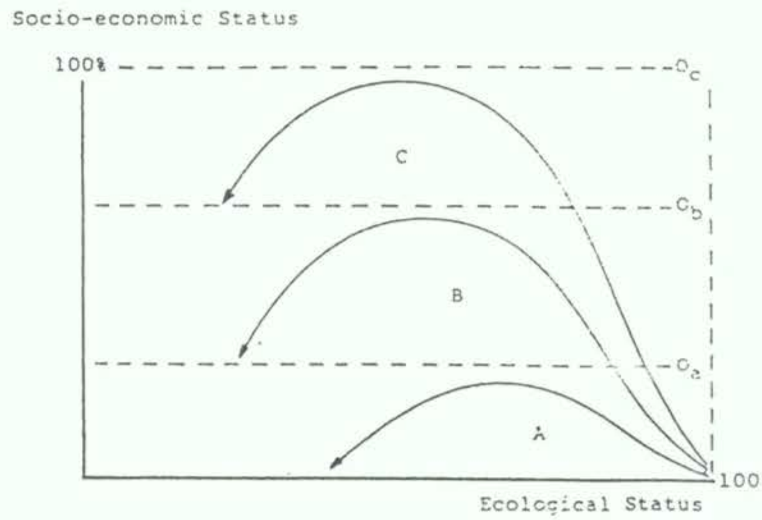

Figure 2. Changes in optimal point and ecological status depending on development and management approach.

Curve A represents a primitive agricultural society, beginning at a point with the original ecological situation without socio/economic benefits. Following the curve socio/economic benefits become greater and the environmental impact increases. At the top of the curve a kind of optimum is reached and after this further environmental stress reduces socio/economic yield and the system may even collapse. Modern agriculture could be represented by curve C showing that higher environmental disturbance may be necessary before economic benefits are realised, but also that greater benefits can be achieved before the resilience point is reached. The same concept can be used to compare different project alternatives for a single situation.

There are a number of reasons causing failure of water resources development and management projects. On the administrative level in most countries important purposes such as hydroelectric power generation, irrigation, flood control, and water supply are dealt with by different authorities each with their own separate responsibilities, doing their work independently from each other. In the last 20 years a lot has been improved in this respect, but still lack of coordination exists. In some cases coordinating bodies have been established covering entire river basins in spite of provincial or national borders. An interesting example is the Mekong Committee established in 1957. It has proven to be very useful as an instrument for the member countries to discuss issues of mutual interest, to execute regional studies, and to coordinate plans related to the Mekong River.

Experiences over the last 30 years teach us that a number of problems cause negative impacts on the environment. Four major problems causing failure of water resources development and management projects can be highlighted:

1. Inadequate dealing with environmental, social, and cultural consequences of water resources projects;
2. Lack of integration of watershed land management with water resources development;
3. Insufficient allocation of water among competing users in the context of efficiency, equity, and sustainability;
4. Ineffective implementation of water resources projects.

Cultural, Social, and Environmental Consequences

Many major water resources development projects (such as the construction of dams and reservoirs) have generated unexpected negative social, environmental and cultural consequences. The natural environment as well as the social circumstances of the people living in the area of construction have changed in many cases drastically. Often projects have been planned and designed without sufficient research of the interrelationships between people, water, environment and development. Four types of social and environmental consequences of water development projects are:

1. Already slightly mentioned is the disruption of human settlements and human activities. Construction of the Nam Pong Reservoir in Thailand forced 4,000 families to move to another area. In China preparations are being made for the construction of the Three Gorge Dam on the Yangtze River to provide flood control and to produce 100 trillions kilowatt-hours of electricity per year. For this project an estimated 1,000,000 people have to be resettled. Many cases are known where resettlement was given low priority in the project plans and implementation caused dramatic social consequences for the people concerned;
2. An often unexpected consequence is the creation of favourable habitats for parasitic and water-borne diseases, such as schistosomiasis, malaria, filiariasis, and river fluke infections;
3. The third type is chemical and physical. Land use changes may cause soil salinisation and water logging, especially where adequate drainage facilities are lacking. Deforestation can cause erosion followed by sedimentation in streams or reservoirs. In some cases sedimentation has caused severe reduction of the capacity of a reservoir as for example the Sanmexia Reservoir on the Yellow River in China. Also the impacts on groundwater quality resulting from poor planning and management of landaus especially in rural areas are manifold;
4. An important ecological consequence is the spread of aquatic weeds in canals or reservoirs. These plants reduce the capacity of the canals and cause higher water losses through evapotranspiration.

In the 1970s developing countries started to consider environmental and social assessment methods for water resources projects. With help of donor agencies two types of environmental and social assessment guidelines and procedures were developed.

First the environmental impact approach (EIA) which was developed as a complementary instrument to study environmental and social impacts. The main steps in the EIA are:

1. Identification of the likely impacts which need to be investigated in detail;
2. Impact prediction that involves an estimation of the likely nature of impacts in quantitative and/or qualitative terms;
3. Impact interpretation and evaluation, including comparison of different impacts with each other;
4. Identification of mitigating measures and monitoring requirements;
5. Monitoring and communication.

Environmental indicators used in this approach are: climatic indicators; indicators for terrestrial subsystems such as land and soil quantity and quality and wild life; and indicators for aquatic subsystems such as running and still waters and groundwater. The main purpose of water resources projects remained development and the influence from the environmental impact assessment was in practice marginal.

This led to the call for a broader approach which resulted in development of the second type, the multi-objective approach. This procedure incorporates environmental and social aspects along with economic development from the planning up to the management stage. This approach which represents a multi-objective synthesis of environmental, social and economic considerations, is still in its infancy. To develop and implement a multi-objective approach is in practice rather complicated. The approach has to relate to the substance of a problem and also to the institutional and cultural structure of the planners and managers. The process of making trade-offs between project objectives is difficult as it depends on educational backgrounds, on customs and tradition, and on existing rules and laws. One of the most important criticisms of the approach is that multi-objective planning leads to an enormous amount of investigative work and analysis with high costs and possible delays. Still, recent water resources development history shows that insufficient investigations can lead to wasted and undesired expenditures many times greater than the cost of the assessment. The indicators used in this approach are:

- physical-geographical indicators;
- hydrological indicators;
- physical chemical indicators;
- biological indicators;
- socio-economic indicators;
- health and nutrition;
- cultural components;

Watershed Management

Watershed management can be defined as the process of planning and implementation of activities involving water and related land resources of a watershed, taking into account related social, economic, environmental, and institutional factors, with special emphasis on the linkages between upstream and downstream parts of a watershed and their respective human and physical endowments.

An integrated water development approach, whereby water and land interactions upstream as well as downstream in the planning and implementation phases are included, has only occasionally been practised as water development projects usually only dealt with individual river sections involving construction of dams, reservoirs and power plants. Watershed management has been practised as a separate activity, usually coordinated by the ministry of agriculture or forestry.

The problems of sedimentation and pollution in particular have made policy makers aware of the need of proper management of the upstream watershed. Since 1970, in some countries, such as the Philippines, upstream watershed management of important reservoirs was executed by the water development agency in charge of operating the reservoir. In other countries, as in Indonesia, attempts were made to deal with upstream watershed management and downstream water resources development in an integrated way on a river basin basis.

Water Allocation

When water demand is greater than water supply the following options can be recognised:

1. Create more infrastructure to supply available water resources (more reservoirs);
2. Improve supply management;
3. Demand forecasting;
4. Improve demand management;

Demand management includes rational water allocation which has recently become an issue in the humid tropics since the realisation that water is not an infinite resource. In the past it was the practice to tap additional available surface and groundwater supplies to meet increasing demands. Very little attention was given to making more efficient use of existing water supplies and to reducing water requirements through water pricing or use of new technologies such as the recycling of water and waste water treatment and reuse. Water pricing is being more and more applied, it includes:

- Basing the price on the cost of water (cost of investment, operation and maintenance, and replacement costs), other relevant costs, and a reasonable profit margin;
- Designing prices according to different industrial classifications, encouraging low water consumption;
- Ensuring planned water allocation.

Implementation

Many problems arising in water resources development and management projects find their source in the implementation. Failures in the construction phase by time delays or cost overruns, and in the operation and maintenance phase by lower actual outputs than planned are the main problems. The outputs can be agricultural production, hydroelectric energy, soil conservation and sedimentation reduction. Other implementation failures are related to the relocation of people as mentioned earlier and prevention of water logging or soil salinisation. Three important reasons for failures in the implementation are:

1. Insufficient attention in the planning phase to practical implementation problems. It is a classical problem that plans prepared behind a desk do not always work in the same way in practice;
2. Not enough attention given to operation and maintenance. The financing in particular is often not properly prepared;
3. Lack of involvement of the local users and managers in the different phases of a water resources project.

Conclusion

Four problems causing negative impact on water resources development and management projects have been discussed. To deal with these problems it can be concluded that water resources projects should be handled with an integrated approach which:

- applies integrated watershed management, giving enough attention to the interactions between land and water ecosystems, including processes of evaporation, transpiration, runoff, erosion, sedimentation, and groundwater storage;
- includes demand management, resulting in a more effective use of the available water resources;
- pays attention to the different administrative water resources sectors on local, regional and national levels. Plans prepared on the different levels have to be linked up to each other. Many projects have to be seen from a basin wide context beyond regional or national borders. A planning hierarchy can be divided in three levels: international agreements; national land development and water resources development plans; and regional water resources plans;

- applies conjunctive planning and operation of surface and groundwater, including artificial recharge of groundwater aquifers.

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SESSION TWO

REPORTS ON WATER RESOURCES ASSESSMENT AND INTEGRATED MANAGEMENT IN VIETNAM

WATER RESOURCES SERVICE PRODUCT MUST BE A COMMODITY (*)

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Water resources development is an infrastructural and social branch of the national economy. Under the circumstance that the economy is switching to a controlled market economy from the subsidised and concentrated mechanism being gradually replaced by the mechanism of cost-profit accounting, all infrastructural branches in general and the water resources development branch in particular have also to change the characters and mode of activities from mainly free of charge to the service economy. It, therefore, should be affirmed that the water resources development product is a service commodity. At the same time, the possibility of reproduction of investment capital for irrigation facilities-managing and exploiting enterprises as well as the role of the State and authorities at all levels, in achieving the capital reproduction for the branch of water resources development should be affirmed so as to create a considerable source of budget revenue and to reinvest actively capital in the irrigation development. The possibility of capital reproduction in the branch of Water resources development is realistic and of a great practical significance. In our opinion, the foremost thing is to make everyone fully acknowledge and recognise the ten following questions:

1. The careful consideration in the elaboration of the building plan and the priority in the investment capital for irrigation construction is of a paramount significance for the country's socio-economic strategy. The water resources development (like all other infrastructural projects) must be a first step in socio-economic development, without it in the balanced economic structure we would have to pay for an expensive price and the economic growth rate would be considerably slackened in many years.

2. The product of irrigation facilities managing and exploiting enterprises is very necessary for production and life. Being turned out for sale, it is also a commodity, hence all its price components have to be correctly and fully reckoned like for all other commodities. In other words the commodity product of the irrigation service is an important and decisive input creating a premise and condition for the effective promotion of all other factors for intensive farming. The support, if necessary, for agriculture must be equally shouldered by all input elements to avoid the situation that the most important and decisive input itself has had to "eat own capital" interminably resulting in the serious degradation of irrigation and drainage facilities while other input elements have been allowed to conduct business through cost-profit accounting, gaining interest.

3. Production and business households using the water resources service product will be able to create a marked growth in productivity and quality in agricultural production resulting in earning big sums of surplus profit. It is, therefore, absurd to give subsidy through irrigation service price to those households, which has caused an unnecessary and avoidable loss for the national budget and a social inequality [1]. Hence, the irrigation service price must be fully reckoned.

4. The irrigation service product is the non-competitive product (monopolistic product) which can not be automatically priced by the market. Therefore, representing all irrigation facilities managing and exploiting enterprises, the Water resources development branch must urge the Government to approve a reasonable price frame which conforms to the laws of the market mechanism and creates conditions for the enterprises to preserve and develop their capitals and raise the quality of their service. At the same time, all production branches, particularly agriculture, should be encouraged to buy the water resources service product so as to develop production.

5. Both tendencies: raising the price too high (due to monopoly) and lowering the price (due to the State subsidy) cause serious consequences. But the latter consequence, namely lowering the price down too low, is particularly harmful and difficult to overcome: Households using water through the low-paid irrigation services earn big profits (false profits) while irrigation services enterprises suffer from big

losses (false losses). In spite of its subsidy, the State is financially unable to make up big budget deficits to hundreds of irrigation facilities managing and exploiting units with tens of thousands of water resources works being degraded.

6. The irrigation service prices and irrigation fees are all counted into the production cost, which reflect the fair, equal and unequivocal economic relationship between two production and business subjects - the service provider and the service receiver - through economic contracts. Therefore, this must not be taken as a kind of tax, and the word "pay" should be replaced by the word "contribution" of the irrigation fees. In that spirit, we would like to propose that some 30 kinds of expenditures that the peasants have to shoulder should be reconsidered and clearly classified into "contributions" (excluding taxes) which must be minimised and "payment" which must be correctly and fully reckoned. By so doing, the services for agriculture in general and the irrigation service in particular, can better serve agriculture while the peasants have been accepting the input service prices.

7. In order to encourage all localities in the country to bring into full play their land and labour potentials so as to produce more social wealth, the irrigation fees must act as an instrument to regulate the mutual interrelations between the advantageous and disadvantageous areas in irrigation. This can be achieved through the application of average irrigation service prices mechanism.

8. Investment capital can be recovered but slowly: Beside their direct services to peasants with concrete addresses, irrigation facilities - managing and exploiting enterprises also render indirect service (for the improvement of ecobiological environment as well as people's living conditions). That is also the reason why, in spite of their great efficiency, the reimbursement of investment capital of water resources projects is lower than of other infrastructure. Because of this, the governments of many countries have worked out policies in support of investors in the construction of irrigation projects. But that support is only limited (2) to the extension of the time for basic amortisation, namely the acceptance of the demand for investment capital recovery in the long run. This means that the capital loaned for the construction of irrigation projects must be recovered from efficiency of those projects themselves, not from the profits of projects of other branches such as oil and gas, electronics. Realities show that "money which comes from one place must go into that place". That mechanism helps all production and business subjects heighten their responsibility in managing their capitals from the beginning to the ends as well as in turning around the capitals with high efficiency, which, of course, must be in line with the State's policy on investment in each economic and technical branch.

9. Due to the fact that the water resources service product can not be traded directly (by means of : "to a give product and to take cash down immediately" like for ordinary commodities) but through periodical payment under contracts, so effective measures should be taken to conduct and arbitrate in the process of signing, implementing, completing and paying contracts between service providers and service receivers.

10. All kinds of taxes: the water resource tax, the land tax, the fixed capital tax (exception now) should be fully paid when the approved water resources fee increases by degrees to the right price. By then, the Water Resources development branch will be able to contribute a worthy part to the State budget. For instance, if we irrigate 5 million hectares, a volume of 30 billion cubic meters of water is needed; and if only 20 VN dong are taxed on each cubic meter, the water resources development branch can yearly contribute 600 billion dong to the budget. Fresh water is a very valuable resource. In West Asia, North Africa and many other parts of the world, the fresh water is more precious than oil. In some areas, a large quantity of energy is needed to produce fresh water from sea water for daily use. Singapore has to spend more than one billion US dollars a year to import fresh water. Meanwhile, fresh water in our country is rather abundant, so why shouldn't we think from the financial point of view to make full use of the advantage endowed by nature(3)

To switch from the state of giving free of charge to the state of capital recuperation is a complicated task. It is not merely an economic matter, but also a socio - psychological question, which must be settled in an overall, synchronous and appropriate way. However, that is the inevitable process in the present stage. We need a correct mechanism which, with the support of all people, can quickly enter intc life, bringing vitality to tens of thousands of existing irrigation constructions. So, the water resources development will have conditions to balance the capital for extensive and intensive reinvestment as well as the constant improvement of its service to agricultural production in the new stage. This is not only a problem of urgent significance for the creation of capital and a driving force for the economy, but also a burning question of social equality: in areas where initial investments were made and projects have yielded economic efficiency, the state has continued to spend more money for the repair and upgrading of projects and subsidy in electricity price while many others which have seen no investment so far are queuing up for their turns.

(*) ECONOMIC TIMES OF VIETNAM REVIEW 4/1992

(1) Especially in the condition that our country is in the initial stage of industrial development, with many industries and production units still failing to get out of the state of false profit and real loss (See "Where from Investment is Made", Information Theory Review Issue 12/91)

(2) (See "Where from Investment is Made", Information Theory Review Issue 12/91)

(3) For several years now, the State has adopted a policy of encouraging the development of production. The entire population are actively responding to that policy and contributing efforts to make the economy healthy. Yet, not a few enterprises, including water resources service enterprises, have neglected their main tasks and run after profits by building hotels, restaurants, conducting businesses. The directors of those establishments have only cared for jobs not belonging to the tasks and functions of their units while no attention to main duties has been paid. That is a serious breach of discipline of managing infrastructure systems in general and water resources systems in particular. Because water resources enterprises produce non-competitive and monopolistic commodities, no other ones can replace their entrusted function.

METHODS FOR CALCULATING IRRIGATION FEE

Dr, TRAN NHON

I- *METHODS FOR CALCULATING IRRIGATION FEE*

There are 4 methods provided for calculating Irrigation Fee, they are shortly discried as below :

1- Calculating Method based on ordinary benefit of Water Services Seller

Someone thinks that : Fee of Irrigation, cost of water supply or cost of irigation servises must be calculated base on the principle of reserve and development Water Servicer's Funding :

$$P_{TL} = C_{TL} + V_{TL} = Z_{TL} + m_{TL} \qquad (1\text{-}1)$$

$$m_{TL} = \eta Z_{TL} \qquad (1\text{-}2)$$

Including :

- η is the interest rate due to the irrigation services brought, that is increasing with the facter of Z_{TL}, this method is considered only in simple way of water service seller. The value of η is to be considered as arouding value of average business interest rate in the whole country.

2- Calculating Method based on ordinary benefit of Water Services Buyer

a) Inceasing Share Coefficient α_{sp} :

Cost of Irrigation fee P_{TL} = Inceasing Share Coefficient x Value of Increaing Production

$$P_{TL} = \alpha_{SP}(P_{SP}^{TL} - P_{SP}^{0}) = \alpha_{SP} M_{SP} \qquad (1\text{-}3)$$

Including : α_{sp} less than 1, P_{SP}^{TL} , P_{SP}^{0} are Values of real production gained in two cases : irrigated and non-irigated , M_{SP} is Value of Increaing Production without taking account the inceased cost (landwork, seed, fertilize, insuarance, workman...) for effective use of Irrigation Services.

b) The rate of sharing super profits α : Cost of Irrigation fee P_{TL} = sharing super profits Coefficient x Value of super Profits :

$$P_{TL} = \alpha\left[(P_{SP}^{TL} - \Delta C) - P_{SP}^{0}\right] = \alpha M \qquad (1\text{-}4)$$

Including : ΔC inceasing cost for effective use of irrigation services;

M is Value of super Profits = Value of Increaing Production M_{SP} - inceasing cost for effective use of irrigation services ΔC.

$$M = M_{SP} - \Delta C \qquad (1\text{-}5)$$

$$\alpha_{SP} \langle \alpha \langle \qquad (1\text{-}6)$$

3- Calculating Method based on the combination of Economic benefits between the Water Services Seller and the Water Services Buyer

The formula of said method is written as follow:

$$P_{TL} = C_{TL} + V_{TL} + m_{TL} = Z_{TL} + m_{TL} \qquad (1\text{-}7)$$

$$m_{TL} = \alpha_{l} M \qquad (1\text{-}8)$$

$$M_{SP} = P_{SP}^{TL} - P_{SP}^{0}$$

M is Value of super Profits gained base on the use of irrigation servises,

α_l is the coefficient if sharing super profits without the use of irrigation servises,

$$\alpha_l \langle \alpha \langle 1 \qquad (1\text{-}9)$$

4-The tradational method for calculation of irrigation fee : The common method for calculation of irrigation fee has been recorgnized for long time in the fact, this formulation could be shown as below:

$$P_{TL} = \zeta \varepsilon P_{SP}^{TL} = \varphi P_{SP}^{TL} \qquad (1\text{-}10)$$

$$P_{TL} = \varphi' \left[P_{SP}^{TL} \right] \qquad (1\text{-}11)$$

Including :

- ε : the coefficient of sharing production gained due to irrigation services(*) (Xuzifang and Shenseifun- Calculating method for Economic benefits of mirrigation services in China-Water Resources Services Magazine 276 No January+February).
- ξ : The coefficient less than 1, give a water user a partial of the value of super production in order to encourage them to spend water.

ζ : about 0,4-0,6 (needs to consider more in detail)

P_{SP}^{TL},$[P_{SP}^{TL}]$ are the real value of obtaining production (annual or average of years) In general speaking, $P_{SP}^{TL} \rangle [P_{SP}^{TL}]$ for the value production unit per the unit area irrigated (1-15).

φ, φ' are the level of irigation fee (or the level of the cost of irrigation service) fits with the calculating method base on real obtaining production, and production unit. nomally, $\varphi \langle \varphi'$ (1-16)

II- *THE RELATIONSHIP BETWEEN THE IRRIGATION SERVICES, SHARING COFFICIENTS AND OTHER CONCERNED FACTER*

The relationship has been established among the different formulation shown in iterm I :

$$\varphi = \zeta\varepsilon \qquad (2\text{-}1)$$

$$\varphi = \frac{\alpha M}{P_{SP}^{TL}} \qquad (2\text{-}2)$$

$$\varphi = \frac{\alpha_{SP} M_{SP}}{P_{SP}^{TL}} \qquad (2\text{-}3)$$

$$\varphi = \frac{Z_{TL} + \alpha_l M}{P_{SP}^{TL}} = \frac{Z_{TL}(1 + \frac{\alpha_\varepsilon M}{Z_{TL}})}{P_{SP}^{TL}} \qquad (2\text{-}4)$$

$$\varphi = \frac{Z_{TL}(1+\eta)}{P_{SP}^{TL}} \qquad (2\text{-}5)$$

$$\alpha = \frac{\varphi P_{SP}^{TL}}{M} = \zeta\varepsilon P_{SP}^{TL} \qquad (2\text{-}6)$$

$$\alpha = \frac{\alpha_{SP} M_{SP}}{M} \qquad (2\text{-}7)$$

$$\alpha = \alpha_l + \frac{Z_{TL}}{M} \qquad (2\text{-}8)$$

$$\alpha = \frac{Z_{TL}(1+\eta)}{M} \qquad (2\text{-}9)$$

$$\alpha_{SP} = \frac{\varphi P_{SP}^{TL}}{M_{SP}} = \frac{\zeta\varepsilon P_{SP}^{TL}}{M_{SP}} \qquad (2\text{-}10)$$

$$\alpha_{SP} = \frac{\alpha M}{M_{SP}} \qquad (2\text{-}11)$$

$$\alpha_{SP} = \frac{Z_{TL} + \alpha_l M}{M_{SP}} \qquad (2\text{-}12)$$

$$\alpha_{SP} = \frac{Z_{TL}(1+\eta)}{M_{SP}} \qquad (2\text{-}13)$$

$$\alpha_l = \frac{\varphi P_{SP}^{TL} - Z_{TL}}{M} = \frac{\zeta\varepsilon P_{SP}^{TL} - Z_{TL}}{M} \qquad (2\text{-}14)$$

$$\alpha_l = \alpha - \frac{Z_{TL}}{M} \qquad (2\text{-}15)$$

$$\alpha_l = \frac{\alpha_{SP} M_{SP} - Z_{TL}}{M} \qquad (2\text{-}16)$$

$$\alpha_l = \frac{\eta Z_{TL}}{M} \qquad (2\text{-}17)$$

$$\eta = \frac{\varphi P_{SP}^{TL}}{Z_{TL}} - 1 = \frac{\zeta \varepsilon P_{SP}^{TL}}{Z_{TL}} - \qquad (2\text{-}18)$$

$$\eta = \frac{\alpha M}{Z_{TL}} - \qquad (2\text{-}19)$$

$$\eta = \frac{\alpha_{SP} M_{SP}}{Z_{TL}} - \qquad (2\text{-}20)$$

$$\eta = \frac{\alpha_l M}{Z_{TL}} \qquad (2\text{-}21)$$

The above formulations indecate the relationships between the different coefficients used for calculating irrigation fee. We can use them to calculate some coefficients when we know some other ones.

Fore example : If we know:

- Z_{TL} : 300 Kg/ha/ croping
- M_{TL} : 1.200 Kg/ha/croping
- P_{SP}^{TL} : 4.000 Kg/ha/croping
- α_L : 0,3

From (2-4) $\varphi = \frac{Z_{TL} + \alpha_l M}{P_{SP}^{TL}} = \frac{Z_{TL}(1 + \frac{\alpha_s M}{Z_{TL}})}{P_{SP}^{TL}}$

We have value of $\varphi = 0,165$ or $\varphi = 16,5\%$ real abtaining production.

With the same input data, we can have the results of other facters such as : $\alpha = 0,55$ (2-6) or (2-8)
If $\Delta C = 800$ Kg/ha/croping, we have $M_{SP} = 1200 + 800 = 2000$ Kg and then $\alpha_{SP} = 0,33$ (2-10).....

WATER RESOURCES AND WATER USES ASSESSMENT AND MANAGEMENT IN VIETNAM

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1. INTRODUCTION

Till now many people considered our water resources very prosperous: there will never be any water crisis in the future. This opinion and might have been right in the past when the country's population was small (25 - 30 millions), the water demands were very low, industry and agriculture were not developed so much and waste waters were negligible; water bodies were thought to purify themselves. Now we are in the last decade of 20th century. The population grew by 2.5 times in comparison with that 45 years ago, industry and agriculture are fast developing and water demands are larger and larger. Population centres every where require growing provision of water for domestic purposes; domestic and agro-industrial waste waters carry many toxic chemicals polluting and deteriorating heavily water quality in many places especially during low flow period and dry season while river water level is very low and unable for self purification. Even in some ground water aquifers, due to over exploitation ground water provision capacity is receded and in many wells water is saline, acid sulphate, polluted, ground water level is lowered by 5 - 10m after decades of exploitation; somewhere there is land subsidence threatening buildings, houses, dikes. Some large water constructions did not bring desirable designed effects, gave heavy socio - ecological impacts with expensive costs. Water resources developments often did not go along with basin land developments: deforestation, exploitation of virgin soils for agricultural purposes badly affected surface and ground water cycle; the intensive erosion caused big soil losses / deterioration, river bed sedimentation and enlargement in upper reaches while scouring in lower reaches of dams made unforeseen losses. Socio - economic activities in changing basins often had bigger and bigger impacts and changed natural conditions of water cycle and resources, caused deepening conflicts between water demands and provision, in water quality, seasonal and annual variation of water volumes, in upper - middle and lower parts of the basin. So urgent needs in proper water resources management for sustainable socio - economic development.

2. WATER RESOURCES AND WATER USES IN VIETNAM

The tropical monsoon climate with high rainfall provides favourable conditions for flow formation and created a thick network of rivers in the country. Along the coastline, in average there is one estuary per 20 kilometres. Accounting the rivers longer than 10 kilometres, there are 2,345 rivers in the whole country.

Of all river systems, the Mekong has the largest flow of 520 cubic kilometres while the Red and Thai Binh rivers have 137 cubic kilometres, Dong Nai: 31 km^3, Ca River: 24 km^3, Ma and Chu rivers: 20 km^3, Gianh river: 8 km^3, Bang and Ky Cung rivers: 7 km^3, other small rivers: 120 km^3. The high and low annual flows recorded over the past years differ 1.5 times even 30 times. The difference between the two flows in rivers with small catchment areas is more than 10 times whereas for large rivers it is only 1.5 to 3 times.

Generally speaking, water of Vietnam rivers is of good quality meeting various needs of the national economy and people's life. The salinity intrusion into river water varies significantly according to the tidal regimes and seasons. In the northern delta, the highest salinity falls in January, February and March, while in the former 4th zone (Central Vietnam) the highest salinity happens in March, April and May and the lowest one in September and October every year. In the Mekong Delta, the highest salinity occurs in March - April and the lowest one in September - October. In Ca Mau peninsula in particular, the salinity in river water is very high, even equals sea water salinity in certain places: the salinity exceeds 4% in the whole year. In general, on major rivers, up to 30 - 40 kilometre from river mouths, salinity in water exceeds the permissible limit for crop cultivation.

In addition, due to industrial, agricultural development, urbanisation, population growth, increasing demands for water use, more and more liquid wastes from population and industrial areas flow into rivers and lakes, thus water environment in some localities is seriously polluted, affecting production and people's life and the fresh water ecosystems. For instance, in Hanoi, at some places of sewage channels the water is very dirty with very bad smell, oxygen content is very low even at the zero level. BOD5 is high, more than 50mg/l, NH_4: 20mg/l, NO_2: 1mg/l, H_2S: 30mg/l. Fortunately, the recent To Lich River Improvement Project reduced the contamination of the river considerably. In Ho Chi Minh City, water in some sewage canals is darkened and with bad odour; organic content is high, with COD up to 596mg/l, BOD5: 184.5mg/l; dissolved oxygen is usually at the zero level. In the Lam Thao - Viet Tri area, sometimes in the low flow season, the tributary running through the City and industrial plants is seriously polluted: pH is so low (4.0), acid content is highly ferrous; organic content: NH_4 and NO_2 are rising. According to estimated figure, the hydropower generation potential of the country could reach more than 28 million kW. The practical economic hydropower potential is about 60 billion kWh per year, equivalent to 20 million kW of installed capacity. The Red River can generate over 50 million kWh per year. Hydropower potential in Vietnam is abundant and relatively evenly distributed throughout the territory. Apart from building large hydropower plants, small - scale hydropower stations have been constructed in more than 500 locations with total production of nearly 4 billion kWh per year, supplying electricity for local needs and regulating river flows for local agricultural production.

Groundwater

According to surveys and investigations undertaken by the geological survey of Vietnam, there is a great potential of ground waters, and the total natural reserves in inland territory reaches 1513 cubic meters per second or 130 million m^3/day, accounting for almost 15% of total surface water in the whole territory. However, groundwater resources are not evenly distributed over hydrogeological regions. Looking at the geological formations, ground water is abundant in unconsolidated formation with biggest reserve (26% of total reserve), in the intrusive, geological formation it makes 17%, in the metamorphic geological formations 16%, in the mixed geological formation 16%, in carbonate 5%, in terrigenous formations about 15%.

According to data collected up to 1989 from 150 areas in the whole country where exploration works are concentrated in major cities and towns reserves exploitable immediately from the alluvial sediment formation reach 855,000 cubic meters per day, accounting for 71% of total reserves volume on industrial scale of the country, the ground water reserves exploitable from the carbonate formation may be 138,000 cubic meters per day, accounting for 11% of total reserves. As far as the exploitable reserves are concerned, some 15 million cubic meters per day could be withdrawn. This figure shows the abundant ground water resources of the areas under exploration. In the near future, it is possible to increase the exploitation of ground water to 2.7 million cubic meters per day.

With regard to water quality, ground water in the hilly and mountainous regions is good, meeting human needs. However, in certain areas, ground water contains high content of Fe, hardness and high corrosive feature due to carbonic acid that make it unsuitable for industrial use and require its treatment before use.

In the northern and southern plains, groundwater quality changes greatly because of the impact of saline water on the surface and in the depths: groundwater is often found to be brackish, acid sulphate. In many cultivated areas because of the use of fertilisers and insecticides in agriculture and in some urban and industrial areas, ground water is contaminated to various degrees, leading to its quality degradation, unsuitable for use.

The excessive exploitation of groundwater resources has reduced these resources, made ground water levels declined. Water levels in various drilling wells lowered from 10 to 20 meters and the supply capacity was reduced by half. There are many examples of excessive water extraction causing qualitative and quantitative depletion of the natural resources, posing a possible crisis unless managerial measures are taken in order to conserve the precious groundwater resources.

Mineral and thermal waters

According to incomplete statistics, in Vietnam there are more than 350 sources of mineral and thermal ground waters, including carbonic group located in the southern most area of Central Viet Nam, south of the Central Highlands, eastern region of South Vietnam, northwest and northern regions of South Vietnam; the sulphide group in north-western region and mountainous areas of Central Vietnam, the siliceous group in the Central and Southern areas of Central Vietnam; the ferrous group in Northern (Bac Bo) and Southern (Nam Bo) plains; the bromid - iodide - borid groups located in the sedimentary basin of Hanoi; coastal region in Quang Ninh; the fluoride group in southern Central Vietnam; the radioactive group is newly discovered in some places in Mo Duc and Phu Lao. The majority of mineral water resources are also thermal waters. Counting only the prospected sources, there are 169 springs of which 63 are warm (30 - 40 degrees Centigrade), 70 are hot (41 - 60 degrees Centigrade), 36 are very hot (60 - 100 degrees Centigrade) There is no thermal spring in the geological region of Northern plain, but thermal water exist in deep layers; in the Southern plain there is no thermal springs except two warm sources.

According to rough estimation it is possible to exploit up to 86.4 million litres per day of mineral and thermal waters.

The above - mentioned statistics show that Vietnam has rich, abundant and various mineral and thermal ground water resources which are good for medical treatment for refreshment and aquaculture purposes. Some of them may have geo-thermal energy and are able to used for drying of agricultural, forest and marine products, for incubating, silk unwinding from cocoon and electricity generation ... In several cases where thermal water has high contents of some elements/components with suitable technical and economic conditions, it is possible to develop commercial production of carbon dioxide and sodas from them. Mineral and thermal water resources are evenly distributed over the whole country, especially in some large urban areas, beautiful sceneries and historical sites. That facilitates exploitation of this natural resource for socio-economic development of the country.

Water uses

The data collected in the North since 1954 and in the South since 1975 show that water resources have been intensively developed. River and sea dyke systems of about 7,000 kilometres length have been constructed and consolidated to protect effectively the delta regions and coastal plains from floods and inundation. The dyke system has been strengthened more than ever. More than 30% of cultivated areas have been irrigated. Many multipurpose irrigation projects have been built to exploit the water resources, to regulate river flows between the flood and dry seasons such as Hoa Binh, Tri An, Dau Tieng, Thac Ba, etc. Up to now, only 50 cubic kilometres of water resources accounting for 6% of total annual stream flow are utilised.

As projected to the year 2000, in order to increase the total irrigated area up to 6.5 on 10 million hectares, it needs the total water volume to be at 60 cubic kilometres and 10 - 15 cubic kilometres for animal husbandry. Water needed for a population of 80 million would be estimated at 8 cubic kilometres, for the industrial sector would be 20 cubic kilometres. The overall water volume needed would reach 90 - 100 cubic kilometres, and thus by the year 2000, the water volume quantity needed for development purpose would be approximately 30% of the water resources generated on Vietnam territory. Particularly, the need arises mainly in the dry season when river water recedes. From the available data, it is estimated that in many areas the need for water in dry season exceeds the available resources at the time 50% or as much as 100%. This shows that without good management, the possible expansion of transport and communication should be taken into account.

Over the last few decades, the rising socio-economic development has profoundly affects the fresh water ecosystems and the water resources and in this connection, among them attention should be paid on the deforestation, excessive exploitation of forests, mining, road and bridge building, urbanisation and industrialisation, building of a series of small and medium-scale reservoirs. Soil erosion is seriously expanded in the midlands and mountainous regions. In many areas, due to deforestation, some streams have dried up, ground water resources reduced. Liquid wastes from the urban areas, industrial and agricultural production in some places caused water contamination beyond the permissible limit, particularly in the dry season. Environment and ecosystems in several areas have been degraded, big floods and droughts tend to increase in many areas.

One of the causes for such a situation, that needs measures to overcome, is the management and protection of water resources, from planning, designing, constructing and operating. Environment aspects have not been fully studied; sometimes people tend to separate the water resources use from the ecosystems and environment problems. When the projects are put into operation, there are no means to regularly monitor and assess the state of water resources and the project operation in order to draw necessary experiences for modifying, innovating or improving the management and protection work of water resources.

3. WATER RESOURCES MANAGEMENT

3.1. Experiences show that, water resources management may be defined as complex of actions toward exploitation, use and control of water resources in order to get best products and optimal natural conditions for society. That is the mobilisation of every forces in water resources assessment, planning, carrying out plans, coordination of activities in storing, conducting, allocation, protection and conservation of water resources, environment, ecology by system of measures, tools, institutions and organisations necessary for the management. It is clearly a highly combined work linking important activities concerning physical aspects of soils and water surfaces/ground and rain waters, the economic activities like irrigation/fish raising, tourism, water borne navigation, social aspects like water resources exploitation and people enjoying/suffering from water resources projects.

3.2. Water resources assessment

The demands on domestic, food production, sanitary, socio-economic water supply are growing larger and larger, but water resources in each territory, each basin are limited - somewhere and sometimes they are really at final limits especially in low flow period and in dry areas. Water ecological systems, water basins are water resources and places for wastes deposition at the same time. Human socio-economic activities heavily influence water resources to the level beyond their waste absorption capacity: water quality is degraded and polluted with chemicals, bacteria's, radiation materials, sediments and other physical/chemical changes. Deforestation, urbanisation, improper soil cultivation techniques aggravated risks of floods/droughts in both intensity and frequency. World climate is unstable and changing. The rising of world temperature leads to change in distribution of rainfall, runoff and ground water recharge, the water cycle is in disturbance and not stable as in the past.

The water resources management requires periodical and regular evaluation, monitoring of the water resources variation, changes in quantity and quality and their conditions as well.

Hydrological observation network should meet the requirements of inventory of water resources in quantity and quality, their variation in space and time, changes under natural conditions and human socio-economic activities. The former consideration of stability of hydrological processes during decades, even in century is no more realistic for computation/forecasting purposes due to changes in basin/region environment and ecology.

3.3. Methodology in water resources management

3.3.1. The demands of the future

During last 40 years, since the peace restoration in the North (1954) and after 1975 country's liberation, the water resources exploitation was in fast development and mainly concentrated in the exploitation of surface and ground waters for irrigation, power supply, domestic water supply in cities, villages, industry, reduction of damages caused by floods through the construction of reservoirs on the basins (about 3600 reservoirs) and factories for ground water exploitation.

One notable shortage in the water resources development is the management of head water areas of watersheds and the conservation of water resources have been paid little attention. So water structures did not meet designed cost-effectiveness, their maintenance was not good. The water structures had many and sometimes serious socio-environmental impacts. Most of the available water constructions were built in most favourable sites and cost-effective so the constructions of new structures would have many difficulties and very expensive. Improper watershed management led to erosion, washing of basin surface, floods and droughts were more and more severe. New ground water resources are more and more limited and their pollution from cities, industrial and agricultural centres, salinity intrusion is growing.

In meeting of growing demands in the future it needs better water resources management through renovation of knowledge and methods. One of these basically changes is to shift the development of water resources to balancing of water resources and centering in water conservation, effective management of water demands/uses and further development of new sources for water supply compatible with environment-ecology at lower cost/easy implementation.

3.3.2. The future management methods should be able to solve effectively the following main problems

a. The socio-environmental impacts

In fact, the water resources projects may give good and bad results. There are many projects that are planned and designed unsuitably to the complex relationship between man, water, environment and development. The bad results may be recognised in 4 forms:

(1) The disruption of human economic activities. The construction of large dams and reservoirs forced resettlement from the reservoirs sites of hundreds thousand people, creating serious psychological, economic, cultural, religious problems to be solved in new abode, especially the ones concerning social, physical and infrastructures.

(2). Various water projects in different places created favourable habitats for parasitic and waterborne diseases such as schistosomiasis, malaria, filariasis and river fluke infections especially in cases of irrigation systems.

(3). Environment and social disruption in physical and chemical aspects. The results are aggravated with changes in agricultural techniques, in surface/ ground water regimes due to construction of irrigation systems or flood protection structures. Soil salinization and waterlogging due to improper irrigation technique are classical examples of the type. One of the heaviest environmental impacts is the construction of reservoirs for flood control and hydropower generation. The results are too fast sedimentation annulling the reservoir effectiveness ahead of time. Other impacts of water resources projects on environmental are influences on ecological systems, animal and plant colonies, that have unforeseen harms with enormous cost for restoration or even unable for recovering coupled with further serious losses.

The mentioned discussion shows that how important and meaningful is the environment impact assessment of water projects. It is necessary to include it and restoration proposals right in the project planning, design and implementation process, the trade- off/ balancing between socio- economic targets and environment conservation.

b- Watershed management: close linkage between land and water

Watershed management is defined as process of formulation and implementation of a basin water and land resources exploitation where we should fully and all round examine every factors relating to society, economy, environment and institution with special attention to close linkage of the basin upper and lower parts, the interactions between land and water, the solution for erosion and scouring leading to land degradation/ reduction of agricultural and forest productivity, prevention of sedimentation and water pollution in lower reaches, limitation of mud- flow, flash flood, carrying out integrated measures in planting- land processing techniques for erosion control together with traditional measures of land and water conservation.

Some of water and land linkage approaches in watershed management are as follows:

-The basin should be considered as a single unit with the interrelationship and interdependencies between land and water management.

-Basin approach requires the consideration of the Bio- physical linkages of upstream and downstream activities.

-Basin approach is necessary and useful for planners and managers in overall consideration of relevant facets of resources development including on- site and off- site affection relating to projects in forestry, water/ land conservation, development of villages, cities and farm systems.

-Basin approach requires regular assessment of environmental impacts including the effects of land and water use activities on systems in upstream and downstream.

c- Rational water allocation

There are several efforts in water allocation in Vietnam to meet the demands at very cheap cost even without any charge at all. There are no competition and conflict in water uses. So due attention has not been paid on economic, effective water use, on price policy and water use technology as well. Experiences in various developing countries showed that due to population growth, extensive economic development, growing economic and environmental expenses in water sources exploitation it requires firm management of water demands and effective uses of available water together with development of new sources at lowest cost. This strategy requires application of modern water use technology, water recycling system in industrial factories, waste water treatment and reuse technologies to reduce unit water use for industrial product and irrigation, conjunctive surface water and ground water management, rational price systems for water provision and permissible pollution limits for waste water including increasing block rates and differential rates for drought periods.

Many countries use system analysis in water resources planning and the components in water resources planning are as follows:

Assessment of time and space water use models

Analysis of demands and impacts on water resources by these activities.

Analysis of natural systems including hydrological, meteorological, biological, geo-morphological.

Formulation and analysis of measures in water resources management strategy

Evaluation of strategic measures using benefit-cost analysis and multiple-objective analysis

d. Water resources management implementation

One of the most important problems in water resources management is effective implementation of plans, programs. Summing up past experiences in many countries showed that the shortages in implementation are delay and high cost in construction, lack of water for irrigation in agriculture, and hydropower during operation and maintenance, incongruent land conservation and sedimentation reductions. Other failures are ineffective relocation of people displaced from reservoirs areas and in successful prevention of waterlogging and salinization of adjacent to irrigated areas. Major causes of failures are inadequate attention to examination of socio-environment impacts during planning; improper interrelation between irrigation and agriculture production for every small area, each farm. Financial investment for construction operation, maintenance has not been provided timely and adequately. That led to structure destruction, degradation and especially disruption of linkage between land and water uses in management of basin, irrigation systems.

4. SOME RECOMMENDATIONS

From practices in various countries in ESCAP region it is clear that flooding, drought, erosion, sedimentation, surface and ground water pollution, salinization are more and more serious problems which impact heavily on limited water and land resources and are main factors limiting future socio-economic development. The flood plains and upper areas will be occupied by socio-economic developments with unforeseen socio-environmental negative effects.

Some water resources problems for future studies may be selected as follows:

(a) Floods and droughts

(b) Scouring and deposition in reservoirs and rivers

(c) Urban hydrology - land subsidence - salinity intrusion - water pollution - rainwater drainage - flooding - water supply - allocation of scarce water sources;

(d) Ground water quality in coastal and plain areas, salt water intrusion in ground water and problems related to expanding urbanisation.

(e) Domestic and sanitary water supply in rural and cities areas.

Recently we have developed water sources rather fast, in near decades we should concentrate on good water resources management. The water resources management methods should be compatible with interaction, linkage between social, economic and physical aspects. Those are:

- Physical relationship of quantity and quality of surface water in rivers, lakes, estuaries and groundwater. Due combination of surface and ground waters from planning to implementation stages.

- Complex interaction between land and water ecological systems, coupled with physical process of surface and subsurface water evapotranspiration, erosion, sedimentation and ground water storage. This includes the basin management of surface runoff and ground water accumulation.

- Actual and planned human activities in time and space will greatly impact water management due to growing demands and aggravating water pollution problem.

- The relationship between water resources sector and other sectors at local, regional and national scales requires consideration together of water resources and socio-economic sections in the projects, in planning at various levels from local, regional to nation wide.

- The complex political governmental and institutional context within which human activities take place may lead to underestimation of environment problems. Multiple objectives, combination of methods, multiple decision-makers are characteristics of this complex management setting.

From the above analysis, in order to achieve a sustainable development of water resources, to maintain the quality and quantity of restorable water resources and effectively protect environment and water ecosystems in the coming decades, it is necessary to work out a national action plan which is aimed at the following:

- Determining a national development guideline or strategy on water resources, that should be directed at the sustainable development, closely linking water economy with effective protection of water ecosystems.

- Taking into full consideration of environmental aspects in all water resources development projects, particularly the aspect of protection of water and forest resources.

- In a strategy of risk and disasters management, apart from anti-deforestation programme, efforts should be made to reforest the barren hilly lands, to develop agro-forestry measures to cope with land erosion.

- Attention should be given to the provision of monitoring equipment and laboratories, the improvement of institutional arrangements, methods of surveys, and forecast of hydrologic changes.

- Conducting comprehensive studies of impacts on the water ecosystems.

- Conducting studies on urban hydrology and that of large reservoirs like Hoa Binh, Tri An, Dau Tieng and Thac Ba.

- Organising at an appropriate level surveys of surface erosion in basins in relation to topography, climate, land, geology and deforestation.

- Monitoring climate changes which affect the water resources and ecosystems.

- Special concern should be given to the infrastructure of the sustainable development of the water resources and ecosystems, including knowledge on hydraulics and water resources, system of policies and legislation, water quality standards.

- Expanding international cooperation in the fields of water resources, particularly regarding international rivers as the Mekong or the Red Rivers, there should be close cooperation among the riparian countries within a comprehensive plan to ensure the common interests and benefits of all countries while exploiting and protecting water resources and environment.

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GROUNDWATER MANAGEMENT AND PROTECTION IN VIET NAM

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Groundwater is a mineral resource and is at the same time an Important component of the water resourceS and an environmental factor directly affecting the life of humans and the biosphere in general, so it is called by some scientists "the blood of landscape". Hence the management and protection of the groundwater resources is of primary concern in many countries, including Vietnam.

1. OUTLINE OF THE GROUNDWATER RESOURCES OF VIETNAM

According to the available hydrogeological data, it is possible to differentiate three main aquifers in the territory of Vietnam which are most prospective for large scale public and industrial water supply.

1. Aquifer in the unconsolidated Quaternary and Neogene sediments, distributed mainly in the plains and intramontane valleys

2. Aquifer in the Triassic and Paleozoic sediments distributed mainly in the Northeast, Northwest Bac Bo and North Trung Bo regions

3. Aquifer in the Neogene - Quaternary basalts distributed mainly in the Central Plateau and East Nam Bo regions.

The terrigenous and mixed sediments, which have less groundwater productivity, are of certain importance for medium and small scale water supply.

Geographically, the Bac Bo plain is the most potential in groundwater. The Mekong delta is also prospective, but there are some complex problems involved, particularly those regarding recharge sources and hydrochemical conditions. The Central Plateau and the Nam Bo plain are also prospective in the groundwater which occurs in basalts, but in a limited extent.

Qualitatively, the groundwater in Vietnam is in general of good quality, except the coastal zone where it is saline. In many places of - Bac Bo and Nam Bo plains, the groundwater is contaminated with alum and ferrous ions. In some large cities and industrial centres the groundwater is polluted due to the waste disposal.

The natural groundwater dynamic reserve of the whole country, according to the preliminary calculation, reaches about 130 million m3/day. The exploitable reserve is listed according to the results of prospecting an exploration in different areas within the country as follows-.

demonstrated reserve:	5 0 million m3/day
Probable reserve-	3.0 million m3/day
Possible reserve-.	15 million m3/day

The groundwater resources include also mineral and thermal water sources, which are distributed widely in the territory. Totally 350 mineral and thermal water sources have been recorded, half of which are springs. The mineral waters of our country include all types known in the world: carbonated MW, sulphide MW, siliceous MW, ferrous MW, bromide-iodide-boride MW, fluoride

MW. radioactive MW, arsenic MW. Many mineral water sources are at the same time thermal water. Taking the springs alone, throughout the country there have been registered 169 sources with temperature from 30 to 100oC. Thermal waters with temperature over 100oC were discovered by deep wells drilled in the Hanoi depression, of which the most important are the wells yielding water with temperature 150 - 170oC at the depth of 3,000 - 4,000 m.

II. STATUS OF GROUNDWATER EXPLOITATION AND UTILISATION

At present, throughout the country there are 120 urban centres having water supply systems which are extracting daily about 2 million cubic meters of raw water, of which groundwater accounts for 33%. This water supply system has only ensured the water supply for 60 % of the urban population. Apart from the leakage (about 30 - 40 %) and the industrial water supply, the average consumption rate has reached only 60 l/day per capita. In Hanoi and Ho Chi Minh City in particular the consumption rate may be higher but still not exceeding 100 l/day per capita. Such a rate is too low for a modern city. Therefore the Government is planning to increase the ratio of the population benefiting from water supply to 80 - 90 % with the average water consumption rate increased to 100 - 150 l/day per capita.

That was regarding the quantity. Qualitatively, in many places the water has not met the hygienic standards.

In the country side, the groundwater exploitation and utilisation has a long tradition. According to incomplete statistics, throughout the country there are approximately 4,000 dug wells. During the last decades relatively modern methods of groundwater abstraction have been applied such as drilling, electric pumping, hand pumping, wind operated pumps, etc. to get water for domestic water supply, animal husbandry, food processing, etc.

Since 1982, a rural water supply program has been carried out with the aid of UNICEF. Boreholes have been drilled for domestic water supply of the rural population. This program has been expanded to all over the country with number of wells drilled upto 1994 amounting to 118,000, ensuring the clean water for about 17 million people (accounting for 31 % of the rural population. The rest of the rural population still are using water from rivers, lakes, ponds, not meeting the sanitary standards.

The "Mountain area water supply program" operated by the Geological Survey of Vietnam is being carried out in some water-short areas of the Northern border provinces and will be expanded to the mountain and remote areas throughout the country.

Mineral and thermal water resources are also being exploited and used effectively for medical treatment in some spas. During the recent years a campaign of mineral water bottling has risen in many localities with a production of 43 million bottles/year, which is much promising. Some of the mineral and thermal water sources have been used effectively for cultivation of algae, producing soda, carbon dioxide, and experimental breeding of shrimps and fish during the winter time, as an energy source.

The above presentation shows that the groundwater resources of Vietnam are rather abundant. In many areas, they can ensure large scale water supply and in fact they have taken their effect, first of all in the water supply for urban areas, important industrial areas, and ensure the clean water for rural areas. However, the exploitation and utilisation of groundwater in the last period have been still in a limited extent. Therefore this resource should be paid more attention in order that it may serve more effectively not only the urban water supply, but also the agricultural production in the rural and mountain areas.

III. GROUNDWATER MANAGEMENT AND PROTECTION

Although the groundwater investigation, development and utilisation in Vietnam has been carried out since a long time ago, its management and protection have been paid attention only in the recent years. Some important events took place recently such as the establishment of the State Department for Management of Mineral Resources, the propagation of the Ordinance on Mineral Resources (1989), in which the groundwater is considered as a mineral resource, requiring control and protection in accordance with Laws. This was followed by the Decrees of the Government regarding the details of implementing the Decree on Mineral Resources, the Regulation of the Ministry of Heavy Industry on protection of groundwater resources (1992).

Besides, some provinces and cities have also propagated at local level their regulations and standards on natural resources and protection of the environment including the groundwater. Those are legal documents based on that the natural resource and environmental management institutions are carrying out the inspection and dealing with violations causing damages to the groundwater resources. However, the situations are developing in a complicated manner, and becoming serious in some aspects,

In order to carry out the management of groundwater resources in scientific aspect, in 1990 the Geological Survey of Vietnam started construction of a groundwater monitoring network in the three important economic regions of the country the Bac Bo Plain, Nam Bo Plain and the Central Plateau, at the same time, special monitoring networks in Hanoi area and the area of Hoa Binh Hydropower reservoir were established. A research project on groundwater pollution in plain areas is also being carried out.

However, the control of the groundwater resources in the last period expressed some weak points as follows:

1. There is still no strategy on water resources for orienting reasonably the exploitation of water resources for human and economic purposes, protection of the water resources and the environment. This has lead to the bias either toward surface water or groundwater, causing confusion, in some cases high prices had to be paid while planning the water supply for a particular object.

2. There is a lack of coordination between investigation and exploitation. In some areas the groundwater has been investigated in great detail, but after a long time it still has not been put to exploitation. In the contrary, in some areas with urgent demands, no exploration have been carried out. This would cause losses to the economy.

3. Although a great amount of investigations have been carried out, a national inventory of groundwater resources has not been established. The monitoring and prediction of quantity and quality changes caused by different natural or man-made factors has been delayed. The monitoring on the groundwater abstraction, the study on the groundwater degradation and pollution have not been paid due attention. Therefore there is a lack of data to suggest a rational exploitation for the purpose of groundwater protection.

4. Legal documents on groundwater management have been delayed in propagation and have not been largely distributed. On the other hand, the national inventory in this aspect have not been regularly and strictly carried out. Violation of Laws and regulations on groundwater are still frequent, but have not been detected and treated in time. Some activities having effects on groundwater, such as indiscriminate well drilling, uncontrolled disposal of wastes that causes groundwater pollution, etc.., are not controlled by resources and environmental management agencies.

5. Organisationally, the delineation of the responsibility in groundwater management between different ministries is still confusing.

In short, the groundwater resources management works in our Country has been neglected for a long time, up to now has not yet Put 'into order. This has caused many bad consequences, the most common ones are pollution, salinisation increase in drawdown and reduction of well discharges,

The pollution of water resources in general arid of the groundwater in particular in Vietnam has not reached the level of the developed countries, but in many places there appear some signs of pollution, of which the most problematic, one is the pollution caused by domestic and industrial wastes in populated and industrialised areas Hanoi, Viet Tri, Thai Nguyen, Bac Giang, Da Nang, Ho Chi Minh City, Bien Hoa, etc. and the pollution due to the fertiliser and insecticides, used in the agriculture.

In the near future, when a series of export processing zones and joint venture companies will be established, the risk of environmental pollution in general and that of groundwater in particular will be increased, if no preventive measures are applied.

The salinization of the groundwater is also widespread in the coastal areas. Here the groundwater occurs in the equilibrium between the fresh and saline water. If the abstraction is not rational, the fresh-saline equilibrium will be destroyed and the saline water will invade the fresh water aquifer and cause the groundwater to be saline This phenomena has happened in many wellfields in Quang Ninh Phong, Vinh. Ho Chi Minh City,Bien Hoa, Kien Giang.

Together with the quality degradation, in areas of large- scale groundwater exploitation there are signs of decrease in groundwater quantity, expressed in the decrease of discharge and excessive drawdown in wells. For example, in Hanoi, groundwater exploitation was started in 1909 with a discharge of 20,000 m3/Day. The abstraction increased radically as follows. 1954: 40,000 m3/day, 1978: 164,000 m3/day, 1985: 265,000 m3/clay. With this the groundwater level have dropped considerably. According to the groundwater- monitoring delta, for 10 years (1978-1988), the drawdown in the wells have increased by 1.1 to 1 8, even 2,8 times. Due to the drop of the groundwater level, the discharge of each production well also tends to decrease. Thus, in order to increase the capacity of the water treatment plants in Hanoi to 500,000 m3/day by 1995 as planned, it requires thorough studies, accurate calculation and serious technical measures to avoid adverse effects.

In Xuan-(Dong Nai province), during 1985 - 1987 there was a big campaign in well drilling for coffee irrigation. In near 5000 Ha of 7 most important coffee planting areas alone, 300 wells were drilled. Besides there were hundreds of dug wells. In peak irrigation periods, abstraction could be as much as 50,000 m3/day. Such an unorganised exploitation from a dense well network in a small area has caused an extensive drawdown. Within only a few years, the groundwater level dropped 5 - 6 *m*, in some cases up to ten meters, causing depletion in many wells. In some cases, the lack of knowledge in local stratigraphy has lead to underground leakage and loss of reserve.
Besides the groundwater depletion due to the groundwater exploitation for irrigation, the groundwater reserve is being reduced due to flowing wells. This happens in many places, especially in East Nam Bo, the Mekong delta and in Central Plateau.

IV. RECOMMENDATIONS FOR GROUNDWATER INVESTIGATION, EXPLOITATION, UTILISATION AND PROTECTION

Due to the intensive economic development, the water demands in general and that of groundwater in particular for different branches of national economy and for domestic uses are ever increasing. In order to meet those requirements, during the coming period the groundwater investigation, exploitation, management and prctection must be further intensified, with the following tasks:

1. Speed up the establishment of a water resource strategy, comprising also groundwater, as a basis for rational planning of groundwater investigation, exploitation and utilisation for different economic and human purposes, with economic efficiency and ensuring ecological balance and environment protection.

2. Continue regional hydrogeological investigation and mapping in order to assess systematically and accurately the groundwater resources in the whole territory as well as in individual important economic and populated areas. Intensify the groundwater management and protection, carry out state inventory of the groundwater and thermomineral water resources, establish groundwater register, edit and publish monographs on groundwater resources, develop hydrogeological databases, organise well the storage of the hydrogeological information.

3. Intensify and -improve the quality of the groundwater prospecting and exploration, with the emphasis given to the large population and industrial centres, the important new economic zones. Promptly put into exploitation the reserves already explored, to meet the needs for water supply of the above mentioned priority objects. More attention should be paid to the use of groundwater for irrigation and reclamation of agricultural land. Due attention should also be paid to the water-short and mountain areas. Extend the exploitation and utilisation of thermo-mineral waters for medical treatment, spas, bottling, tourism, aquaculture, extraction of soda, carbon dioxide, geothermal energy.

Continue editing and propagating regulations, standards, detailed and comprehensive instructions on groundwater management and protection, frequently inspect and promptly deal with the activities causing damages to the groundwater resources, stop the chaotic groundwater and thermo-mineral water exploitation.

Speed up the completion of the national groundwater monitoring network and carry out monitoring and prediction of groundwater regime in the Bac Bo, Nam Bo plains and Central Plateau, expand the monitoring network to the Central coastal plain and throughout the country. At the same time establish special monitoring networks for monitoring groundwater and geodynamic processes in urgent areas, the hydropower reservoirs of Hoa Binh, Tri An, Dau Tieng, Yali, large scale groundwater exploitation areas, Hanoi, Ho Chi Minh City.

Further carry out investigation on pollution, salinization, groundwater resources degradation in vulnerable areas, in areas with residual toxic chemicals after the war in the South. Investigate and deal promptly with the loss of groundwater reserves due to the wells overflowing for a long time.

Apply the method of groundwater artificial recharge to increase the groundwater resources and prevent the salt water encroachment in coastal areas. In the mean time carry out research in dealing with the adverse effects caused by groundwater.

4. Improve the organisational structure for groundwater studies and management, intensify the training and augment the qualification of the technical and management staff in the field of hydrogeology and groundwater resources,

5. Improve and renovate equipment. promptly apply advanced methodology and modern techniques into the groundwater investigation, management and protection. Refine the standards and procedures on groundwater management for unified application.

6. Expand the international cooperation in the field of hydrogeological investigation, groundwater management and protection.

SESSION THREE

COUNTRY REPORTS

APPLICATION OF HYDROLOGIC MATHEMATICAL MODELS FOR WATER RESOURCES MANAGEMENT IN VIETNAM

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Abstract: During last decades, the hydrologic mathematical models have been strongly developed in Viet Nam with many purposes: runoff forecast and prediction, computation for design, sedimentation in reservoirs, planning research (making master plans), evaluation of effects due to human impact causing the change of large - scale natural processes, hydrologic risk management, water resources system analysis, researching the impact of climate change to water resources ...

Based on the scientific reports, papers and other documents which were obtained from the application of models to the Viet Nam territory (in large, medium and small catchments), the author review the progress on application of hydrologic mathematical models for water resources management in Viet Nam till now.

1. INTRODUCTION

"Freshwater is a finite and vulnerable resource, which is vital for the sustenance of life, for all development activity, health and environmental maintenance" (Copenhagen Statement) [3]. At present time, having good knowledge on water resources management is an urgent requirement for all mankind and each nation.

Hydrologic mathematical modelling is one type of knowledge which ' people need to know. That's why the hydrologic mathematical models are developing quickly.

2. THE HYDROLOGIC SYSTEM AND THE MATHEMATICAL MODELS

2.1. *Hydrologic System*

For many years, scientists have been using mathematical modelling as a tool for increasing their knowledge of the behaviour and the operation of physical systems.

"*A system* - according to the definition by J.C.I. Dooge (1973) (4] - *is any structure, device, scheme or procedure, real or abstract, that interrelates in a given time reference, an input. cause or stimulus of matter, energy or information and an output, effect or response of information, energy or matter*

The hydrological cycle is one such system. In a study of the generation of streamflow, only some parts of the whole system need be considered, while studies of particular hydrological processes may require treatment in much greater detail,

A model is a simplified representation of a complex system. A mathematical model is a model in which the behaviour of the system is represented by a set of equations, perhaps together with logical statements, expressing relations between variables and parameters.

Mathematical models are one kind of model of the hydrologic system (other kinds, such as physical models, analog models, etc. are not considered here). In general form, a mathematical model might be described by an equation as follows:

$$F[x_i(t), y_i(t), \partial x_i(t)/\partial t, \ldots, \partial^k x_i(t)/\partial t^k, \partial y_i(t)/\partial t, \ldots, \partial^p y_i(t)/\partial t^p, \theta_l, \ldots, \theta_q] = 0 \quad (1)$$

where:

$x_i(t)$ - input variables of the system at time t

$y_i(t)$ - output variables of the system at time t

θ_j - parameters of the system

Whenthe system is very complex, i.e. as in the hydrological system, it may be adequate for many purposes to adopt some relatively simple form **f** for the
function **F** above and to express the "lack of fit" by means of an error. At the same time, the hydrological variables (inputs and outputs) are often measured at discrete intervals of time (monthly, weekly, daily, hourly ... or averaged over such intervals. In this case, the model (1) can be written:

$$y_t^{(i)} = f[x_t^{(i)}, x_{t-1}^{(i)}, \ldots, y_{t-1}^{(i)}, y_{t-2}^{(i)}, \ldots, \theta_1, \theta_2, \ldots] + \varepsilon_t \qquad (2)$$

This means that the output y(i) at time t of the system is dependent upon its own past values and on the current and past inputs to the system.

Mathematical models in hydrology can be classified into two main groups: Conceptual and Empirical. The classification is based on whether or not the functional relationship between the variables is derived from consideration of the physical processes involved.

Conceptual models can be used in the following circumstances (Clark, 1973) [2]:

(1) To provide short-term forecasts

Assume that the values of input (xt, xt-1, ...) and the parameters (**O** 1, **O 2,** are known, then the value of output y can be found from the model (2). This is the forecasting value at time t of output.

(2) *To investigate the effects of proposed physical changes to the catchment*

If the change in land-use can be fully represented by substituting different values for the model parameters then the model can be used to determine the effects of the physical changes to the catchment.

(3) To *extend a discharge record of short duration by transforming a long rainfall record into estimated discharge.*

2.2. An outline of linear system identification

According to Hsia (1977) [6], the system identification problem can be classified into two categories (6]:

(1) A black-box problem

This is a complete identification problem. It implies that we don't know anything about the basic properties of the system (linear or non-linear, memorials or with memory ...)

In practice, however, some assumptions must be made if any progress is to be achieved, so the problem immediately reduces to a "grey-box" problem.

(2) A grey-box problem

This is a partial identification problem. In this category, some basic properties of the system (e.g., linearity and time - invariance) are assumed to be known. However, while we may assume a particular form of model, we don't know the specific order of the equation governing the system or the value of the coefficients of the equation.

A particular catchment behaves as a system, with rainfall, land-use processes as inputs and evaporation, transpiration, runoff, sediment , water chemical component ... as outputs of this system. If we wish to consider this whole system, then we are of necessity dealing with a non - linear system. In that case., one of the simple equation may be as follow:

$$Q(t) = \int h(\tau).P(t-\tau).d\tau + \iint h(\tau_1, \tau_2).P(t-\tau_1).\ P(t-\tau_2).\ d\tau_1.\ d\tau_2 + \dots$$

$$+ \iint \dots \int h(\tau_1, \tau_2 \dots \tau_n).P(t-\tau_1).\ P(t-\tau_2)\dots P(t-\tau_n).d\tau_1.\ d\tau_2\dots d\tau_n \quad (3)$$

However, if- the model input is effective rainfall only and the output is the observed discharge then unit hydrograph techniques, which have been widely used to solve this kind of problem, may be used. This is based on the assumption of linear system behaviour. The problem now reduces to a problem of linear system identification, a grey-box problem. To pursue this analogy, the shade of "grey" depends on the degree of constraint we impose on the model, that is, the degree to which we specify the internal structure of the model. If we specify it explicitly in parametric form, where each of the parameters is capable of physical interpretation and perhaps even direct measurement then the model is "conceptual". Most of our models, however, fall between the extremes of "pure" black-box and "pure" conceptual models, that is, our models are generally "grey-box". The philosophy of model building is to start with simple forms, such as linear forms discussed below and work upwards in complexity as required.

2.3. Some basic concepts of *system theory*

2.3. *1. Linear system*

A single input / single output system is said to be linear if its behaviour can be described by a linear differential equation of the form:

$$A_n.\ d^n y(t)/dt^n + A_{n-1}.\ d^{n-1}y(t)/dt^{n-1} + A_{n-2}.\ d^{n-2}y(t)/dt^{n-2} + \dots + A_1.\ dy(t)/dt +$$
$$A_0.\ y(t) = C_m.d^m x(t)/dt^m + C_{m-1}.d^{m-1}x(t)/dt^{m-1} + C_{m-2}.d^{m-2}x(t)/dt^{m-2} +$$
$$C_1.dx(t)/dt + C_0.x(t) \quad (4)$$

where:

X(t) - the input function to the system

y(t) - the output function to the system

Ai, Ci --the coefficients

If y(t) or any differential of y(t) appeared other than to the first power, then the system would be non - linear.

A linear system has the following properties:

(a) *Proportionality.-*

If X,I(t) -4 yi(t) then M.X,(t) -4 M. V,(t) where M is a constant

(b) *Superposition*

if Xi (t) y, (t) and Z,(t) *xi(t)* for all t

then(t) -> qk(t) =*Yyi(t)*

2.3.2. *Time - invariant system*

A system is said to be Time - Invariant when its parameters do not change with time. For such a system, the form of the outputs depends only on the form of the inputs and not on the time at which the inputs are applied. This means that in equation (4), the coefficients Ai and Ci are all constants.

If any or all coefficients Ai and Ci were functions of time t, then the system would be a time - variant linear system.

2.3.3. Lumped and Distributed systems

A system is said to be Lumped if the input and output are concentrated at definite points. In this case, equation (4) is an ordinary differential equation.

A system is said to be Distributed if it accounts for behaviour variations from point to point throughout the system. In this case, equation (4) is a partial differential equation.

If there were several inputs and several outputs, equation (4) becomes a set of differential equations, ordinary or partial depends on whether the system was lumped or distributed respectively.

2.3.4. Memory of a system

The memory is the length of time in the past over which the input affects the present state (Dooge, 1973). Consequently, a system can be said to have a zero memory, a finite memory or an infinite memory,

2.3.5. *Stable and Unstable*

A system is said to be unstable if a bounded input produces an unbounded output. Otherwise, it is stable.

2.3.6. *Damped and Undamped*

A stable system when disturbed (by an impulse input) may oscillate indefinitely, i.e. it is undamped. If its oscillations eventually die out, it is damped (if the, oscillation dies out without ever changing sign, it is highly damped or critically damped)

3. APPLICATION OF HYDROLOGIC MATHEMATICAL MODELS IN VIETNAM

3. 1. *Review*

The complete hydrologic mathematical model applied early in Viet Nam was the SSARR model. The first time, SSARR model has been applied by the Committee for Coordination of Investigations of the Lower Mekong Basin by the end of the sixtieths. The SSARR program set was stored in the archives of the Computer Centre at Ho Chi Minh City and widely used by many bodies since 1975, at first by the Water Resources, Electric Power and Hydrometeorological offices. It has significantly impulsed the development of hydrological computation and forecasting on small, medium and large catchments. The Vietnamese specialists have developed the LSSAR model for flood forecasting of the Mekong delta, taking into account the tidal effect and adapting it to both overbank flow and flood peak phase. The SSARR model was also used for flood forecasting of complex river systems in the Red - Thai Binh rivers. The reliable forecasting period of these models was of 1 - 3 days and the term might be more prolonged.

For expanding the application of the SSARR model to small and medium catchments in many regions of different features, it should be concentrated on the solution of related problems such as selection of suitable parameter set and of typical relations commonly used for many small catchments in the system (e.g. RS RGS, ROP - SMI relation...). Regarding the catchments of high infiltration (such as basaltic soil at Central Highland, the karst phenomenon at the northern and north eastern areas ...), the catchments with diversified topography and inhomogeneous rainfall distribution .... it should be provided investments to study the adjustment of the model in order to obtain adequate accuracy.

The TANK model has been applied in Viet Nam by the end of the eightieths. The TANK model was relatively simple and has an intuitive physical meaning, that's why many Vietnamese specialists preferred to use it, but its application was only limited to small and medium catchments and has not been extended to large catchments because of two reasons:

- An increase of tanks drew a rapid increase of model parameters and the method of selecting optimal parameter set was still a difficult problem to be solved.

- At the present time, in Viet Nam the software of the TANK model is nearly incomplete in comparison with that of the SSARR model.

In addition to runoff forecasting methods ever used for over past some decades such as Kalinin - Miliukov method, HMC method, Unit hydrograph, Isochrone method ... it was testing, together with the application of the SSARR and TANK models, to apply other rainfall - runoff models such as SMART, NAM and some other deterministic models.

Since the sixtieths, it has been carried out in Viet Nam research works on application of stochastic models e.g. harmonic analysis of runoff data series, application of the theory by Aliokhin to annual runoff forecasting and recently to monthly runoff forecasting, single and dual Markov process, Monte - Carlo experimental method, the Auto Regressive, ARMA and ARIMA model of the first and second order .. The application of these stochastic models to hydrology was developed in the two following directions:
- Application of stochastic models to the creation of monthly and annual runoff series for the operational computation of seasonal and annual regulation reservoirs. Together with the reservoirs as well as the small and medium hydroelectric stations such as Thac Ba, Da Nhim ... and two large hydroelectric stations: Hoa Binh (in the Da River) and Tri An (in the Dong Nai River). According to calculations made by specialists of Water Resources and Energy bodies, the application of statistical

models can increase the electric output to billions kWh. The preliminary calculations are perfecting to become the most profitable modes of reservoir exploitation.

- Use of stochastic models for gradually changing diagnosis to long-range runoff forecast. In Viet Nam, the distribution of rainfall and runoff is very inhomogeneous in time and many abnormal changes take place; the forecast of monthly, seasonal and annual runoff is a very urgent requirement, but much remains to be done for its implementation. The long-range forecast of rainfall, at the presemt time is still at the experimental stage Therefore the conditions are not sufficient to compute - from predicted rainfall and through deterministic models - the runoff volume with corresponding forecast range. That's why, the use of internal informations inherent in observed runoff records through statistical models to determine the near future tendency is a research aspect of promise. The improvements such as submission of an orientated criterion to select one realisation in the random number field increase the accuracy of monthly and seasonal runoff forecasts close to the degree permitting the operational forecasting to be carried out; application of stochastic models of Thomas - Fiering type to the error adjustment of deterministic models and to the raise of computation accuracy of runoff by models. The application using combination of deterministic and stochastic models to forecast weekly and monthly runoff has brought about results of great promise.

The hydraulic mathematical models of river systems was fairly soon applied in Viet Nam and rapidly disseminated. In addition to the mathematical model of the Mekong river flood established by SOGREAH and applied to computation from 1963 to 1965, the TIMOD developed by Netherland specialists and computed for the Mekong river (1973 - 1974), the mathematical models of drainage systems in North Viet Nam plain, the flood computation scheme of the Red River and Day river were implemented since 1968. The explicit difference schemes were used first (characteristic net method, Lax scheme, central scheme ...); they were subsequently followed by the use of implicit schemes (four - point scheme by Drongkers, scheme by Vasiliev). The Vietnamese hydrologic - hydraulic specialists could solve one dimensional hydraulic problems for the purposes of hydrological computation and forecasting, water resources planning and management, salinity intrusion and alumisation calculation, works design and operation...

3.2. Some results in details

3.2.1. Application of SSARR model to flood forecasting of the Red River System [14]

SSARR model is applied to simulate the streamflow at Ha Noi (143,OOOkM2) using rainfall data of 16 sub-basins. The basin incorporates -two reservoirs and two bypass channels, making possible the flood detention and bypass. The model parameters and relationships are determined by the trial and error method and by the optimisation method. An ARMA model is combined to apply the adaptive correction to operational forecast of the inflow to the Hoa Binh reservoir. The accuracy of 24-hr forecasts regarding inflow and pool level is acceptable. In the case of longer forecast period, the quantitative prediction of rainfall has a very important meaning.

3.2.2. Application of LSSARR model to flood forecasting of the Mekong Delta [1 5]

The following programs are applied to flood estimation and forecasting of the Mekong Delta:

(1) LSSARRI program: the Delta is divided into 20 reservoirs, 33 junctions and 12 boundaries

(2) LSSARR2 program: the Delta is divided into 34 reservoirs, 70 junctions and 14 boundaries

(3) The forecasting program for Tan Chau and Chau Doc stations is composed of 3 subprograms: the first for the beginning of flood season, the second for the high flood period and the third for the

flood peak, respectively. The delta streamflow may be well simulated in the LASSRR1 ans LASSRR2 programmes but due to insufficiency of Hydrometeorological and topographical data and lack of experience on calibration analysis, the effectiveness of this simulation is still low.

3.2.3. *The mathematical model for forecasting flood flow to reservoir and water level fluctuation of reservoir serving the management and operation of small and medium reservoirs [18]*

Based on the theory of unit hydrograph, the model is developed to simulate direct runoff or surface flow component. From water balance equation of soil moisture storage and groundwater storage, the model estimates interflow and baseflow components by linear equations between outflow and storage in each zone. The two indexes: antecedent precipitation index (Pa) and (D-index are considered for determining water loss from the storm pattern to the soil moisture storage. The instantaneous unit hydrograph (IUH) is used as a transformed function for hydrologic watershed routing. The inflow to reservoir can be finally routed through reservoir using inflow - storage - discharge (ISD) method or Puls method.

From 12-hour or daily rainfall data, the model can carry out 6-hour or shorter time forecasts on the inflow to reservoir and on its water level fluctuation corresponding to reservoir operation alternatives. It may help the managers to choose adequate type of reservoir operation which ensures flood protection for both reservoir and downstream area. The model is successfully applied to the operation of Dau Tieng reservoir at Tay Ninh province.

3.2.4. *Combining deterministic - stochastic models to forecast monthly flow for medium catchments in Viet Nam [19]*

A deterministic - stochastic model is developed for forecasting monthly flow of medium river catchments in the monsoon tropical areas of Viet Nam. The structure of the model is described as follows:

$$Y_t = \sum_{i=1}^{p} Ki.Yt-1 + a_t$$

where-. Yt - streamflow at instant t
Ki parameters of the model

at random component computed from rainfall records

The model is tested using data of two medium river catchments in North Viet Nam (Ngan Sau river at Hoa Duyet station and Cau river at Thac Buoi station). The accuracy of monthly flow forecast increases from 4 to 41 percent in comparison with computation results obtained from stochastic model only.

3.2.5. *Use of stochastic models for forecasting annual flow [16]*

After studying the different models, a new method was proposed for computing the random component, based on the analysis results of the observed series periodicity. The random numbers having normal distribution with zero mean and unit variance are divided into subdomains. This contains the random numbers of greater values and the other one includes those of smaller values. Instead of the choice of any random number in the AR(p) model, the random number is selected in the suitable subdomain based on the periodicity criterion.

The model is applied to Ca river at Yen Thuong station. The forecast accuracy obtained from the ARIMA (2,0,0) model is 71% whereas it attains 78% using this method and both meet the requirement.

3.2.6. *The two - dimensional hydraulic model used for the areas possessing complex topographic conditions (20]*

The solution of the horizontal two - dimensional Saint - Venant equation system for the areas possessing complex topographic conditions is dealt with. In the simple cases, this system of equations can be solved by the implicit difference scheme such as splitting or alternate direction one, etc. However, under complex topographic conditions such as a lot of islands, the flow in dry area and the suddenly varying flows, the use of explicit difference scheme is more effective. Of these two schemes, the later is applied to compute the flow at Viet Tri confluence, the Ha Noi Port area and the flood plain area of Van Coc - Dap Day.

3.2.7. *The two - dimensional model for computing the flood plain flow in the Mekong Delta [21]*
Based on the finite difference scheme, a two - dimensional model for computing the flood plain flow in the Mekong Delta is established. In the model, a continuous computation is carried out from the time that water is still flowing inside the main channel till the overbank flow inundates the entire flood plain and when water recession takes place from the flood plain to the main stream again. The difference meshes are not necessary to be rectangular. The original form of paddies or natural river sections, therefore, can be kept up

The model is calibrated and verified over a network including some tens of storage areas. After that, it is applied to the computation of flood flow in Long Xuyen quadrangle and widely used for the other regions of the Mekong Delta. The model meets various requirements of flood protection and agricultural production to a high accuracy.

3.2.8. Estimation of streamflow in shallow water areas using harmonic analysis method [25]
In order to resolve the problems of sedimentation and erosion prediction of estuaries, flood propagation on the plain, dispersion of pollutants in lakes, bays, rivers, etc. different methods are used for simulating the hydraulic behaviour in these shallow water areas. Among them, the finite element method (EM) is the most advantageous one.
Based on the periodicity of tidal motion, the shallow water problem is solved using the EM and the harmonic analysis method, i.e. to decompose unknowns by Fourier series, to convert the complex equations into many simpler equations of identical form, and to use EM for solving them. The final result is got by combining intermediate ones.

According to the above procedure, the TC86 program is used for solving successfully the problem of two - dimensional flows in shallow water areas to an adequate accuracy. It is also applied to compute the velocity fields of flow at the junction of Dong Nai - Tri An, at Can Gio estuary and at some other places

3.2.9. Preliminary tests on the modelling of water pollution in rivers [22]

Biochemical oxygen demand (BOD) and Dissolved oxygen (DO) are two major indicators for water quality control. There are various types of stationary models to calculate BOD and DO. The primary one is developed by Streeter Phelps. However, a few non - stationary models have been developed, especially these for river network. The tests on the use of Streeter - Phelps model and the fractioned step method to simulate the propagation of BOD and DO in the Cau and To Lich rivers were implemented. An one - dimensional non-stationarv model of water quality in river network was also applied.

3.2.10. *Flood forecasting model of Hoa Binh reservoir(1 7]*

The model includes: generated runoff component (based on SSARR model) and routing component. There are three submodels to generate runoff in 3 areas (Nam Mu river at Ban Cung, area from Lai Chau/Ban Cung to Ta Bu and area from Ta Bu to Hoa Binh) and three other submodels for routing runoff (from Lai Chau to Ta Bu; from Ban Cung to Ta Bu; from Ta Bu to Hoa Binh). The model was used for 24, 36 and 48-hours forecasting time.

3.2.11. *Flood identification model for Hoa Binh reservoir [26]*

There are two steps in this model: the first step is general identification and the second one is tactical identification. Three routing models we're applied: motive wave, diffuse wave and dynamic wave models. The last one was based on VRSAP model, in which some black-boxes were added.

This model was applied in operational forecast during the flood season 1993. In the Red River, average errors for water level at Ha Noi, Thuong Cat and Hung Yen were about 4 - 8 cm; maximum error was less than 25cm. In Thai Binh
River, the average values were about 9 - 12cm and maximum value was less than 32cm.

3.2.12. *Applied Linear Perturbation Model to calculate discharges of Dong Nai River at Tri An [28]*

Based on daily data series of three rainfall stations (Da Lat, Dak Nong, Bao Loc) and one upstream station (Ta Pao), four models were applied to calculate daily discharge for Tri An station: Simple Linear Model with one and two inputs, Linear Perturbation Model with one and two inputs. The author found that the Simple Linear Model was not good because runoff regime at Tri An station having seasonal characteristics. With memory length m = 50 days and maximum number of harmonic for Fourier series was 4, the effective coefficient of model R **2** equal to 80.23% in calibration period and 87.29% in verification period.

3.2.13. Long-range inflow forecasting to Hoa Binh reservoir by Integrated Analysis Method [24]

Planning and control of water resources systems have become increasingly important in recent years. At the same time, attempts have also been made to

increase the efficiency of existing reservoirs, especially of multipurpose ones. All those require the use of long-range inflow forecasts. There is a great number of methods for long-range inflow forecasting, which could be identified in three different approaches:

- Regression method;

- Conceptual models;

- Time series methods.

Based on a general review of existing methods, Integrated Analysis Method have been developed and applied to forecast seasonal and annual inflow to Hoa Binh Reservoir.

The Integrated Analysis Method is built by combining elements of the Stepwise Regression and Time Series approaches with an intention to provide an information basis of the autocorrelation structure and of the relationship between streamflow and factors affecting it. This method has been developed to reflect the observed data properties and is a flexible too[capable of incorporating all relevant information for seasonal and annual inflow forecasting.

Tne good result obtained in seasonal and annual Hoa Binh inflow forecasting demonstrates the applicability of this method in operational forecasting as well as the capability for its use in the development of long-range inflow forecasting for other reservoirs.

3.2.14. Application of WENDY model for Red-Thai Binh rivers system (1 1]

Using the facilities of the SEFLOW module of WENDY, first of all a model for the Da river over a length of 50km downstream of Hoa Binh Dam has been composed. For calibration of this model cross-sections sounded in 1984 and 1992 respectively were available. Using monthly average values for discharges, water levels and sediment concentrations a fairly good simulation of the river bed development was achieved. As such it was proven that this model was capable to hindcast a known situation quite satisfactorily.

Consequently, the same model could be used with some confidence to forecast the future development of the river bed, not only for Da river but also for the Red River. For this the initial model has been expanded: at the upstream section also the Thao and Lo rivers have been incorporated, while the downstream boundary has been shifted to Hung Yen on Red River at some 55km downstream of Ha Noi. Unfortunately few cross-sections on Thao and Lo rivers measured in 1984 and no cross-sections on these rivers sounded in 1991 or 1992 were available for calibration of this model. Therefore the quality of this calibration can hardly be evaluated. However, taking into account the fairly good calibration of the first model, it is believed that the expanded model is also quite reliable since it was composed in a similar way.

3.2.15. Application of SMART model (30]

SMART model was applied to the Nuoc Vang catchment. The total calibration period used was four years (1971 - 1974) and verification period was two years (1975 - 1976). The model efficiency for the Ordinary Least Squares Form was 69.65% (for calibration) and 64.26% (for verification). The model efficiency for the Gamma Parametric Form was 66.73% and 64.02% respectively.

3.2.16. Combining WENDY and RIBASIM models to evaluate the effects of potential reservoir development on the Red River Delta (5]

The WENDY (Water and Environment Dynamic) model consists of four main components:

- WAFLOW: the basic component for flood routing through a network of rivers or canals;

- SEFLOW: the component to compute morphologic changes in the network;

- SUSFLOW: the component for forecasting morphologic changes when the adaption length of the sediment concentration vertical is considerably large;

- SAFLOW: computing salinity intrusion.

The RIBASIM (River Basin Simulation) model allows the schematization of a river basin by means of a variety of so called nodes. The approach in simulating individual reservoirs was to maximise firm power, hydropower generation capacity, while assuming a certain role of the reservoir in flood mitigation. By changing both technical characteristics as well as operation policy (expressed in amounts of firm power required from each reservoir and flood control operation rules), alternatives can be investigated smoothly.

3.2.17. Application of USDAHL model (31]

USDAHL model was applied to the Lang Ga catchment - a small catchment inside the Research Runoff Experimental Station. This small catchment satisfied the requirements of USDAHL model: rainfall automatic record data series in Dong Dat site which was calculated with breakpoints during the flood season and standard time interval (hourly) during the dry season, Pan evaporation data were measured by GGI-3000, temperature data were observed at meteorological station nearby and runoff data were measured at Lang Ga station. The results of model were good enough to generate runoff from meteorological factors.

3.2.18. Salinity intrusion model for downstream of Red - Thai Binh Rivers system [27]

The Saint - Venant and diffusion equations were applied for downstream of Red - Thai Binh rivers system. This area was divided into 65 sections, 39 nodes and 18 boundaries. The first upstream boundary was after Hoa Binh Dam; 5 other upstream boundaries were at Phu Tho, Vu Quang, Dap Cau, Cau Son and Chu; 9 downstream boundaries were at Nam Trieu, Cua Cam, Lach Tray, Van Uc, Thai Binh, Tra Ly, Ba Lat, Ninh Co and Day; 3 additional boundaries were in Boi, Tich and Day rivers.

3.2.19. *Applied SWIMM model to calculate sedimentation in Hoa Binh Reservoir [29]*

Two areas were used to apply SWIMM model: The first area was in upstream of Hoa Binh Dam (Da River), from cross - section number 14 (near Hang Doi mountain) to cross - section number 18 (at Nanh Village). The second area was in downstream of Hoa Binh Dam, at Got Lung confluence node where Thao and Da rivers coming to the Red River (from cross - section SD1, ST1 to SH7)

3.2.20. Using MITSIM model to study of planning reservoirs in the Red River Basin (23]

MITSIM model was applied to calculate water balance and analyse the different scenarios in planning for the Red River Basin (in Viet Nam territory only).

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THE ASSESSMENT AND MANAGEMENT OF WATER RESOURCES IN AUSTRALIA

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National Water Quality Management Strategy

ABSTRACT

Australians rely on water for agriculture, for industry, for urban water supply and in some areas for hydroelectric power. Most Australians live in cities in the coastal areas. The availability of water varies greatly across the continent. The total runoff is unevenly distributed with 95% of the runoff contained in the catchments along the north, east and south-east coasts. More than 80% of the area of the continent relies to a large extent on groundwater.

Australia has adopted the principles of ecologically sustainable development as the basis for water resource management. Management plans are generally catchment based. State and Commonwealth authorities have worked towards a consistent approach to water resource assessment and water allocation. Sustainable water quality management is currently a strategic issue in Australia. Ministers agreed that a concerted national approach was necessary and that a National Water Quality Management Strategy would be developed. The Strategy provides policies, a process and a series of guidelines covering different aspects of the water cycle.

1 INTRODUCTION

An adequate supply of good quality water is of critical importance to the well-being of all Australians. Water resources are important to individuals' standard of living, the nation's economy and the environment.

Australia has extremely variable rainfall and runoff. The climate varies from tropical in the north to temperate in the south.

Australia is claimed to be the driest inhabited continent.

- For about 75% of Australia, rainfall does not exceed evaporation for any month of the year.
- Average annual flow from all Australia's river systems is estimated to be less than the flow from the Mississippi River.
- No other continent has lower precipitation and runoff in proportion to its area.
- No other continent has a lower percentage of runoff to precipitation.

Rainfall Runoff of the Continents

	% Runoff
Africa	38
Asia	48
Australia	12
Europe	39
North America	52
South America	56

From Water 2000 Report'

Australia has three levels of government, the Commonwealth Government, State or Territory Government and Local Government.

Most Australians live in the coastal areas. The Coastal Zone Inquiry defined the landward extent of the zone as the existing local government administrative areas abutting the coast. This zone occupies 17% of the land area of Australia. About 86% of Australians live in this zone.

Under the Australian Constitution, the responsibility for water resources lies with the States and Territories. In a number of States, local government provides water supply and sewerage services to cities and towns.

In a country that is as poorly endowed with water as Australia, it is essential that institutional arrangements support and facilitate the sustainable management of Australia's water resources.

The Commonwealth, States and Territories have worked together to provide a consistent approach to water resource management through the Australian Water Resources Council. The Australian Water Resources Council has recently merged with other Ministerial Councils to form the Agriculture and Resource Management Council of Australia and New Zealand. It comprises Commonwealth, State and Territory Ministers responsible for agriculture, soil conservation and water matters.

2 SCOPE OF THIS PAPER

This paper deals with:
- the assessment of Australia's water resources
- Australia's approach to ecologically sustainable development
- integrated catchment management
- the development of the National Water Quality Management Strategy

3 WATER RESOURCE ASSESSMENT

In 1987, the Australian Water Resources Council published the *1985 Review of Australia's Water Resources and Water Use*. The information in this section of the paper is taken from a summary of that report by Bergman.

3.1 BASIS OF ASSESSMENT

Resource concepts.

The *1985 Review of Australia's Water Resources and Water Use* compiled the water resource information for 245 river basins in Australia and then aggregated this information into twelve drainage divisions.

The resource was assessed within a framework comprising four levels:
- the **total water resource** - the volume of water present in the environment, measured as mean annual runoff for surface water, and mean annual recharge for groundwater,
- the **divertible resource** - the portion of the runoff and recharge which can be developed for use,
- the **developed resource** - the portion of the divertible resource which has been developed for use, and
- **resource utilisation** - a measure of the portion of the developed resource which is actually used.

Emphasis was given to the second level of assessment, the divertible resource, as the prime measure of the resource. The divertible resource is defined as "the average annual volume of water which, using current technology, could be removed from developed or potential surface water or groundwater sources on a sustained basis, without causing adverse effects or long-term depletion of the storages".

The assessment takes account of variability of flow, evaporation rates, surety of supply and related factors. It takes no account of whether there is any use for the water.

Constraints

The calculation of the divertible resource excludes water that is set aside for regulatory purposes such as transpiration usage in wetlands and minimum streamflows to meet environmental requirements. However, socio-economic constraints which currently exist in areas reserved for national estate, ecological preservation or land title are treated differently. The resources affected by these constraints are included in the divertible resource, and the extent of the constraint is noted. About 8% of Australia's total divertible resource is currently constrained in this way, and most of the constrained resource is in northern Australia.

Major and minor resources

Divertible resources were classified into major and minor resources. Major resources are capable of supplying sufficient water to sustain a small town or irrigation development, and generally exceed 500 megalitres per annum. Minor resources are too small or scattered to be diverted for major supply developments.

It is not meaningful to combine the major and minor resources because there are limitations on the interchangeability of the two components.

Surface Water and Groundwater

Surface water and groundwater resources are closely related and often directly interconnected. In some areas base flows in streams are maintained by drainage from underground sources, while in other areas, streams are a source of replenishment for underground supply. Consequently, the exploitation of one resource can affect the availability of supply from the other. However, the resources vary considerably in location, use, development potential and management approach, and it is desirable to consider each type separately. Table 1 gives a summary of the water resources of Australia.

3.2 EXPLANATORY NOTES ON THE ASSESSMENTS IN TABLE I

(a) SURFACE WATER RESOURCES

Mean Annual Runoff

For most river basins, streamflow increases downstream and is greatest at the mouth of the river basin. The mean annual runoff was calculated as the outflow from the basin.

For river basins where the flow decreases in a downstream direction, runoff was calculated as the combined mean annual runoff of each of the major catchments in the river basin, calculated at the point where the flow is greatest and excluding runoff from upstream basins. Many of these river basins are in central Australia. A comparison of runoff and outflow highlights the variability of runoff in inland Australia. Flow often occurs in occasional large floods which dissipate rapidly. In the north of the Murray-Darling Division, the Warrego and Paroo basins have a combined mean annual runoff of 1.4 million megalitres, but an outflow of only 10,000 megalitres.

In many basins where flows have been modified by storages and diversion works, the 'natural' flow is inferred by considering records of actual flows, upstream diversions and storage impoundments and releases.

Table 1: Australia's water resources and their utilisation. The table shows water resources, the amount divertible and utilisation. The data are for fresh and marginal resources in units of 000's of megalitres per annum.

		Surface Water Resource								Groundwater Resource				
	drainage division	mean annual runoff	mean annual outflow	major divert-ible resource	developed resource	imports	exports	use of major res-ource	use of minor res-ource	major divert-ible resource	use of major resource	minor divert-ible resource	use of minor res-ource	total water use within division
North-east Coast	I	83,900	83,900	22,900	3,540	0	68	910	60	1,720	617	717	72	1,660
South-east Coast	II	41,900	41,900	14,900	4,280	0	1,135	2,020	15	1,460	456	960	43	2,530
Tasmania	III	52,900	52,900	10,900	1,020	0	0	115	55	116	0	341	5	175
Murray-Darling	IV	24,300	12,200	12,300	10,000	1141	77	8,000	14	1,380	525	539	110	8,650
South Aust. Gulf	V	877	767	231	118	75	4	213	19	74	54	78	26	312
South-west Coast	VI	6,670	6,600	1,860	385	0	10	307	76	881	287	618	10	680
Indian Ocean	VII	3,960	3,840	285	27	0	0	0	3	263	56	517	5	64
Timor Sea	VIII	80,700	80,700	22,000	1,980	0	0	89	6	2,610	15	3,220	16	126
Gulf of Carpentaria	IX	92,500	92,500	13,200	78	63	0	110	6	1,900	116	1,159	13	245
Lake Eyre	X	6,310	0	204	26	1	0	5	5	463	95	559	30	135
Bulloo-Bancannia	XI	1,090	0	41	0	0	0	1	0	55	15	21	2	18
Western Plateau	XII	1,580	0	102	0	14	0	14	1	790	12	502	14	41
	TOTAL	397,000	375,000	98,900	21,500			11,800	261	11,700	2,250	9,360	346	14,600

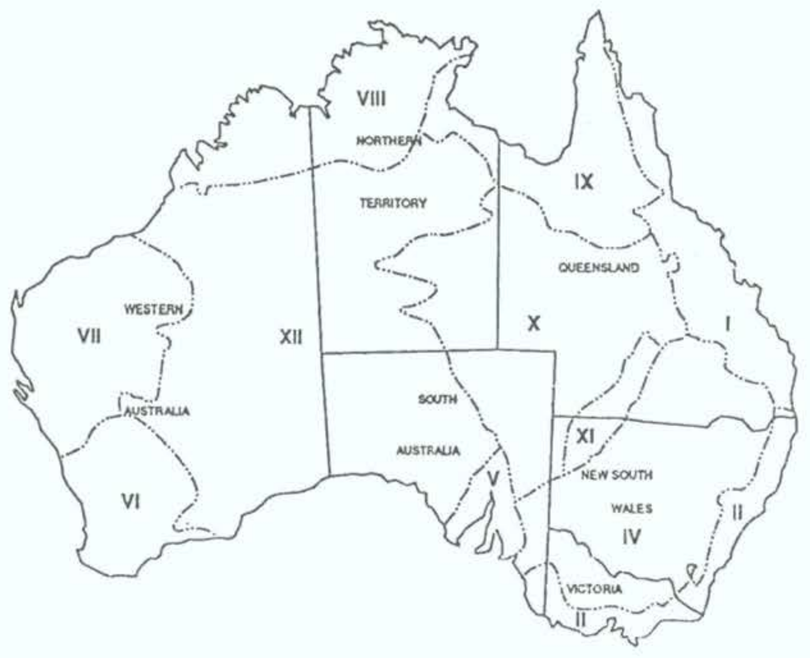
After Bergman[1]

Within the Murray-Darling Division, the mean annual runoff is 24.3 million megalitres (Table 1) but the outflow at the mouth of the Murray River is only 12.2 million megalitres. This indicates that under natural conditions, 50% of the water that originates in the Division would be lost through natural processes before reaching the sea. Under existing conditions, most of the available water is consumed, and the outflow at the Murray mouth only occurs when flow exceeds requirements.

The Divertible Resource

The major divertible resource was calculated by identifying the actual and potential dam sites within river basins. Although many dam sites were identified on the basis of detailed hydrologic studies, others were identified using selection of suitable sites from maps without field investigations.

A standard method for computing storage yields was not adopted. Different methods were used depending on the amount and accuracy of the available data. Yield estimates were maximised by allowing for the raising of existing dams, run-of-river diversion and the operation of dams in tandem. The accuracy of data varied appreciably between drainage divisions and is lower in northern Australia where large areas are not gauged.



Drainage Divisions of Australia
(Surface Water and Groundwater)

The Developed Resource

The developed resource was calculated for existing storages and for storages under construction, and included licensed withdrawals from streams. It is the total volume of water that could currently be used if required, and is not to be confused with actual water use which is often considerably less.

The Minor Resource

Minor surface water resources include the yields from farm dams, roof runoff, desalination plants and water harvesting schemes such as paved catchments. These resources were not assessed at a national level due to conceptual difficulties, in particular:

- runoff from artificially paved catchments and yields from seawater desalination cannot be measured in an effective way as a potential resource, arid
- minor resources such as farm dams can collectively have a significant impact in reducing the major resources of an area.

(B) GROUNDWATER RESOURCES

Groundwater resources were initially assessed for groundwater provinces and recomputed for river basins. Groundwater provinces are major areas having a broad uniformity of hydrogeological and geological conditions, which were identified as either predominately sedimentary or fractured rock.

The Divertible Resource

The divertible resource is the volume of groundwater which can be removed per annum on a sustained basis without decreasing the long-term yield and quality of the resource. Yield estimates vary according to the pattern of demand and the security of supply required by the user. The time over which groundwater withdrawal can be sustained is a management decision based primarily on user needs, where the rate of withdrawal may incorporate an allowable period of failure of the supply. The safe yield of a groundwater resource changes over time, and the lowering of water tables often results in induced recharge and consequently an overall increase in the safe yield.

The Developed Resource

The developed groundwater resource is measured as groundwater abstraction and makes no allowance for bore capacity which is often much greater than use. Abstraction is approximately equal to groundwater use, although abstraction may be higher than use in areas where part of the flow from bores is allowed to run to waste or where transmission losses occur through evaporation and infiltration.

(C) WATER USE

Water use is the total use of water within a region, calculated as the water withdrawn from the region's resources for use within the region, plus imported water.

3.3 THE BROAD PICTURE

From a national perspective:

- the total runoff of 397 million megalitres is unevenly distributed across Australia; 9596 of runoff is contained in the six drainage divisions along the north, east and south-east coasts.
- of the runoff occurs in the sparsely populated Gulf of Carpentaria and Timor Sea divisions, 45% in the North-East Coast, South-East Coast and Tasmania divisions and 6% in the Murray-Darling division.
- the divertible surface water resource is 98.1 million megalitres, only 25% of total runoff. This is very low by world standards, due primarily to the high variability of the runoff, high rates of evaporative loss and the general lack of adequate dam sites.
- only one fifth of the divertible resource has been developed for use (21.5 million megalitres), and a little over half of this (11.8 million megalitres) is used. The low overall use reflects several factors, including non-consumptive (hydroelectric) use, developments under construction and the difference between the theoretical (mean annual) yield from developments and actual water used.

the major groundwater resource of 11.7 million megalitres is considerably less than the surface water resource, and is distributed fairly evenly across the continent. One fifth of this resource is currently used. the minor divertible groundwater resource is 9.4 megalitres, of which only 0.34 million megalitres is used.

At the drainage division level:

- within the Murray-Darling (Division IV), over 80% of the available surface water resource has been developed, and 80% of this is utilised, primarily for irrigation in the southern regions of the Division. The Snowy Mountains Scheme diverts 1.14 million megalitres of the surface water resources of Division IIinto Division IV. Little use is made of minor surface water resources due to the availability of reticulated supply.
- in the South-East Coast (Division II) a large portion of the surface water resource has been diverted to supply Sydney, Melbourne and Newcastle, and also as part of the Snowy Mountains Scheme.
- in Tasmania (Division III) the developed surface water resource is well in excess of water use because of the development of the resource for hydroelectric power, a non-consumptive use.
- within the South Australian Gulf (Division V) all resources are heavily utilised. The total water use of 312,000 megalitres includes 241,000 megalitres from the Division's resources and 71,000 megalitres imported from the Murray-Darling Division. The portion of the divertible surface water resource still undeveloped is either of marginal quality or located in remote areas of the division.
- the remaining eight Divisions cover 80% of the continent, and rely to a large extent on groundwater. Even in Timor Sea (Division VIII), which has a developed surface water resource of 1.98 million megalitres (primarily Lake Argyle), groundwater is an important source of water.

4 ECOLOGICALLY SUSTAINABLE DEVELOPMENT

Australia published the *National Strategy for Ecologically Sustainable Development* in 1992. Its origins stem back to the release of the *World Conservation Strategy* in 1980, the *National Conservation Strategy for Australia* in 1983, and perhaps more importantly, the 1987 report of the World Commission on Environment and Development *Our Common Future* (the Brundtland Report).

In the section dealing with water resource management, the National Strategy for Ecologically Sustainable Development identifies the challenge as:

> To develop and manage in an integrated way, the quality and quantity of surface and groundwater resources, and to develop mechanisms for water resource management which aim to maintain ecological systems while meeting economic, social and community needs.

The strategic approach is to ensure that development decisions which impact on water resources are based on acceptable quantity and quality criteria, and that management requirements to meet those criteria on a sustainable basis are recognised. Efforts will be focused on: using water more efficiently; allocating water for stream-flow and other environmental uses: and minimising pollution. The two objectives for water resource management are:

- To develop water management policies which are based on an integrated approach to the development and management of water resources; and
- To develop and maintain the most effective mix of water resource management mechanisms.

The actions include finalisation and implementation of the National Water Quality Management Strategy. This Strategy is described in more detail below, A fundamental objective of the Earth Summit held in Rio de Janeiro in 1992 was to ensure that the principles of Ecologically Sustainable Development are put into practice. Agenda 21, an outcome of the Summit, addresses a wide range of water quality issues including waste minimisation, clean production, improved sewage treatment and the utilisation of sewage and wastes. Implementing Agenda 21 in Australia will involve all levels of Government in a co-operative approach. In terms of water quality, the National Water Quality Management Strategy will form an important means of implementation.

5 CATCHMENT MANAGEMENT

For many years, catchments have been recognised in Australia as the most appropriate geographical area for managing water resources. A number of States have established catchment committees to promote practices that will maintain or improve water quality. These catchment committees aim to involve all of the land users in the catchment in co-operafively setting water quality goals and then planning and implementing actions to achieve these goals. These actions will span across soils, water and vegetation. They will cover rural and urban activities.

The Murray Darling catchment is the largest river basin in Australia and has parts of the catchment in four different States. The allocation and use of water has long been an issue. The River Murray Commission was established in 1915. Up until 1984, it dealt mainly with water allocation issues. The Murray Darling Basin Council was established in 1987 because of the recognised need to consider water quality issues and to take a basin wide approach to management issues. The Council consists of Ministers from the Commonwealth and the four States with responsibilities for land, water and the environment.

The Ministerial Councils have developed water resource policies and programs. Currently, work is in progress to produce a set of principles on water entitlements for the environment, to provide water to maintain existing ecosystems.

6 NATIONAL WATER QUALITY MANAGEMENT STRATEGY

The Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand are working together to develop the National Water Quality Management Strategy. The Strategy applies to the fresh and marine waters of Australia. The National Health and Medical Research Council is involved in aspects of the strategy which affect public health.

6.1 STRATEGY OUTPUTS

Theoutputs resulting from implementation of the Strategy include
catchment water quality management plans
coastal water quality management plans
groundwater quality management plans
the levels of ***service provided by water authorities*** for water and sewerage services, e.g., drinking *water quality, acceptance of industrial wastes, sludge management, and effluent reuse which meet the needs and capacity to pay of the local community.*
further development of regulatory. and market frameworks.

The Strategy provides **policies,** a **process** for water quality management, and a set of **national guidelines.**

6.1 COMMUNITY INPUT TO THE STRATEGY

Community views form a crucial part of the strategy. The community will be involved during both the development and the implementation of the strategy. The community is encouraged to have an input and to comment on the national policies and guidelines as they are being developed. The community will be involved in the implementation stage, in working with the catclunent manager to identify community desires and to take part in the process to resolve the trade-off between community desires and economic, social and environmental impacts.

For community involvement to be effective, the community needs to be informed about, and understand the issues of water quality and the way the strategy may be used to manage water quality.

6.3 STRATEGY PAPERS

The papers of the Strategy include:

- Policies and Principles - the cornerstone of the strategy as it sets the direction of the other papers of the Strategy.
- Implementation Guidelines - describes the Strategy, how local communities, within the framework of State legislation and policies, may use the documents to produce water quality management plans.
- National Guidelines - These technical papers provide guidelines for many of the aspects of the water cycle. They have been written primarily for people in the private and public sectors who have a background in water quality management.
- Information Papers - These are papers written for a general audience or for specific groups within the community. They include Discussion Papers as well as papers highlighting aspects of the strategy of particular interest to groups such as industry, farmers or schools.

Policies and Principles

The policy objective for the Strategy is *"to achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development."*

The water quality strategy provides policies which flow from the key principles of Ecologically Sustainable Development. These principles include:

- *integrating economic and environmental goals in policies and activities*
- *ensuring that environmental assets are appropriately valued*
- *providing for equity within and between generations*
- *dealing cautiously with risk and irreversibility*
- *recognising the global dimension*

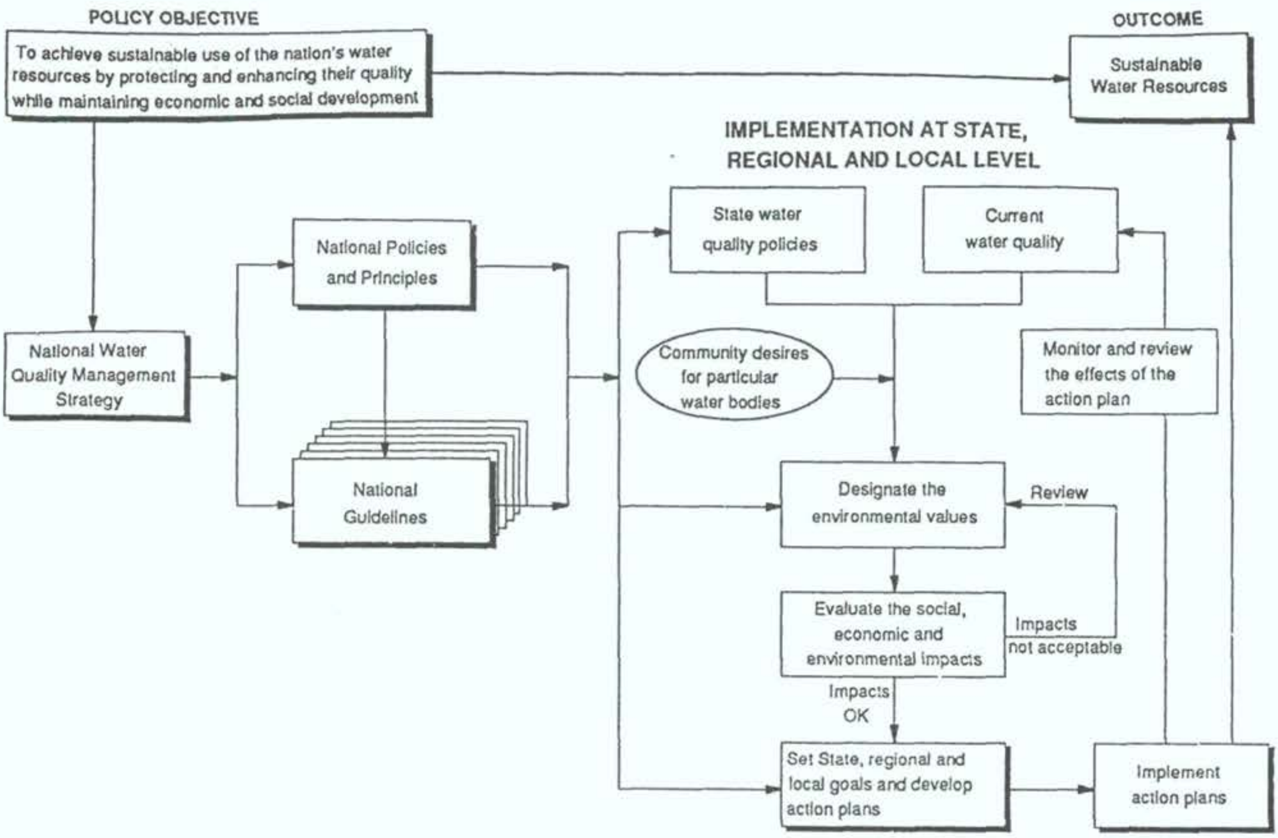
The National Water Quality Management Strategy builds on these recommendations and provides the framework to protect the quality of local waters throughout Australia. The Strategy provides the transition from policy recommendations to real outcomes.

The strategy envisages that both regulatory and market based approaches will be used in developing water quality management plans. Regulation may include licensing the quantity and quality of effluent that may be discharged. Market based measures seek to influence behaviour by having differential costs which depend on the quantity and the quality of the discharge.

Implementation Guidelines

The Implementation Guidelines describe the steps in developing and implementing plans to manage fresh and waters and groundwater.

The key to Managing water quality is agreeing on the water quality goals for local waters and developing a management plan designed to meet these goals. The concept of environmental values (or beneficial uses) is used to develop the water quality goals. The two terms have almost the same meaning - Any use or value of the environment that is conducive to public benefit welfare, safety, health, or aesthetic enjoyment.



The environmental values (from "Australian Water Quality Guidelines for Fresh and Marine Waters") are:

- *Protection of aquatic ecosystems*
- *Recreational water quality and aesthetics*
- *Raw water for drinking water supply*
- *Agricultural water use*
- *Industrial water quality*

It is envisaged that implementation of the Strategy will occur at State level after considering:

- the National guidelines,
- State and Territory water policies,
- community preferences on the use of local water bodies. .
- environmental values for the local waters,
- the current water quality,
- the economic and social impacts of maintaining current water quality or of meeting new local water quality goals.

The water authority and the environment protection authority are seen as lead agents in implementation of the strategy. The community will be encouraged to identify environmental values to be protected for the local waters. When the environmental values to be protected are defined and the water quality goals have been set, an action plan can be put in place. The local action plans would include a range of regulatory and market based measures and would usually be developed for catchments or sub-catchments.

National Guidelines

The strategy covers issues across the whole of the water cycle. National guidelines focusing on specific water resource issues are being developed. The aim of the guidelines is to help the community, catchment managers, environment protection agencies and water authorities to develop local action plans for water quality management.

A list of the twenty papers of the Strategy is at Appendix 1. The aim is to have all papers completed late in 1995. To date three papers have been finalised, another five have been issued for public comment. The remainder are being drafted by the various working groups.

6.4 MONITORING AND REVIEW

A nationally consistent water quality monitoring and reporting framework will be developed. Consistent and appropriate indicators, testing protocols and data storage and retrieval will be covered. The goal is to provide information on the water quality status of priority water bodies as well as trends in water quality.

7 CONCLUSION

Austratia's total runoff of 397 million megalitres is unevenly distributed across Australia; 95% of runoff is contained in the six drainage divisions along the north, east and south-east coasts. Much of this runoff is remote from the population centres and the developed agricultural land in Australia. The divertible surface water is only 25% of total runoff. About one fifth of the divertible resource has been developed for use.

Catchments are recognised as the geographical unit for water resource management The States and Territories have prepared management plans for priority waterways. The Commonwealth, State and Territory Governments are developing a nationally consistent approach to water quality issues through the National Water Quality Management Strategy.

APPENDIX I

NATIONAL WATER QUALITY MANAGEMENT STRATEGY

List of Documents

Paper No. | Title

Policies and Process for Water Quality Management

1. Water Quality Management - An Outline of the Policies
2. Policies and Principles - A Reference Document
3. Implementation Guidelines

Water Quality Benchmarks

4. Australian Water Quality Guidelines for Fresh and Marine Waters
5. Australian Drinking Water Guidelines - Summary
6. Australian Drinking Water Guidelines
7. Water Quality Monitoring and Review

Groundwater Management

8. Guidelines for Groundwater Protection

Guidelines for Diffuse and Point Sources

9. Rural Land Uses and Water Quality
10. Guidelines for Urban Stormwater Management
11. Guidelines for Sewerage Systems - Effluent Management
12. Guidelines for Sewerage Systems - Acceptance of Trade Waste (Industrial Waste)
13. Guidelines for Sewerage Systems - Sludge (Biosolids) Management
14. Guidelines for Sewerage Systems - Use of Reclaimed Water
15. Guidelines for Sewerage Systems - Sewerage System Overflows
16. Effluent Management Guidelines for Farm Dairies and Dairy Processing Plants
17. Effluent Management Guidelines for Piggeries
18. Effluent Management Guidelines for Wool Scouring
19. Effluent Management Guidelines for Tanning and Related Industries
20. Effluent Management Guidelines for Wineries and Distilleries

APPENDIX 2

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WATER SUPPLY AND ITS MANAGEMENT IN CHINA

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Abstract

The paper gives an assessment of water resources, water supply and use in China. The situation of the water use of various sectors and water supply in 2000 will be analysed. Some management works on water supply aspects will also be introduced.

Water Resources

The average annual precipitation volume in China has been estimated at about 6,189 billion cubic meters, equivalent to annual rainfall of 648mm, that is only 80 per cent of the world mean. About 56 per cent of this precipitation uses up evaporation, and 44 per cent of it takes shape of surface runoff.

Based on observations from 1956 to 1979, the average annual runoff of all rivers of China has been estimated at 2,711 billion cubic meters, the volume of groundwater in plains throughout the country has been estimated at 187.3 billion cubic meters.

The total volume of replenishable water resources, taking into account the interrelation between surface water and groundwater has been estimated at 2,812 billion cubic meters.

The main characteristics of water resources are:

1. Total volume not less but per capita amount low

In comparison with other countries, China's total annual runoff ranks sixth in the world, next only to Brazil, the former USSR, Canada, U.S. and Indonesia, however, the per capita amount of runoff estimated at 2,474 cubic meters/year is only about a quarter of the world mean. As for the availability of water per hectare of the cultivated land, is estimated at 28,000 cubic meters/ha, which is about two - thirds of the world average.

2. Water resources uneven regional distribution and deviated from land resources

The distribution of water resources over China is extremely uneven between the south and north. The average annual rainfall is more than 500mm in depth for the southern river basins, but it is only around 100mm for catchment regions of the Yellow River and Haihe River.

The regional distribution of the country's water resources is also deviating from that of the population and cultivated land. For the Yangtze river basin and southern regions, these are 81 per cent of the total water resources, while this reflects only 36% of cultivated area and 54.4% of population of country. Meanwhile, the water resources of the large river basins north of the Yangtze river is only 19 per cent of the country, but they have 64 per cent of the cultivated land among them, as most outstanding, the cultivated land of the Yellow River basin, Huaihe basin, Haihe basin and Liaohe basin which is 42 per cent of the country, while only 9 per cent of water resources of China on there.

3. Water resources uneven distribution in seasons and years

China is located at the East Asia monsoon area. The summer monsoon plays an important role in determining the annual rainfall and runoff for various regions of the country. Most rain falls in China during the summer, about 80 per cent of annual total precipitation falls between May and October.

The water resources are not only unevenly distributed in season, but also vary considerable over years. There was a continuous 11 year (1922 - 1932) low flow period in the Yellow river, the average runoff of this period was only 76 per cent of the normal year.

So China's water resources are not plentiful. With national economic development and population increase the problems of water supply and its use will be more and more. How to rationally utilise water resources and strengthen water resources management will be very important.

Water supply and use

In 1988, there were around 8,300 reservoirs in the country, mainly of small and medium scale, with a total capacity of 450 billion cubic meters. There were 6800 large irrigation districts, each of them could at least irrigate 666.7 hectare cultivated area. Groundwater has been largely used for irrigation in the northern and north - western provinces of China to supplement surface water. In 1988, about 2.50 million tubewells had been constructed, with a total capacity of 65.0 million kilowatt. In addition, there were about 1,000 public water works and 25,000 tubewells owned by industrial enterprises to supply water for industry and cities, whose production capacity reached 127 million cubic meters per day by the end of 1988.

In 1988, the water resources engineering actually produced about 500 billion cubic meters, and the public water works and other supply works produced water close to 5.6 billion cubic meters. The total supplied water was around 505 billion cubic meters, in which used runoff of rivers was about 447 billion cubic meters, that was 16.5 per cent of average of used annual runoff and increased 65.9 billion cubic meters from1980. The groundwater was about 58 billion cubic meters, that was 11.5 per cent of total actual supplied water in 1988.

In 1988, actual irrigated agricultural area was close to 41 million ha. Water used in irrigation was 387 billion cubic meters, that was 76.66% of the total water supply. The water use of other aspects in rural were 60 billion cubic meters, that was 11.9% of total used water. The industrial water use was about 48 billion cubic meters and urban domestic use water was 10 billion cubic meters, that was 9.5% and 1.9% of total water use.

In 1988, per capita use of water was 464 cubic meters/year, that was about 16.7 % of the per capita amount of water resources.

At that year, the development and utilisation of water resources in China was uneven, southern area lower than in the northern area, such as, in the Yellow river basin and Haihe river basin the utilising degree of runoff already reached 53.0% and groundwater utilising degree was 83.5%, but at that year the groundwater utilising degree in the whole country was only 0.08%, the volume of water shortages was about 4.0 billion cubic meters, which was 8 percent of the volume of actual water supply.

Water demand of various sectors in 2000

According to estimations of some departments, the total population of China will reach 1.25 billion in 2000. In spite of the rapid urbanisation growth, at least more than 870 million people will still live in rural areas. With the living condition development, the water use of population and livestock in rural area swill increase. By the year 2000, the water demand for rural domestic use is expected to reach 51.0 billion cubic meters per year.

From 1949 to 1984, the average annual growth rate of population in cities was 3.01 per cent. The current urban development policy is aimed at controlling further growth of large cities, developing medium cities and expanding small cities. By estimation, the water demand for residential and municipal uses in urban areas would reach 21.9 billion cubic meters in the year 2000.

In agriculture, on the assumption of 400 kg of grain per capita, the total grain output of 500 million tons will be needed to meet the demand for food of 1.25 billion people in year 2000. So the irrigation area will need to grow with 3.3 million ha from 1988. Estimated water demand for irrigation in China in 2000 will be 477.3 billion cubic meters.

In China, the industrial production is mainly concentrated in urban areas, although more and more rural industries increase rapidly over the country. The ratio of industrial water reuse remains quite low. On the average, less than 50 per cent of water is reused by industries located in urban areas, while the rate of industrial water reuse by rural industries is much less. On this assumption, growth in industrial water demand has been projected at an average rate of 4.3 per cent annually up fresh water in the industrial sector is expected to reach 79.6 billion cubic meters.

As mentioned above, in 2000 the total water demand of China will be 650 billion cubic meters, about 150 billion cubic meters more than the volume of actual of water use in 1988. Among them, for the increase in quantity, the irrigation water demand rise is higher, the rising rate of the domestic water demand in urban areas is faster.

Water supply and its management

A high rate of increase of water demand brings some problems for water supply. Because of an uneven distribution of water resources in the north of China, water resources are quite limited and the growing gap between water supply and demand has become the main impediment of the economic and social development. In order to mitigate the contradiction of the water supply and use, the interbasin water transfer must be considered. If the planning project of diverting the water from the Yangtze River to north China is completed, about 8.0 billion cubic meters of water will be transported over the Yellow River and the critical situation of water shortages in north China can be relaxed.

In south China, because of water pollution the water that can be supplied is not enough although the water resource is relatively plentiful. According to the figures from 1,845 cities and towns, the amount of waste water discharged during 1980 was 31.5 billion cubic meters, of which more than 90 per cent entered directly into rivers without any treatment. Water pollution causes directly economic damage of 30 million yuan each year. The current situation is that the area of water source pollution is still expanding, it is therefore of vital importance to control the pollution and protect water sources.

The other problems also affect water supply, such as the built water engineering works aging, the capacity of supply water of which decrease, the funds to construct new water supply engineering is not enough, etc., but those will be gradually improved in future.

Now a lot of works have been done on management of water supply in China, such as:

1. Carrying out the rule of taking use water licence

Practising the rule of taking use water licence is in order to strengthen water supply management, the basic work of instigation and assessment of actual water supply and use in some experimental counties and cities have been done since 1990 and this work is successfully progressing. Now more than 200 experimental units are already completed and licences are applied for and sent out. The work is carried out over the whole country.

2. Developing the work of long - term water supply plan

This work will be combined with the development plan of the national economy, fully consider the interrelation of water supply and national economy, and make the water supply engineering development plan more scientific and reasonable, the result of this work will be the guide of building new water engineering schemes in the yearly water development plans.

WATER RESOURCES ASSESSMENT AND INTEGRATED MANAGEMENT IN INDONESIA

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ABSTRACT

Indonesia's development has progressed over the past two or three decades. From a poor and unstable position in the mid-sixties, the economy has strengthened and diversified, the food intakes and income levels of the people have risen dramatically. The proportion of the population living below the poverty line has decreased significantly.

These developments, in very large measure came about because of aggressive agricultural development policies. In the seventies and eighties, a total of about 25 trillion rupiah was spent on infrastructure. New schemes were developed across the archipelago, sophistication of irrigation systems was emphasised to increase technically irrigated sawah by a million hectares, and intensification programs were introduced using fertilisers and high yield varieties of rice. This direct strategy of focusing on development of indigenous resources increased food availability and reduced mass poverty. Along with the agricultural development, supporting infrastructure was developed. Roads, rail, seaport and airport facilities have been developed, and the country's communications network has been expanded.

Through these years of agricultural infrastructure development planning, policies were continuously improved and updated in order to better achieve the desired effects. By and large, these have been of the nature of fine-tuning the strategy for development. At this point, at the beginning of the-off Era ,when the country is anticipating greater industrialisation and greater export production of increasingly wide range of goods and services, we are seeing more stresses on our water resources. Virtually all of our development, not just irrigated agriculture but also plantation crops, non-food crops, timber extraction, and manufacturing development, is impacted by and has impact upon our water resources. As our utilisation of water resources become more extensive and more intensive, we must approach the planning and management of existing and new development with full recognition of the inter-relationships in the river basins. We must plan, develop, and manage the basin resources recognising the water resources as a system, and we must use a systems approach to develop and to manage within integrated strategies.

I. INTRODUCTION

Water is a natural resource which is renewable through a process known as the hydrological cycle. However, water is not always available on demand, which in this case, associated with time, space, quantity, and quality. Therefore, this natural resource must be exploited appropriately to gain its optimum benefit and prevent it from flowing uselessly into the sea.

As in other countries nowadays, the condition of water resources (quality and quantity) in Indonesia has warranted careful observation due to inefficient use, pollution (surface and groundwater), and also the threat of draught in dry months and floods in rainy seasons.

The above fact resulted from the unstable socio - economic condition of in Indonesia in mid 60's. At that time, most of the people in Indonesia were desperately poor.

In 1967 Indonesia was really poor and its economic was teetering on the brink of collapse. The agricultural sector which was the source of employment and income for 2/3 of the work force showed an annual growth of only 1.4% between 1960 - 1969. With the rate of rural population growth of almost twice as that, the income and living condition of the poor really plunged to the bottom.

Around 1967, the average calorie intake was only 1800 cal/day, far below our nutrition need. Almost 2/3 of the people lived in poverty with the income so low even to meet their basic needs. In major cities, the inflation was rocketing, unemployment and poverty reached deep into all social strata, and whatever resources available were used by the Government to import basic needs, such as food and fuel.

Breaking free from the vicious circle of poverty and agricultural stagnation was one of the top priorities of the "Pemerintah Orde Baru". Most of it was reached through agricultural and rural development. Increase of rural products contributed to higher income and calorie consumption. Growing food crops in the country was expected to replace the expensive imported food, saving the scarce foreign exchange to import investment goods and industrial products. Ample food reserve at reasonable price came from the growing surplus of rice and easily marketable secondary food to satisfy the demand of the increasing urban population; the scarcity of food which created riots was diminishing. Moreover, increasing export of rubber, coffee, tea, palm oil and copra contributed more foreign exchange and strengthened the economy of their place of origin. The increasing urban income, foreign exchange, and economic stability enabled Indonesia to start industrialisation. Industry appeared as a potential source of income, employment, and foreign exchange with the success of the agricultural sector. With this rapid development, not only the irrigated rice fields, but also plantation crops, non-food crops, and timber affect and are being affected by quality and quantity of our water resources.

Therefore, it is advisable for us to look back into the role of water resources development in the growth of the agricultural sector in the past 25 years. The reason is that according to the Directorate of Water Resources Planning and Programming (1992) who has prepared the national water balance (see Table 1), the total irrigated area in Indonesia at present is more than 49 million hectares and needs 72 billion m3 of water or 92% of the total water demand in Indonesia.

In consequence of such a high rate of development, problems related to the management of water resources development appear, e.g. : water pollution, flood and drought.

II. WATER RESOURCES PROBLEMS

The high rate of development in Indonesia brings various water resources problems including pollution, flood, and draught. Currently, the problems of water quality and environment have become the world's issue and we should remember that water can only be considered as a resources if its quality is appropriate. At present, Indonesia is experiencing the following water resources problems :

2.1 Pollution

In connection with the Government policy of aggressive development in agricultural field, system improvements have been implemented, both intensively and extensively.
Intensification : intensifying the cultivation of existing rice fields, construction of sophisticated irrigation system, extension of technically-irrigated rice fields, use of fertilisers, pesticides, and high quality seeds.
Extensification : development of new rice fields, and extension of technically-irrigated rice fields.
The residue of fertilisers and pesticides used in rice fields causes pollution of the waters in their surrounding areas.
In order to support the national economic development, water is also exploited for industrial purposes. The industrialisation in Indonesia is rapidly growing. Environmental and water quality problems appear

in projects close to the major cities and also in industrial areas As a result, the environment become imbalanced, and the existing ecosystem can no longer be maintained.
To increase the export of non-oil commodities, the existing natural resources have been heavily exploited through extensification of plantations and exhaustion of the forests for their export commodities (wood, rubber, rattan, etc.). The forest ecosystems become accordingly disturbed; and the bare forest land are easily eroded and this leads to sedimentation in rivers and reservoirs.

2.2 Floods

Floods can be classified into two categories, namely the floods that are caused by natural factors and those caused by human activities.

a)Factors causing natural floods
Climate: Indonesia has a high rainfall intensity, 80% occurred in the rainy seasons and the rest in the dry seasons.
Physiographic influence : steep upstream areas with high rainfall intensity cause high peak discharge.
Tidal influence : floods especially occur when the peak floods occur at the same time with the high tides.

b) Floods caused by human activities
Change of river basin characteristics: exploitation of forests, agricultural development, and urban development could increase flood discharge.
Development of flood inundation areas: development of urban and rural areas on reclaimed swamps along the rivers causes floods as the previous natural accommodation of flood become less.
Slum areas, wastes, bridges and other hydraulic structures can obstruct the flows and increase the flood level.
Sedimentation in rivers: higher river beds due to sediment deposition decrease the rivers' capacity and therefore increase the risk of flooding.

2.3 Draught

Draught is highly related to the seasons and happens annually in Indonesia where only 20% of the rain falls in dry seasons.
Exploitation of water for irrigation purposes (92% of the total national water requirement, see Table 1) also contributes to draught. Rapid industrial development and, consequently, development of industrial zones cause problems since the industries demand very large supply of water. Social status of the people which becomes higher with the development also causes higher water demands.
With the fast development of the country, many lands which were allocated for recharge areas have been developed into settlements and such areas have become steadily larger (e.g. the northern part of Bandung). This condition causes higher runoff and lower discharge so that in dry seasons, many wells in those areas become dry.

III. SYSTEM APPROACH TO WATER RESOURCES MANAGEMENT PROBLEMS

In order to solve the problems that arise with the development, it is necessary to create a balanced development which not only results in minimum environmental impact but should also improve the disturbed environment due to previous activities. Therefore, re-arrangements in the field of water resources related to the following need to be made: legislation, institutions , inter-sectoral relationships and spatial problems.

3.1 Legislation

Water is considered as a gift of Almighty God and must be used for the welfare of the people .This statement is clearly written in the Constitution of the Republic of Indonesia 1945 (UUD 1945) therefore the water should be controlled and administered by the state , since the state is the only Body that has the power.

In the Law No.11/1974 (UU 11/74) the State has empowered the Government to administer all water resources, including the natural riches contained therein .The Government may authorize its agencies, in the central, regional or Corporate Bodies, to the Government's power in administration of all water resources.

This authorisation has been distributed to several agencies i.e. The Ministry of Mining and Energy, for Groundwater Administration and also for the development and management of hydroelectric power. The Ministry in charge of surface water resources is presently the Ministry of Public Works. The quality of all natural resources and the environment is managed and administered by The Ministry for Population and environment, and The Ministry of Forestry is in charge of Watershed Protection.

Through the Government Act No.22/82, the Administration of surface water has broken down into major issues i.e.:

-Concept of water resources (WR) Administration
-Coordination of WR Administration
-Priority of WR Utilisation
-Licensing of WR Utilisation
-Operational & Maintenance (O&M) of WR Structure
-WR. Financing System
-Supervision for WR Management

By Presidential Decree No. 15/84, the Government has given the Ministry of Public Work (DPW), the duty to implement Government Administration concerning Public Utilities and their development, which includes the WR. By the Ministerial Decree No. 211/84, the DPW delegates the WR Administration and Development to DGWRD.

Society's involvement in WRDM has, at the early stage, been principally regulated through Law 11/74 and Government Regulation 22/82. The philosophy of society's involvement was to generate the sense of belonging and responsibility of the society, especially who should receive the benefit of the water resources. The participation was mostly directed at O&M in order to sustain the function of the infrastructure. The original philosophy has now been developed to encourage participation in the investment required for WR development.

Law No.5/74 determines tree basic principles in the Administration System, namely decentralisation, deconcentration and co-administration or co-management.

There are several Government Regulations and Ministry PW Regulations on WRDM that have been created based on this approach. For WRM, the most important are:

-Government Regulation No.14/87: Transfer of part of Public Work Affairs to the Regional Government of Level I & II.

-Government Regulation No. 6/88:	Vertical Unit Coordination in the Region.
-Ministry PW Regulation No. 38/89:	River Basin Division
-Ministry PW Regulation No. 48/89:	Resources Management within a River Basin Entity (Unit).
-Ministry PW Regulation No. 48/89:	Conditions for Water Resources Licensing.
-Ministry PW Decree 49/82:	MPW Regional Office Establishment.

By Government Regulation No.14/87, the authorisation of some of the duties in the Development have also been given to the Regional Government, i.e, Provincial Agencies such as the Provincial Irrigation Services. This authorisation includes:

-Planning for Irrigation water distribution.
-Irrigation water distribution
-Irrigation water licensing
-Irrigation period

-Determination of irrigation priorities.
-Construction and maintenance of the main System and its appurtenant works.
-O&M for the irrigation and drainage system.
-Guarding and guarantee the function of the Irrigation system and its appurtenant works.
-Issuing permits for demolition and adjustment of the Irrigation Canals and their appurtenant work.
-Issuing permits for building, adjustment or demolition of other structures which are in the area of Irrigation system.

The structure of organization within the regional government implementing the authorisation, is determined by the Ministry of Home Affairs through consultation with the Ministry of PW.

3.2 Institutional set-up

Generally speaking the institutional set-up will cover at least three areas: Organization; the mechanism to show the responsibilities, legal aspects of the created organization and mechanisms and administration for all activities in WRDM.

At the Central level, the Ministry organisational set-ups related to WR are different from one another. For example the Ministry of Public Works has an organization structure by function; the Ministry of Agriculture by commodity; Forestry by function, and the Ministry of Energy & Mining by resources. In each Province an office has been set up as the representative of MPW for regulatory duties and Guidance.

At the Regional level, Which consist of Provinces (Propinsi) and Districts (Kabupaten / Kotamadya), the structure of the Regional Organization has been set up by the Ministry of Home Affairs through several Dinas or Provincial Agencies. One of these is the Provincial Agency for Public Work as Sub-Dinas Pengairan for 20 Provinces and Dinas Pengairan for 7 Provinces. There is also the corporate body at district level, which deals with water supply, called the Regional Water Supply Company (PDAM).

3.3 Intersectoral relationship

Since the development and management of water resources have multi-sectoral purposes and involve many ministries and users such as rice farmers, breeders, industries, plantations, etc., there are many conflicts of interest. The legislation no.11/74, article 5 states that the Ministry responsible for water resources is ordered to coordinate all administrative activities of water resources, with considerations to the interests of other related Ministries and offices.

In line with the Growing importance of Water Resources to further national development there is a need to coordinate programs, resolve potential conflicts and devise adapted programs at the national level. Within the National Planning Board (BAPPENAS) water is presently considered part of the agricultural sector. A water sector in development should be considered in order to deal with the growing importance of this sector in development and the associated investment planing. In addition, a National Water Commission or Council (NWC) is required for the water sector which should assure an integrated planning approach, involving the relevant ministries. The NWC would be chaired by the minister in charge of water affairs, and consist of 3 units, first a technical working group, chaired by the DG of the Ministry in charge and joined by the DG's from other departments; this group would provide advice on water related programs and investment; second a secretariat for coordination of water related activities; third a policy analysis unit, chaired by a senior WR planner and joined by senior analyst and individuals from the academic community.

The NWC would provide inputs to the national plan, give advice to the ministry in charge and other departments, obtain inputs from them and interact with them for preparation of a water policy note which is updated at regular intervals. The policy unit would enable development of a long term strategy for WR development: at present, practically all planning capacity within DGWRD is occupied with the day-to-day planning and supervision of projects. The NWC could indirectly help pave the way (top-down) for integration and cooperation in the region. This is the basis for successful implementation of the SWS approach. There are two possible alternatives for instituting a NWC, attached to the ministry in charge of water affairs, primarily providing advice to this minister; or establish as an extra-structural body by a Presidential decree: in view of the authority on water delegated by law to the ministry in charge of water affairs, the NWC should provide its advice to this minister. Such a structure may have certain advantages in the relationship with other ministries. In this set-up the secretariat function and policy analysis unit could be attached to or incorporated separately in the ministry of water affairs because of its close relationship to this ministry.

Another requirement for WRDM would be the setting up of a Dam Safety Commission at the National level. This would be a technical regulating unit for general supervision on Dam Safety, covering both the design and construction of new dams and the inspection of existing dams. The Commission would be supported by a secretariat with a technical and administrative section; and an independent dam panel: a group of specialists, appointed as required.

3.4 Spatial problem

Indonesia is an archipelago consisting of 14,000 islands which are grouped into 27 provinces. As the State's boundary is not the same as the hydrological boundaries, then the concept of River Basin Entity (Satuan Wilayah Sungai/SWS) is the best approach to coordination, management, and administration of water resources. The level of integration between WRDM based on the SWS approach and regional development based on spatial plan is another aspect which needs to be arranged by the related institutions.

Realising the complexities of water resources development and management in relation to the increasing demand of water for domestic use, municipal, industries, and also the difficulties in defining the administrative boundaries, then it is necessary to re-arrange the related institutions especially those concerned with water allocation, water quality management, exploitation of groundwater, private involvement, users participation, integrated planning, investment programs, etc. Job description, responsibilities and authorities between each institution must be clearly defined; these matters are currently overlapping, unclear, or have not been established at all.
Based on the Government Decree no. 22/82, the water resources in Indonesia is grouped into 73 river basins. These basins are authorised to the Regional Governments for co-management (Decree of the Minister of Public Works no. 48/89). Co-management here means that the lower regional government will carry out the work planned by the Central Government or the higher Regional Government and is responsible to them.

Currently, two river basins are managed by corporations and 15 others by the Central Government since they cover more than one province or have a strategic role in the national economy.

WRDM is based on policy which emphasises spatial dimensions through the SWS approach. WRDM, in support of National Development, is implemented under a comprehensive and integrated approach with the development and management of related land resources through Spatial Planning at National (SNPPTR), provincial (RSTRP), and district (RUTR) levels.

IV. IMPLEMENTATION OF WRDM

The role of various Ministries in WRDM are divided into several governmental levels according to their functions :

Central	:	Define policy and national plan, regulations
Province	:	Regulations, licenses, coordination and supervision, planning,
	:	operation
District(Kabupaten/Kodya)	:	Executor
Unit Pelaksana Teknis	:	Technical executor of basin-wide aspects.
User association	:	stimulate/encourage community involvement

In PJPT II (Long-term Development - Stage II), WRDM will be implemented through integrated planning (River Basin Management) which is attached to the SNTPR at the national level, RSTRP at provincial level, and RUTR at the local /district level. WRDM will also use a different approach in accordance with the regional characteristics.

For densely-populated islands such as Java where there is an ever-increasing demand for water and floods occur in rainy seasons, WRDM will be implemented through reservoirs.

The eastern part of Indonesia has low rainfall intensity and, topographically and geographically, consists of separate small basins. For this area, small scale and separated water resources development will be more appropriate.

The WRDM-related activities in a SWS must reflect the master plan which had been prepared in accordance with the spatial plan (SNTPR, RSTRP, RUTR). The most important aspect is the consistency of all institutions in carrying out their work plan with the master plan. The SWS Board as a coordinating unit is expected to control all sectoral activities within its authority.

Figures 3 and 4 show the outline of the institutional structure of WRDM and the relationship between each institute. The general overview especially show the WRDM institutions; relationship between various levels of departments. The Ministry of Home Affairs has been included for better interpretation of decentralisation aspects. The relationship is divided into three types, as follows : Line of Command : represents the standard authoritative control (administratively and professionally) from high to low within a particular department. Guidance : represents authoritative guidance on a professional basis, a check with regulations or a budgetary line of control influence. And Consultation : selection and discussion about information, opinion, and plans between two or more institutions.
Figure 5 shows an overview of various functions proposed for different WRDM units.

V. CONCLUSION

The rapid developments in Indonesia have degraded the quality and quantity of the national water resources. Therefore a balanced way of development is required to have a minimum impact on environment and also to create a situation that will improve the environmental condition.

Several approaches may be implemented such as: law enforcement and its implementation to the water law, institutional set-up which is concerned with water resources development, inter-sectoral relationship, and integrated spatial planning.

Water Resources Development Management under PJPT-II will be implemented by using integrated planning River Basin Management linked to spatial planning at the national, regional, and local levels. It will adopt a variable approach in direction and management, based on regional characteristics .

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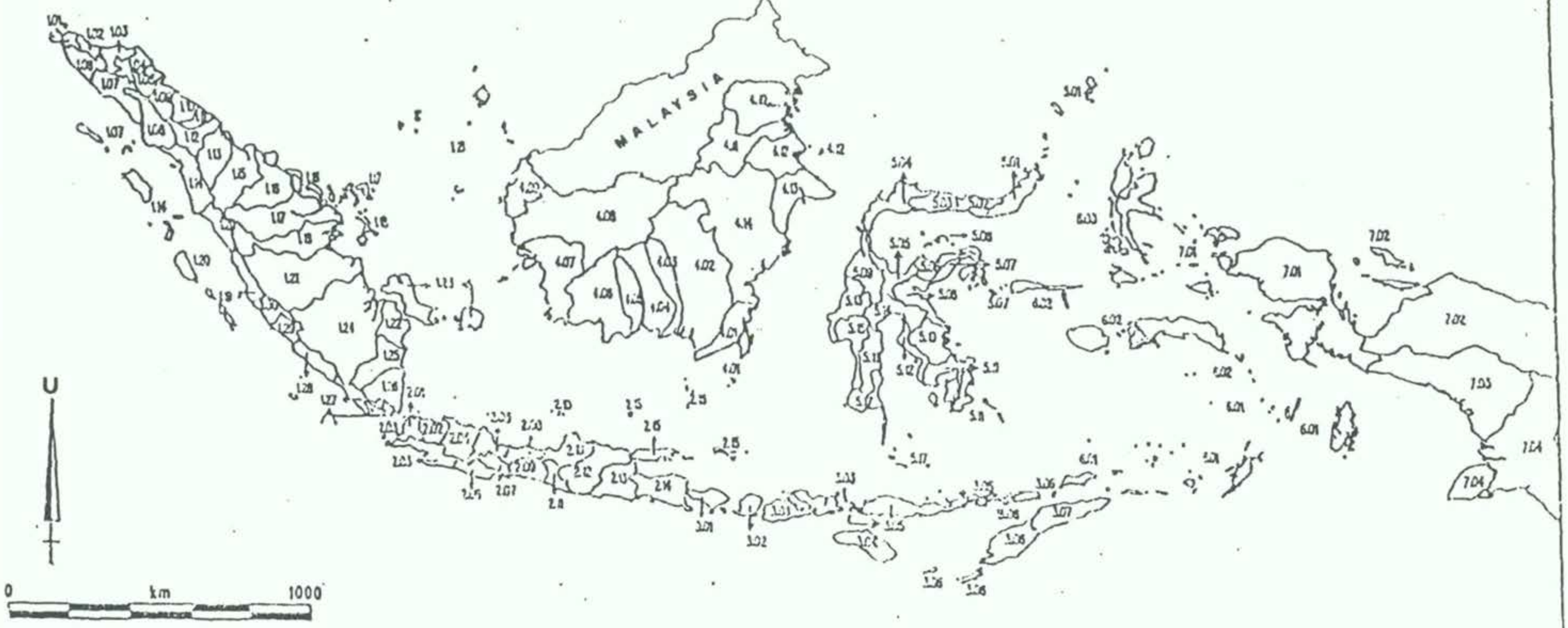
SATUAN WILAYAH SUNGAI



1.01. Krueng Aceh
1.02. Woyla - Uruva
1.03. Pase - Peusangan
1.04. Jambo Aye
1.05. Tamiang - Langsa
1.06. Woyla - Lumbesi
1.07. Singkulet - Teripa
1.08. Singkil
1.09. Wampu
1.10. Belawan
1.11. Bahbolon
1.12. Asahan
1.13. Barumun - Kualuh
1.14. Batang Toru - Batang Gadis - Kolae
1.15. Rokan
1.16. Siak
1.17. Kampar
1.18. Indragiri
1.19. Silaut
1.20. Anai - Sualang
1.21. Batanghari
1.22. Dagilan
1.23. Seluma - [illegible]
1.24. Musi
1.25. Kaswil - [illegible]
1.26. Sipatih [illegible]
1.27. [illegible]
1.28. Canal - [illegible] - [illegible]
1.29. [illegible] - [illegible] - [illegible]
1.30. [illegible] - [illegible] - [illegible]

2.01. Ciujung - [illegible]
2.02. [illegible] - [illegible]
2.03. Cisadeg - Citunlagas
2.04. Citarum
2.05. Cimanuk
2.06. Ciwulan
2.07. Citanduy
2.08. Pemali - Comal
2.09. Serayu
2.10. Jratunseluna
2.11. Progo - Opak - Oyo
2.12. Bengawan Solo
2.13. Brantas
2.14. Pekalen - Sampean
2.15. Madura
3.01. Bali
3.02. Lombok
3.03. Sumbawa
3.04. Sumba
3.05. Flores
3.06. Timor Barat
3.07. Timor Timur
4.01. Cengal - Batulicin
4.02. Barito
4.03. Kahayan
4.04. Mendawai
4.05. Sampit
4.06. Pembuang
4.07. Pawan
4.08. Kapuas
4.09. Mempawah - Sambas
4.10. Sesayap
4.11. Kayan
4.12. Kelai - [illegible]
4.13. Karangan
4.14. Mahakam
5.01. Ranoyapo - Tondano
5.02. Bolango - Bone
5.03. Randangan - Paguyaman
5.04. Buol - Lambure
5.05. Parigi - Poso
5.06. Bongka - Mallik
5.07. Lambak - Wantara
5.08. Laa - Tambalako
5.09. Palu - Lariang
5.10. Lasolo - Sampara
5.11. [illegible]alenag - Roraya
5.12. Towari - Suawu
5.13. Kalaka - Sarama
5.14. Pompengan - Kalaena - Larona
5.15. Saddang
5.16. Walanae - Cenranae
5.17. [illegible]

6.01. Kaler - Aru
6.02. Seram - Buru - Sula
6.03. Halmahera

7.01. Waal - Kais - Omba
7.02. Mamberamo
7.03. Eilanden - Edera
7.04. Digul - Bikuma

ure. 2 Average annual rainfall in River Territories (SWS)

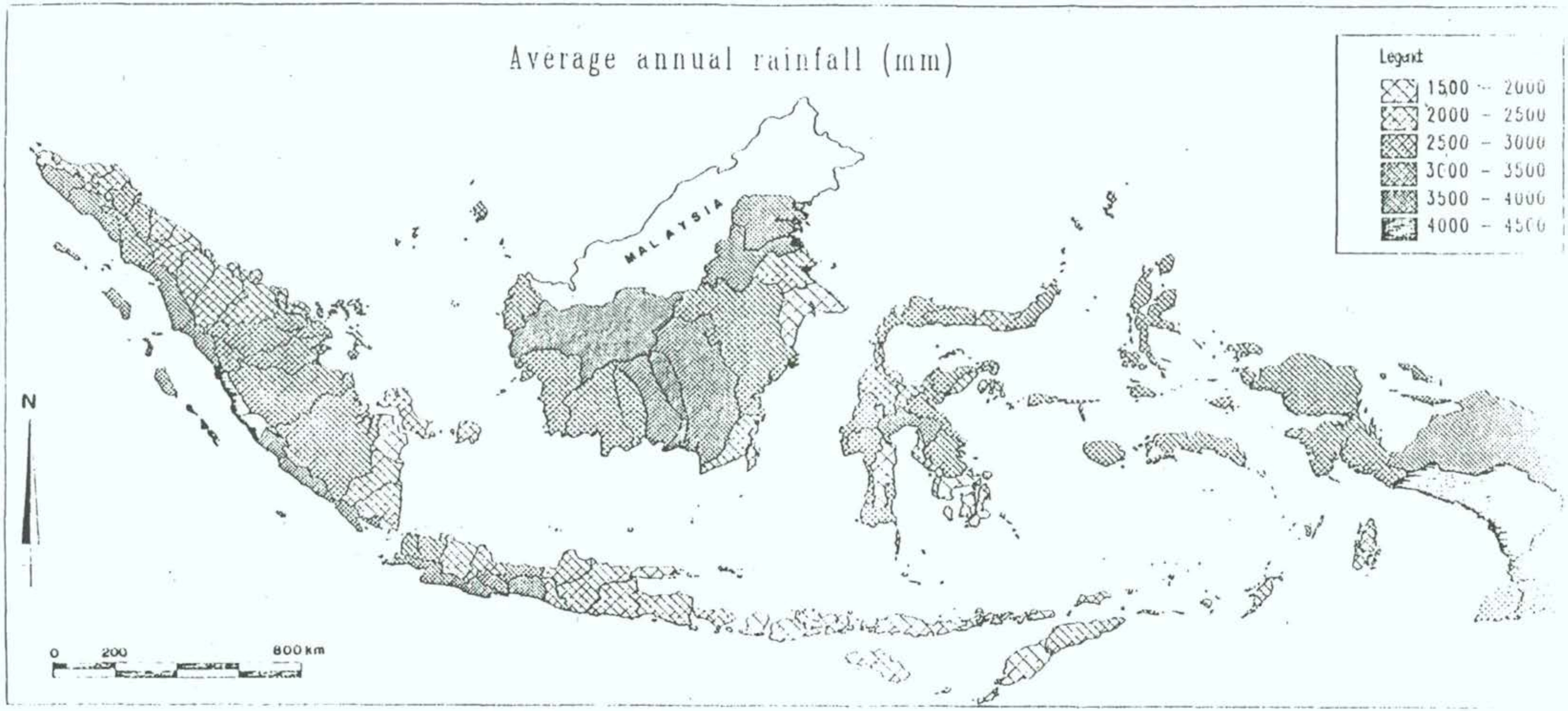
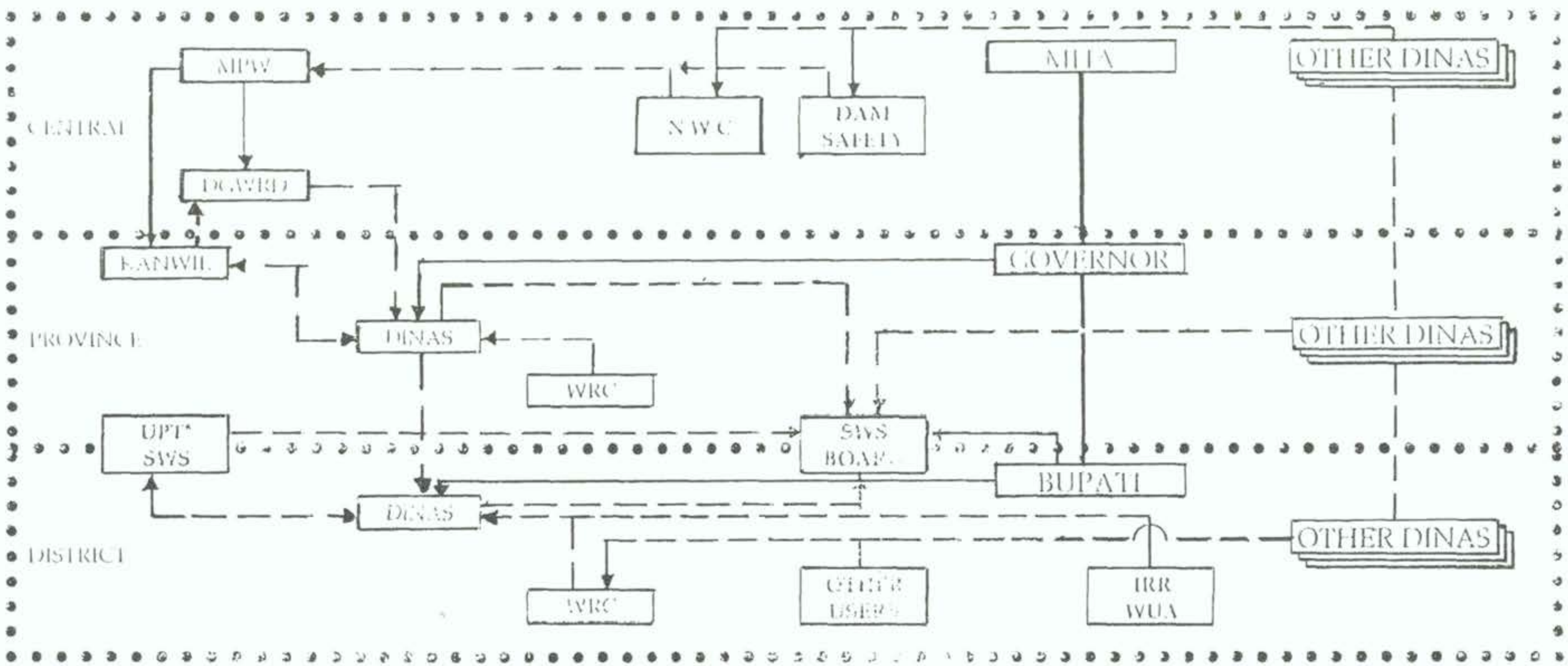


FIGURE 3
LINKS BETWEEN WRDM INSTITUTIONS IN PJPT-II
(SEVERAL DISTRICTS IN ONE SWS)



LEGEND:

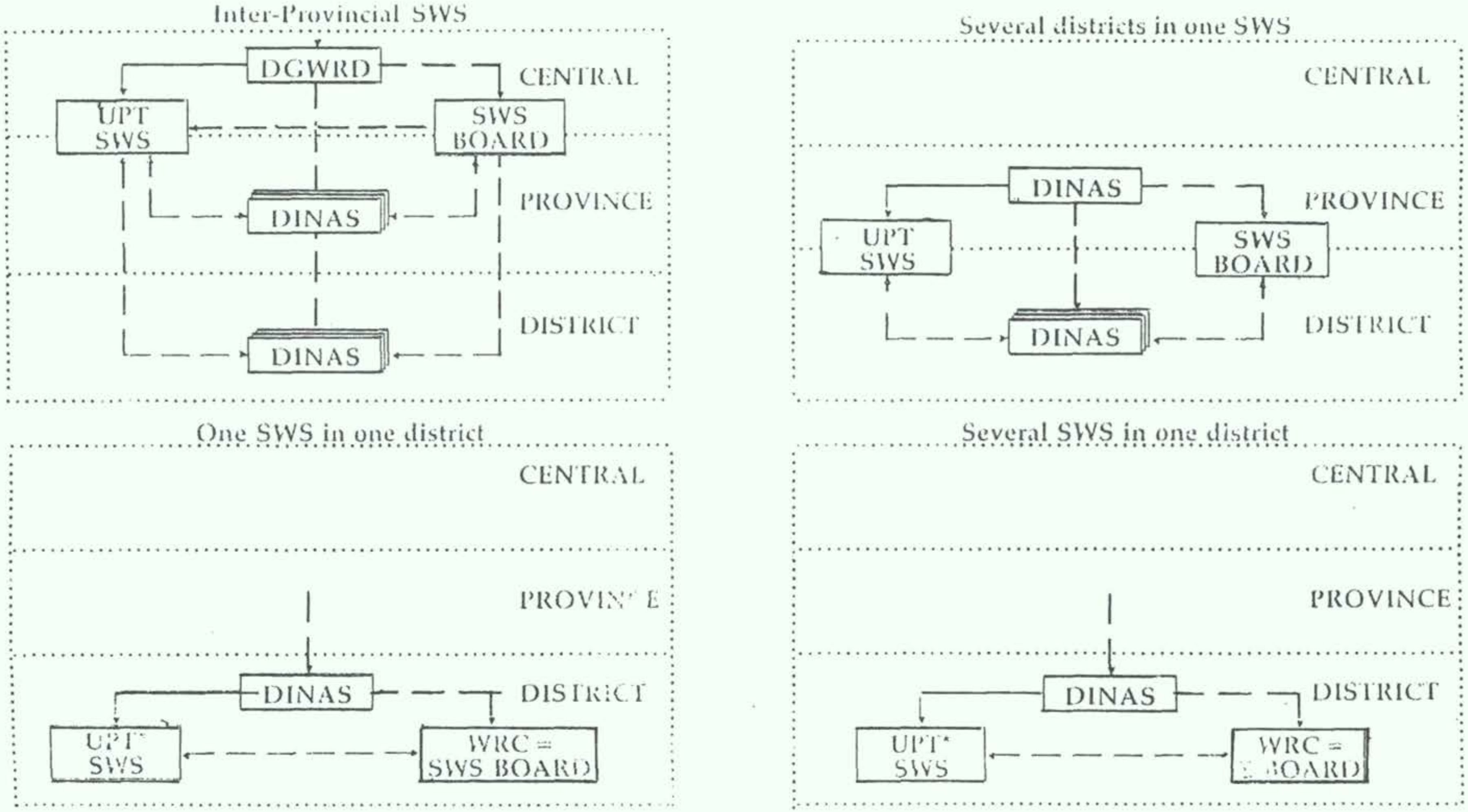
- command line
- guindance & control unit
- consultation & coordination line

UPT SWS or Authority according to status of the basin unit, and
UPT (Authority) or Dinas function added to Dinas relationship between SWS and boundary (see Figure 2)

MHA: Ministry of Home Affairs
MPW: Ministry of Public Works
NWC: National Water Council
SWS: Satuan Wilayah Sungai (River Basin Entity)
UPT: Unit Pelaksana Teknik
UPI: (Technical Implementation Unit)
WRC: Water Resources Committee
WUA: Water User Association

FIGURE . 4

SET-UP OF SWS MANAGEMENT FOR DIFFERENT GEOGRAPHICAL LOCATIONS OF DISTRICTS AND SWS TERRITORIES



* basin function added to Dinas DATI-II

basin function added to Dinas DATI-II

FIGURE. 5

MANAGEMENT AND DEVELOPMENT FUCTIONS AT DIFFERENT INSTITUTIONAL LEVELS OF WRDM IN PJPT-II

UNIT / FUCTION	CENTRAL		PROVINCE		SWS		DISTRICT		
	DGWRD	NWC	DINAS	WRC	BOARD	UPT 2)	DINAS	WRC	UPT 3)
1. POLICY MAKING	■	■	■		□	□	□		
2. DEVELOPMENT PLANNING	■		■			■	■		
3. DEVELOPMENT PROGRAMMING	■		■			■	■		
4. DESIGN AND CONSTRUCTION 1)	■		■			■	■		■
5. O & M									
• WM PLAN,			■			■	■		■
• OPERATION			■	■	■	■	■	■	■
• MAINTENANCE						■	■		■
6. COORDINATION									
• CENTRAL		■							
• PROVINCE				■					
• DISTRICT					■			■	
7. MONITOR	■		■			□	■		
8. EVALUATE	■		■			□	□		
9. REGULATE/LICENCING		□	■	□	□		■	□	□
10. ENFORCEMENT			■			□	■	□	□

■ Mandate

■ Support/Preparatory/Supervision

□ Coordination

NWC National Water Council
WRC Water Resources Committee
UPT Unit Pelaksanaan Teknis (Technical Implementation Unit)

1) design and construction activities spread over different levels acording to handling capacity
2) in case SWS under one district
3) UPT or authority

Tabel 1

Neraca Air Nasional

Kondisi tahun 1990 [Sumber: Direktorat Bina Program Pengairan]

Kode Propinsi	Nama Propinsi	Luas total	Runoff	Runoff	Areal Irigasi existing	Areal Irigasi potensial	Kebutuhan air irigasi	Kebutuhan air domestik di pedesaan	Kebutuhan air perkotaan	Kebutuhan air industri	Kebutuhan air tambak	Kebutuhan Total	Surplus air
		km2	mm/tahun	Juta m3/tahun	Ha	Ha	Juta m3/th	Juta m3/th	Juta m3/th	Juta m3/th	Juta m3/th	Juta m3/th	Juta m3/th
11	DI. Aceh	57.037	1.526	87.038	145.410	65.650	2.293	19	19		62	2.393	84.646
12	Sumatera Utara	72.561	1.455	105.576	273.160	91.840	4.307	44	167			4.518	101.058
13	Sumatera Barat	41.612	2.250	93.627	158.210	32.815	2.495	22	28			2.545	91.082
14	Riau	96.346	1.338	128.911	23.080	159.415	364	16	38		3	421	128.490
15	Jambi	48.518	1.574	76.367	40.850	59.760	644	9	16			669	75.698
16	Sumatera Selatan	101.118	1.474	149.048	59.150	268.655	933	28	85			1.046	148.002
17	Bengkulu	20.876	2.450	51.146	46.210	16.090	729	6	9			744	50.403
18	Lampung	33.345	1.387	46.250	128.250	36.470	2.022	35	28			2.085	44.164
31	DKI Jakarta	656	672	441	9.410	0	148	0	457			605	(165)
32	Jawa Barat	46.352	1.756	81.394	902.740	78.890	14.234	151	498	135	503	15.521	65.873
33	Jawa Tengah	34.531	1.627	56.182	789.210	78.180	12.444	136	300		1179	14.059	42.123
34	DI Yogyakarta	3.212	904	2.904	54.870	4.290	865	9	54			928	1.975
35	Jawa Timur	48.267	959	46.288	930.710	58.450	14.675	155	372	20	846	16.068	30.220
51	Bali	5.655	964	5.451	92.840	4.055	1.464	13	28		79	1.584	3.868
52	Nusa Tenggara Barat	19.740	647	12.772	152.490	14.610	2.404	19	22			2.445	10.326
53	Nusa Tenggara Timur	46.100	625	28.813	63.330	19.095	999	19	13			1.031	27.782
54	Timor Timur	14.799	872	12.905	6.040	20.990	95	3	3			101	12.803
61	Kalimantan Barat	147.872	2.205	326.058	97.450	105.230	1.537	16	25			1.578	324.480
62	Kalimantan Tengah	154.831	1.988	307.804	46.700	186.805	736	6	9			751	307.053
63	Kalimantan Selatan	36.079	1.352	48.779	37.580	167.060	593	13	25			631	48.148
64	Kalimantan Timur	196.291	1.658	325.450	6.090	135.760	96	6	35		44	181	325.269
71	Sulawesi Utara	27.193	1.421	38.641	48.980	9.885	772	13	22			807	37.834
72	Sulawesi Tengah	61.629	1.329	81.905	95.840	20.480	1.511	9	9			1.529	80.376
73	Sulawesi Selatan	62.884	1.415	88.981	316.100	87.040	4.984	35	66		1169	6.254	82.727
74	Sulawesi Tenggara	35.372	1.053	37.247	29.760	19.340	469	6	9			484	36.762
81	Maluku	78.180	1.339	104.683	9.850	56.150	155	9	13			177	104.506
82	Irian Jaya	413.951	2.117	876.334	2.120	619.170	33	9	13			55	876.279
	Jumlah	1.905.007		3.220.995	4.566.430	2.416.175	72.003	806	2.363	155	3.885	79.212	3.141.782

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WATER RESOURCES ASSESSMENT AND INTEGRATED MANAGEMENT IN JAPAN

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Topographical and hydrological characteristics

Japan is composed of 4 islands i.e., Honshu, Hokkaido, Shikoku and Kyushu, and more than 3,000 small islands. Its area is 377,727 km^2. These islands extend over 2,000 km in total length, but only about 300 km in width. Japanese islands are mostly mountains, about 3/4 of them containing long mountain ranges along the centre of the islands, with ones called the Japan Alps which include 3,000 m class mountains and lie in the central area of Honshu. Plains are not so wide, mostly alluvial plains formed by river sedimentation, and rivers are short and form steep channel slope in general.

In Japan, there are 4 distinct seasons including 3 wet periods. In winter, there are heavy snow falls in the Japan Sea side, in particular in the northern Honshu.

The second wet period, observed in June and July is called "Baiu", brings continuous heavy. During the third wet period from July to October, typhoons born in the Pacific Ocean attack Japan and bring heavy rains and strong winds. Because of these 3 wet periods, the mean annual precipitation is as much as 1,800 mm.

Annual precipitation isohyetal map is shown in Fig. 1. During the above mentioned wet seasons, severe rainfalls were recorded, as shown in Table 1 and 2.

Table 1

Maximum recorded point precipitation in 24 hours (in mm)

Place	Prefecture	Precipitation	Date
Hisawa	Tokushima	1,114	11.9.1976
Saigo	Nagasaki	1,109	25.7.1957
Tateyama	Toyama	1,016	19.7.1944
Odaigahara	Nara	1,011	14.9.1923
Nagatani	Nagasaki	997	25.7.1957

Table 2

Maximum recorded point precipitation in an hours (in mm)

Place	Prefecture	Precipitation	Date
Nagayo	Nagasaki	187	23.7.1982
Kobutsu	Nagasaki	183	23.7.1982
Fukui	Tokushima	167	22.3.1952
Fujinomiya	Shizuoka	153	24.8.1982
AÁui	Kochi	150	17.10.1944

Table 3

Major rivers of over 2,500 km^2 in drainage area
(from the north to the south in order)

Island	River	Total drainage area (km^2)	Length of river channel (km)
Hokkaido	Teshio	5,590	256
	Ishikari	14,330	268
	Kushiro	2,510	154
	Tokachi	9,010	156
Honshu	Iwaki	2,540	102
	Kitakami	10,150	249
	Abukuma	5,400	239
	Yoneshiro	4,100	136
	Omono	4,710	133
	Mogami	7,040	229
	Naka	3,270	150
	Tone	16,840	322
	Ara	2,940	169
	Agano	7,710	210
	Shinano	11,900	367
	Jintsu	2,720	120
	Fuji	3,990	128
	Tenryu	5,090	213
	Kiso	9,100	277
	Yodo	8,240	75
	Kuzuryu	2,930	116
	Gono	3,870	194
	Takahashi	2,670	111
Shikoku	Yoshino	3,750	194
Kyusyu	Chikugo	2,860	143

Natural characteristics of rivers

The above - mentioned topographical and hydrological features form the natural characteristics of rivers in Japan, as follows:

1) As seen in Table 3, all the drainage basins are small and the length of river channels are short, due to the topographical nature.

2) Due to the preceding characteristics and the heavy storm - rainfall, the storm runoff flows rapidly with sharp - shaped flood hydrograph, and easily cause severe floods.

3) Also, the specific peak flow discharge per basin area of each river is relatively big, and is 10 times or sometimes 100 times bigger compared with those of major rivers in the continents.

4) The coefficient of river regime, the ratio of the maximum discharge and the minimum discharge in a year of each river, is between 200 and 400, about 10 times larger than that of continental rivers.

5) Sediment load is heavy

Japan is famous for the beauty of its volcanoes and hot springs, but, on the other hand, weak igneous rocks are widely distributed, making the land vulnerable to erosion and debris flow if severe storm - rainfalls occur. Furthermore, large amounts of sediment coming from upper mountain areas cause severe sediment accumulation in dam reservoirs.

Furthermore, the population and important industry have been accumulated in the alluvial plains where potential danger of flood disasters is large. Major cities and towns in our country have been mostly developed in the flooding areas of rivers, and in particular since the high economical growth period since 1960s, urbanisation has progressed rapidly in areas under high risks of disasters such as lowland marshes, alluvial fans and old rice fields which had long been playing a role of natural reservoirs. Due to the remarkable concentration of the population and social assets into urban areas, 50% of population and 75% of assets are now located within the potential flooding areas of rivers.

Table 4 **Large dams by classification of objectives**

Year	Objective	Height in meters					Total	
		15-30	31-60	61-100	101-150	Over 150		
pre-1930	I	809	8				817	
	S	17	5				22	888
	P	36	8	3			47	
	M	2					2	
1931-1950	I	258	12				270	
	S	10	2				12	
	F							378
	P	47	29	7			83	
	M	5	8				13	
1951-1970	I	204	38	2			244	
	S	22	10				32	
	F	31	21				52	668
	P	76	62	30	13	4	185	
	M	29	57	58	11		155	
1971-1990	I	57	69	5			131	
	S	25	18	1			44	
	F	26	59	4	1		90	528
	P	13	17	17	6	1	54	
	M	31	92	70	14	2	209	
1991-1992	I	7	12				19	
	S	1	1				2	50
	F	1	3				4	
	P							
	M	1	15	8	1		25	
Total	I	1335	139	7			1481	
	S	75	36	1			112	
	F	58	83	4	1		146	2512
	P	172	116	57	19	5	369	
	M	68	172	136	26	2	404	
Grand total		1708	546	205	46	7	2512	

Abbreviation:
F - flood control
P - hydroelectric power
I - irrigation
S - municipal water supply
M - multiple purposes

A century of river works

The history of the last 100 years, during which Japan experienced a remarkable rate of modernisation and economic growth, is well reflected in changes of river regime and the riparian environment.

First of all, it should be emphasised that a large number of engineering works and a great deal of financial investment have been made in flood control measures since the end of the last century. In the River Act of 1896, the Meiji government laid emphasis on river improvement works for flood control, and the continuous levee systems were in general consistently built in the middle and downstream reaches of important rivers, with floodways and cutoffs in some cases, in order to protect rice fields and urbanised areas. As a result of these works, the productivity of farm land rapidly increased, and the areas regularly flooded markedly decreased.

On the other hand, because flood flows became concentrated within the river channels and between continuous levees of almost all rivers in the country, the velocity of flood waves and the peak discharge increased. This means that floods were influenced by human activities, including the construction of flood control works themselves and economic developments in the basins. Rapid changes in the factors affecting the condition of river basins are clearly visible in Japan, a country which achieved industrialisation in a short time - the economy was still overwhelmingly agricultural in the Meiji Era - and which underwent further rapid modernisation since the end of the Second World War. The change from smaller to larger floods due to the construction of continuous levees was one of the prime cause of the widespread and severe flood damage sustained in the post - war period.

In Japan rice production has been one of the most important industries throughout its long history. The abundance of water for paddy fields during the irrigation season created the possibility of a stable rice - growing industry. Most of the water from the lower stages of almost all Japan's rivers had been directed to the paddy fields by the middle of the Edo Era, and traditional water rights had been established. A large number of diversion weirs had been constructed since 18th century, and these hydraulic structures made Japanese rivers even more artificial. Furthermore, from the beginning of this century, a large number of works designed to meet domestic and industrial water demand have been constructed, along with substantial hydroelectric installations.

Above all, the rapid growth of the Japanese economy since the latter half of the 1950's brought with it an intensive growth of industry and the concentration of the population into urban areas. This has resulted in a rapid increase in water demand, especially in a big cities such as Tokyo Bay, Ise Bay, Osaka Bay, Seto Inland Sea and so on.

After the enactment of the Electric Development Promotion Law in 1952, and the Multipurpose Dam Law in 1958, a number of huge hydroelectric dams and multipurpose dams (especially for flood control, irrigation and hydroelectric power) were constructed; after the passage of the Water Resources Development Promotion Law in 1962, municipal water supply was given priority in the design of multipurpose dams, to meet the demands of intensive urbanisation.

As can be seen from Table 4, the number of high dams constructed after 1951 is remarkable compared with previous periods. For example, the number of dams higher than 15 m constructed between 1951 and 1978 is about 304 for irrigation purposes, 222 for hydroelectric power and 226 for multi purposes. As a result, there are now few important rivers without dams in their upper reaches, and their appearance has changed strikingly since the 1950's.

Current Water Use

Presently, about 90 billion m^3 of water are used annually in Japan in 1990, of which 16.4 billion m^3 are used by domestic, 15.6 billion m^3 by industries, and 58.6 billion m^3 by irrigation.

Along with the improvement of living standards and industrial growth, water use increased rapidly from 1965 through 1975 by 1.6 times.

Although the growth of water demand has levelled off since 1975 when the growth of Japanese economy became at a moderate pace, the rapid growth in the previous decade caused serious problems in major metropolitan areas, including water shortage in dry seasons, subsidence of ground due to excessive pumping of groundwater, and water contamination due to increased discharge of wastewater, calling for early solution.

At the same time, water has been used as an important energy source that since the natural resources are limited.

(1) Domestic water use

Domestic water is used by household, commercial and public facilities. With the improvement of living standards, water is used for a variety of purposes. Also, the increase in the number of buildings with sophisticated features, such as intelligent buildings, boosts water use.

(2) Industrial water use

Industrial water is used for a wide range of industrial purposes, such as processing, cleaning, boilers, cooling. Water for industrial use has increased rapidly with the increased in the industrial production. However, with recent changes in industrial structure from heavy industries to process and assemble, and improved efficiency of water use (the recovery rate was 75.3% in 1988), the demand for industrial water remains relatively unchanged.

(3) Hydropower

As of fiscal year 1988, the percentage shares of power sources in Japan are 63.4% by thermal power, 12.7% by hydropower, 23.7% by nuclear, and 0.2% by geothermal and others. Recently, the limitation of energy resources has been recognised. After the oil crisis in 1973, the prompt development of alternative energies has been highly demanded. In this sense, hydropower is increasing its importance in terms of effective use of water resources, and reusable clean energy.

Meeting water demand

(1) Frequent occurrence of water shortage

In recent years, water shortages have been experienced in one place or another. For instance, in 1987 and 1994, water shortages occurred in the Tokyo Metropolitan Area, the Kiso river system, Northern Shikoku, and Northern Kyusyu. Although water shortages have been limited to relatively short period of time, serious damages could be inflicted on production activities if they occurred at the seasons when water is most needed. Furthermore, because of the improvement of living standard, water is used for diverse purposes in today's life and our society cannot function properly without it.

(2) Long - term outlook for water demand and supply

Water demand is expected to grow further in the future. The use of household water will steadily increase as the use of flush toilets increases, and the use of business and commercial purposes increase along with urbanisation.

To secure stable water supplies under such conditions as decreasing precipitation, and increasing demand, comprehensive water resources development policies are called for, including the planned development of water resources based on a long -term viewpoint, and the promotion of more efficient use of water, and recycle system including use of treated sewage water, water conservation, use of rainwater, and the modernisation of the traditional water right system.

River environmental problem

As a result of the progress of urbanisation in river basins in recent years, the river environments have changed, water quality has worsened and hydraulic properties fallen. Public demand for the improvement of water quality, and preservation of natural environment has risen.

Watersides are considered valuable open spaces, and support natural conservation, disaster prevention and reaction. The role of such spaces in the formation of regional environment is being evaluated.

For instance, according to the national census on River Environment by the Ministry of Construction in fiscal 1990 to 1991, about 130 million people visited the 109 most important rivers in Japan. This mean that each citizen visits a river about once a year for walking, fishing or sports, and this condition illustrates the recreational role of rivers.

Various works are being carried out, such as the conservation and creation of scenic areas, conservation of natural environment and various projects to improve hydraulic properties. These include the creation of naturally diverse rivers where insects and fish can live, home town river model projects and model project of levees planted with cherry trees.

Porous materials are used for river banks, shoals and pools. Installation and improvement of fish channels, installation of levees with gentle slopes and undulations, expansion of levees, planting cherry trees, river work which is coordinated with town planning.

Also several projects concerning environmentally - sensitive river works are now progressing as follows:

1) River purification projects

2) Naturally diverse river improvement works

3) Aeration systems to increase desolved oxygen

4) Purification systems using natural biological system

Administrative organisation

Administration systems on water resources planning, development, conservation, management, and flood control planning, etc. are executed in several ministries and agencies as follows:

- Ministry of Construction

River Bureau for flood control, water resources development (especially, dam, saline barrier, intake canal, etc)
City Bureau for sewerage planning

- Ministry of Agriculture, Forestry and Fishery

Irrigation water use

- Ministry of Health and Welfare

Domestic water use

- Ministry of International Trade and Industry

Industrial water use, hydropower

- Environmental Agency

Conservation on water quality

- National Land Agency

Water resources development planning, etc.

Scientific societies

The following two are the major societies committed solely to scientific researches on hydrology and water resources

- Japan Society of Hydrology and Water Resources (established in 1988, members: 1,175 in 1991) covers a vast area of water sciences such as physical and engineering hydrology, water resources engineering and planning, applied meteorology, water quality, forestry.

Journal: Journal of Japan Society of Hydrology and Water Resources, bimonthly, vol. 7 (1994)

- The Japanese Association of Hydrological Sciences

(established in 1987, members: 360 in 1991) covers such fields as physical and geographical hydrology, groundwater and geo - chemistry.

Journals: Hydrology, quarterly, vol. 24 (1994)

Other than those two, there are a number of other scientific societies, laáe ones including a hydrology and water resources section or small ones focusing on relatively narrower aspect of water science. They are as follows:

- The Japanese Society of Limnology
- Japanese Society of Snow and Ice
- The Society of Agricultural Meteorology of Japan
- Japan Society of Civil Engineers
- Japanese Association of Groundwater Hydrology
- The Balneological Society of Japan
- Japanese Society of Irrigation, Drainage and Reclamation Engineering
- The Erosion Control Engineering Society, Japan
- Geochemical Society of Japan
- The Japanese Forestry Society
- The Geothermal Research Society of Japan
- Japanese Geomorphological Union
- Japanese Society of Physical Hydrology

WATER RESOURCES ASSESSMENT AND INTEGRATED MANAGEMENT-WATER SUPPLY AND POLLUTION CONTROL IN MALAYSIA

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INTRODUCTION

1. Malaysia comprises of thirteen States and two Federal Territories, covering a total area of 330,000 square kilometres and a population of 19 million. The economy of Malaysia has been expanding at a very rapid rate in the past few years with more focus given to the development in the industrial sector, supported by the availability of good infrastructural facilities in the country.

2. Located in the humid tropics, the country is blessed with an abundance of fresh water resources. However, the rapid economic growth has resulted in an ever-increasing demand for water to cope with the needs of the expanding population, agricultural and industrial development, hydropower generation and other uses. The problems of water imbalance resulting from water-use conflicts is further compounded since water resources development and management in Malaysia have traditionally been fragmented among various Federal and State Agencies in accordance with their functions and activities related to water.

3. In addition to the need to cope with the increasing water demand, there is also the corresponding problem of water quality deterioration as a result of pollution of natural water courses from both `point' and `non-point' sources. The point sources comprise largely localised sources from residential areas, industries, mining activities, animal farms, rubber factories and palm oil mills. Non-point sources include runoff from residential and industrial areas, agricultural lands and forests.

4. In the light of the above developments, it is therefore necessary and timely to address the many issues related to the development and management of water resources in the country. An integrated approach is warranted, considering all related problems, sectoral demands and needs for water. This is to ensure that future developments will not result in undesirable impacts which are not only difficult but also costly to remedy.

5. This paper gives a general assessment on the current status of water resources in Malaysia, focusing on water supply and pollution control.

PRESENT STATUS OF WATER RESOURCES

Water Availability

6. Malaysia receives more than 2,500 mm of mean annual rainfall mainly due to the Southwest and Northeast monsoons. The above average annual rainfall when translated into volumetric quantities on the total land area of the country leads to a total water resources estimated at 990 billion m^3 per year. Out of the above total resources, some 566 billion m^3 (57%) appears as surface runoff, 64 billion m^3 (7%) goes to groundwater recharge and the rest 360 billion m^3 (36%) returns to the atmosphere as a result of evaporation and transpiration. Of the total 566 billion m^3 of surface

runoff, 147 billion m^3 is found in Peninsular Malaysia, 113 billion m^3 in Sabah and 306 billion m^3 in Sarawak. The present annual aggregated domestic, industrial and irrigation water demand is about 11.6 billion m^3.

7. Looking at the above statistic, it is clear that there is an abundance of water resources as compared to the demand. Unfortunately, water stresses are still experienced in the more densely populated and economically developed areas. This is mostly due to the uneven temporal and spatial distribution of rainfall and water resources which has resulted in fluctuating river flows over a wide range.

Current and Future Demand

8. Currently, the annual aggregated water demand for the domestic, industrial and agricultural sectors is estimated at 11.6 billion m^3. The demand is projected to reach 15.2 billion m^3 by the year 2000 and 20 billion m^3 by the year 2020. The breakdown for current water usage is 78% for irrigation, 20% for domestic and industrial water supply and 2% for non-consumptive uses such as hydropower generation, navigation, aquaculture, recreation and mining.

9. Water demand for irrigation, the largest water user is expected to increase from 9.6 billion m^3 in 1993 to 13.2 billion m^3 by the year 2020. However, its overall share of water consumption is projected to drop from 78% to 65% as a result of the various on going programmes for improvement of irrigation efficiency in all major paddy planting areas. The crop diversification programmes from paddy to non-paddy crop in marginal paddy lands is also expected to reduce the overall demand for irrigation water supply.

10. On the other hand, the total share of domestic and industrial water demand is projected to increase from 20% to 30%, i.e. from 2.6 billion m^3 to 6.8 billion m^3 by the year 2020. The share of non-consumptive and other uses of water is expected to increase to about 1.0 billion m^3 or 5% of the total water consumption by the year 2020. The water demand figures are summarised in Table 1.

TABLE 1: Water Demand (billion m^3/year)

YEAR	WATER SUPPLY	IRRIGATION	TOTAL
1993	2.0	9.6	11.6
2000	4.8	10.4	15.2
2020	6.8	13.2	20.0

Water Supply

11. Streams of rivers with or without impounding reservoirs contribute about 97% of the raw water supply sources in Malaysia while groundwater, which accounts for only 3% of the raw water sources, is not widely used due to its limited availability. There are 30 impounding reservoirs in the country from which water is drawn. Several new dams are under construction or being planned.

Impounding reservoirs are being used to feed raw water directly to treatment plants or to regulate river flows for abstraction downstream.

12. Currently, the water supply capacity in Malaysia is approximately 7900 Mld as compared to the demand of 6300 Mld. The supply capacity and demand for each state is as shown in **Table 2**. The water supply system serves 96% of the urban population while for rural population, the present coverage is 67%. High growth in population and economy will result in further increase in demand for water.

WATER RESOURCES DEVELOPMENT

Domestic and Industrial Water Supply

13. As Malaysia progresses towards industrialisation, the demand for water in the domestic and industrial sectors is expected to grow tremendously. In addition, there will be an increasing concern over the quality of the water environment which affects the quality of life covering such aspects as health, sanitation and recreation. Under the Sixth Malaysia Plan (1991 - 1995), the financial allocation for water supply projects totals about RM 3.0 billion (US$ 1.2 billion), representing about 5.2% of the total development budget of the country.

14. To meet the increase in water demand, several projects are being undertaken with the primary aim of boosting water resources in water stress areas. Development of new sources of water is carried out by constructing more dams. Currently, the construction of Buloh and Selangor dams in the State of Selangor, which can give an optimum yield of 3,000 mld are in progress. Two other dams, the Kelinchi Dam in the State of Negeri sembilan and the Beris Dam in the State of Kedah are now at the design stage.

Storage Schemes

15. The construction of storage schemes to regulate the fluctuating flows in rivers has long been practised to support the agricultural, water supply, flood mitigation and hydropower development. At present, there are 40 single purpose and 16 multipurpose dams (excluding saddle dams) with a storage capacity of about 25 billion m^3 in Malaysia. **Table 3** indicates the breakdown of dams in terms of usage.

Inter-State Water Transfer

16. As the majority of the State boundaries in Malaysia are along watersheds, most rivers supplying fresh water resources flow within individual states. With the constitutional provision that water is a State matter, individual states have been planning and developing their own water resources to cater for their own requirement. As a result, a few States have begun to discover that their water resources are not able to meet the current and future increase in water demand. Thus, to overcome water stress in these States, inter-State water transfer will be necessary.

17. The inter-State water transfer has been carried out in the States of Johore and Malacca. This approach is set to become a prominent feature of water resources development in Malaysia in the near future.

TABLE 2 : Water Treatment Capacity and Supply, 1990-1995 (Mld)

State	1990		1993		1995	
	Treatment Plant Capacity	Quantity Supplied	Treatment Plant Capacity	Quantity Supplied	Treatment Plant Capacity	Quantity Supplied
Johor	708	489	1,117	885	1,333	1,240
Kedah	478	374	624	505	813	616
Kelantan	149	116	218	168	245	191
Melaka	143	137	198	159	235	195
Negeri Sembilan	230	230	416	252	451	287
Pahang	528	369	659	464	669	473
Perak	644	564	726	678	972	777
Perlis	54	43	102	80	138	100
Pulau Pinang	533	456	790	523	790	559
Sabah	367	363	386	298	466	348
Sarawak	185	92	243	113	260	160
Selangor[1]	1,793	1,406	2,043	1,897	2,545	2,316
Terengganu	291	114	375	295	525	400
MALAYSIA	6,103	4,753	7,897	6,317	9,442	7,662

NOTE : 1. Includes Wilayah Persekutuan Kuala Lumpur.

Table 3: Number of Single and Multi-Purpose Dams

Single Purpose		No.
1.	Water Supply	27
2.	Hydropower	7
3.	Irrigation	3
4.	Silt Retention	3

Multi-purpose		No.
1.	Water Supply + Irrigation	6
2.	Water Supply + Flood Control	5
3.	Water Supply + Irrigation + Flood Control	2
4.	Hydropower + Flood Control	2
5.	Hydropower + Water Supply	1

Future Development Trends

18. Future programmes for water resources development should be guided by the National Development Policy which aim to give adequate attention to the protection of the environment and ecology so as to maintain the long term sustainability of the country's development. The past approach in water resources development has been based largely on development of new resources through massive capital investment. However, as resources become scarce, greater emphasis should be devoted to the economic and financial viability of such projects. Hence, there is a need to consider the use of non-structural measures such as water conservation, water saving and resources reallocation strategies which are generally less costly to implement.

MANAGEMENT OF WATER RESOURCES

19. The management of water resources in Malaysia involves a number of agencies and the functions and roles played by each agency are shown in Table 4.

Table 4 : Functions and Roles of Agencies Involved in Water Resources Management

AREA	DEPARTMENT/ AGENCY	FUNCTION/ROLE
Water Supply Use	DID	Monitoring of stream flow and supply of irrigation water.
	District Office	Licensing of water use.
	PWD (Waterworks)	Treatment and supply of drinking water.
	NEB	Storage and use of water for hydropower.
	DOE	Control of industrial pollutants.
Water Pollution Control	Local Council	Control and treatment of sewage.
	DID	Control of pollution from irrigation areas.
	Mines Dept.	Control of pollution from mining operations.
	DOE	Monitoring of water quality.
	Fisheries Dept.	Prohibition of use of poisoning or other destructive fishing methods.

DID - Department of Irrigation and Drainage
PWD - Public Works Department
NEB - National Electricity Board
DOE - Department of Environment
MOH - Ministry of Health
GSD - Geological Survey Department
JPBD - Town and Country Planning Department

AREA	DEPARTMENT/ AGENCY	FUNCTION/ROLE
Watershed Protection and Management	PWD	Use and supply of groundwater for domestic and other uses.
	MOH	Survey and assistance to develop groundwater for rural communities.
	JPBD	Land use planning and control.
	Forestry Dept.	Watershed management within forest reserves and protection of forests.
	NEB/Waterworks	Protection of watershed within reservoirs.
	DID	Maintenance of river reserves.
Groundwater	GSD	Assessment of groundwater potential and hydrogeological investigations.
	State Medical	Protection of wells and rural water supplies.
	Chemistry Dept.	Analytical services on water samples monitored.
Drainage and Flood Control	DID	Planning, construction and maintenance of drainage works (agriculture and urban).
	PWD	As above but mainly for urban and roadside drainage system.
	Local Authorities	Planning, construction and maintenance of drainage works within local authority area.

POLLUTION CONTROL

20. Several laws and regulations already exist in Malaysia on the control of the use, protection and management of water and rivers. Based on the existing laws and regulations, the strategies for the management of water quality in the country can be grouped into four major areas namely:

- Monitoring
- Enforcement
- Prevention
- Development

Monitoring

21. In Malaysia, the Department of Environment (DOE) plays a central role in the monitoring and assessment of the quality of the environment. Under the Environmental Quality Act 1974, the Director General of DOE is empowered to:

i) "to undertake surveys and investigations as to the causes, nature, extent of pollution ... and to assist and cooperate with other persons or bodies carrying out similar surveys and investigations",

ii) "to conduct, promote and coordinate research in relation to any aspect of pollution ..." and,

iii) "to provide information and education to the public regarding the protection and enhancement of the environment".

22. The main objectives of water quality monitoring are:

i) to determine the quality of water in its natural states and the various influences that affect its quality,

ii) to assess the impact of human activities upon the quality of water and its suitability for the various uses,

iii) to detect and keep under observation the sources and pathways of specified pollutants, and

iv) to detect the trends in water quality and assess the effectiveness of pollution control measures.

23. In 1993, a total of 116 rivers was monitored to look into the three major sources of pollution. As shown in **Figure 1**, the monitoring reveals the following results:

- based upon BOD index, a total of 12 rivers (10 %) is categorised as polluted and 23 rivers (20 %) as slightly polluted. The balance of 81 rivers (70 %) is considered safe and clean from BOD pollution by organic materials.

- based on ammoniacal nitrogen (NH -N) index, a measure of sewage and animal waste, 35 rivers (30 %) were categorised as polluted, 44 (38 %) slightly polluted and 37 (32 %) clean.

- based on suspended solid index, 65 rivers (56 %) were polluted, 14 (12 %) slightly polluted and the remaining 37 rivers (32 %) were clean. The uncontrolled opening up of land leading to serious soil erosion problem is considered as the main source of this category of pollution.

Enforcement

24. An examination of existing legislations shows that the Environmental Quality Act 1974 is the most comprehensive which relates to the prevention. abatement, control of pollution and enhancement of the environment. Policies relating to waste water treatment and disposal are covered under this Act.

Some of the underlying principals adopted in the formulation of the Environmental Quality Act 1974 are:

- pollution should be controlled at source,
- polluters must pay or bear the costs of their waste or wastewater treatment or disposal,
- discharge standards should be uniform for a particular source, type of industry or activity,
- variable discharge standards ought to be introduced by the Minister of Science and Environment should the uniform standards imposed on every discharge point within a water body be inadequate to maintain the conditions necessary to support the intended use of the water body.

25. Under the Malaysian law, the DOE is given the power to ensure that factories and industries follow strictly to the regulations that have been set. Regular as well as spot checks to these premises are carried out from time to time. Statistics compiled in 1993 showed that about 5733 industries were identified as significant water pollution sources in Malaysia. The five major potentially polluting industries are shown in **Figure 2**.

Prevention

26. Realising the importance of the Environmental Impact Assessment (EIA) as a planning tool for the protection and management of the environment in Malaysia, the Environmental Quality Act, 1974 was amended in 1985. A new provision was made to have the EIA as a mandatory requirement under the law for projects that have been included under the Prescribed Activities of the Act. **Figure 3** shows the number of EIA Reports received by the DOE based upon the category of activity for the period 1988-1993. The highest number is in the field of resort, infrastructure, quarry, industry and housing.

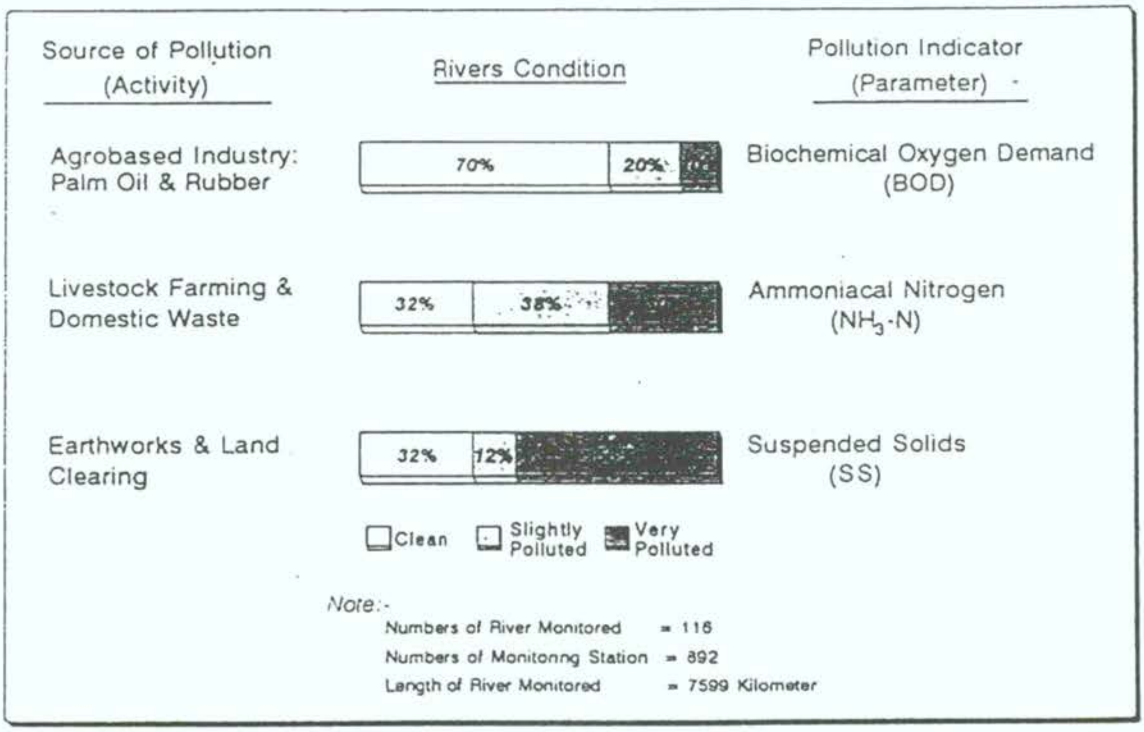
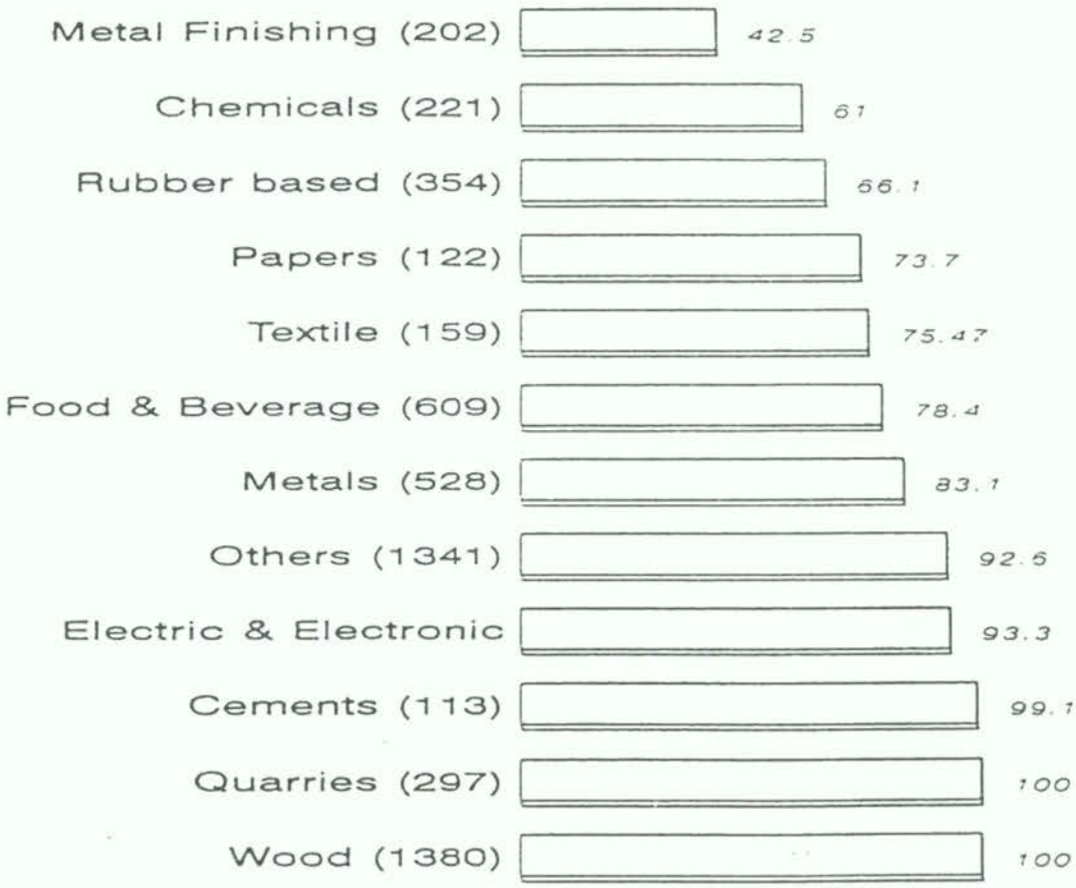


Figure 1: Malaysia: Status of River Water Quality Based On Activity, 1993



Note:
Figure in bracket shows the total number of industries

Figure 2 : Malaysia: Status of Compliance Manufacturing Industries with the Environmental Quality (Sewage and Industrial Effluents - Regulations 1979) for 1993.

Development

27. Programme development can be described in three stages of growth:

- the early period of quantification on pollution problems;
- the current assessment of the effectiveness of various pollution control programmes; and
- future development of a comprehensive health and ecological related monitoring programme.

28. Malaysia has gone through the first two stages in the development of its environmental quality programmes. The third stage of the programme, that is the assessment of the existing state of the environment as it relates more to human health and ecological well being will be addressed according to the objectives of this programme which will include the following activities:

- treatment of sewage,
- classification of rivers,
- biological monitoring,
- human resources development,
- "Love Our Rivers" campaign,
- law review and guidelines.

CONCLUSION

29. Water resources development and management represents an important component of infrastructure development to support and promote the socio-economic growth of Malaysia. The aggravating problems affecting the supply of fresh water resources, rapid increase in water demand and widespread pollution need to be viewed seriously by all parties and appropriate actions taken to address the issues.

30. There is an urgent need to introduce or promote a more rational, systematic and integrated approach in the development and management of this crucial natural resources in order to achieve the much desired sustainable development. Long term strategies and action plans need to be developed through an integrated and consultative approach involving all the relevant agencies at the State and Federal levels as well as the general public with emphasis given to the preservation and conservation of potential water sources and the water environment.

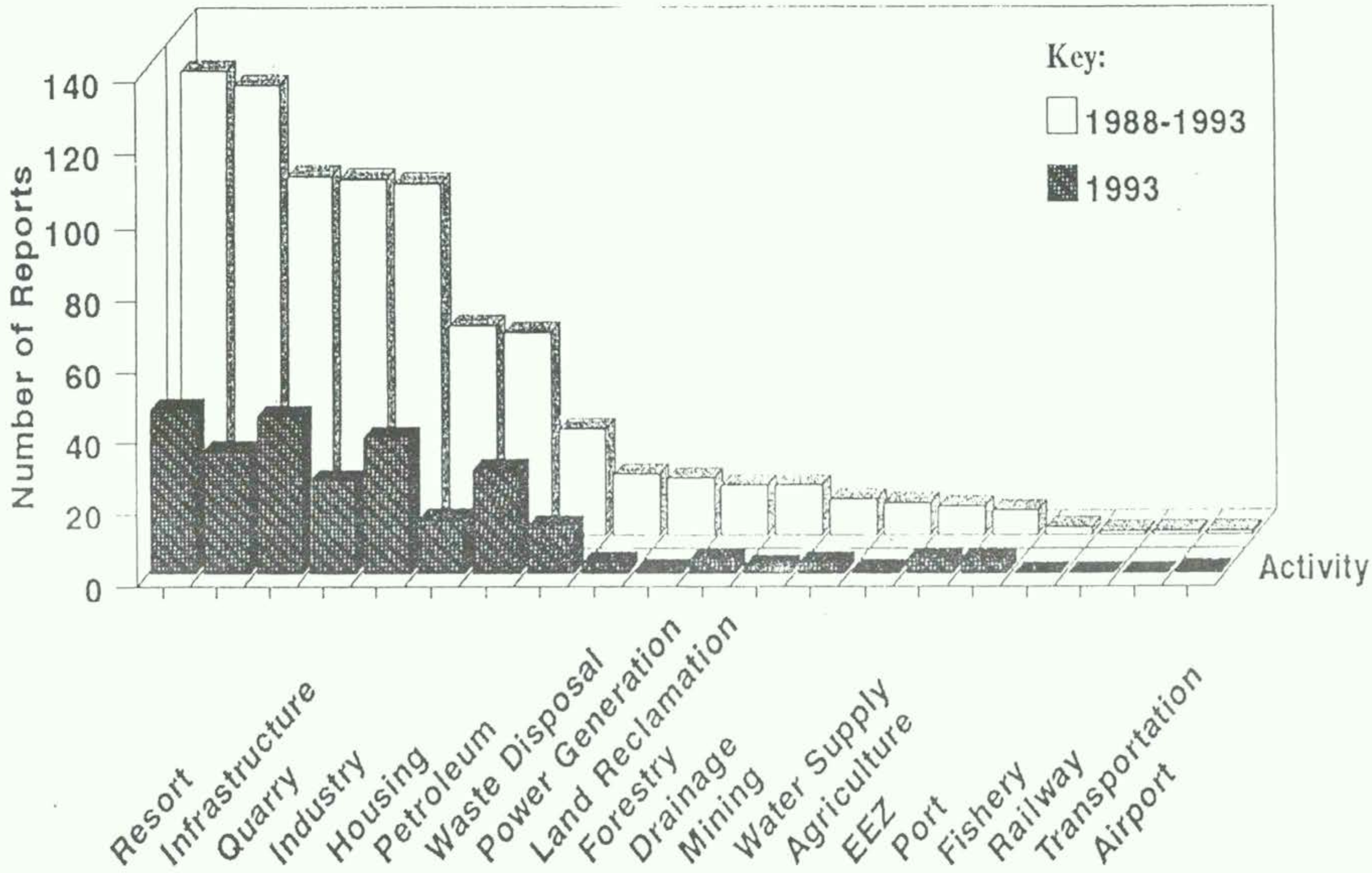


Figure 3: Department of Environment: Number of EIA Reports Received by Category of Activity, 1988-1993

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WATER RESOURCES ASSESSMENT AND INTEGRATED MANAGEMENT IN THE PHILIPPINES

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I. GENERAL

A. Location

The Philippines is located within the zone bounded by Latitudes 4.5 to 21 degrees North and Longitudes 117 to 127 degrees East South East of the Asia mainland. It is an archipelago consisting of more than 7000 islands and islets with an aggregate land area of about 300,000 square kilometres.

B. Climate

The climate is tropical and characterised by four types of climate. An average of 19 typhoons visits the country every year, causing flooding and damage to infrastructure. The temperature ranges from 18 - 28 degrees centigrade.

C. Rainfall

The average annual rainfall is 2 360mm and varies among the regions depending on the prevailing climate and geographic location. The range varies from less than 1000mm in southern Philippines to more than 4000mm in the eastern portion. Generally, the east and west coast of the country experience greater rainfall intensities. The North East monsoon brings rain to Manila and the western coast as well as in the northern part of the archipelago.

D. Regionalization

To carry out water resources assessment studies for comprehensive planning purposes, the country is divided into twelve (12) water resources regions each of which can be considered as water management areas. This regionalization is based on the hydrological boundaries as defined by physiographic features, homogeneity of climate, close correspondence to existing boundaries of the political regions (Figure 1).

E. Previous Assessment Studies

The first national assessment conducted in 1976 was an initial attempt to assess the water supply and demand situation, notwithstanding the limited data with 1975 as the base year and projected to 2000. This is to provide government planners and other users an outlook of the current and projected regional and national water and related land resources development. The assessment approach was essentially on a quantitative dimension by comparing available statistics on water supply with that of the 1975 and projected water demand in the year 2000. Annual surface runoffs available at 50, 75 and 90 percent of the time were estimated for each region with the 90 percent flow used as indicator of low flow. Economic projections of the growth of major water using sectors and their corresponding water demands were likewise estimated for each of the 12 water resources regions. These projected levels of demand compared with the available supply indicated which regions are likely to have long-run water problems in the future.

II. CURRENT WATER RESOURCES ASSESSMENT

Due to the present national concern on water because of its strategic importance in the attainment of the country's development objectives, the National Water Resources Board, realising the urgency of providing the government updated information on water resources, initiated an update of the 1976 assessment of the water supply - demand situation with 1990 as the base year and projected to year 2000. Updates were limited to certain items with available data and information. There is still a limited data base on surface and groundwater because of unfilled data gaps. The major sources of water for development are still surface and groundwater.

A. Water availability

1. Surface water

The amount of surface water flows in a basin depends on the volume of the annual runoff which also vary from basin to basin. Out of the average annual rainfall of 2360 mm, approximately 1000 to 2000 mm find their way as runoff in 421 principal river basins, 59 natural lakes and into the groundwater reservoir with estimated aggregate area of 50,000 square kilometres (Figure 2).

In this assessment, the quantities of annual runoff available 50 and 80 percent of the time were computed for each of the major basins and sub-basins in the region, the latter being considered as the dependable flow. Estimates were based on the daily flow duration studies of rivers with available records. Flows in rivers without complete records were derived by correlation techniques with the nearest basin with record and similar hydrological features.

Table 1 shows the natural runoff expressed in million cubic meters (MCM) in the twelve (12) water resources regions at 50 and 80 percent dependability.

2. Surface water quality

The deterioration of the water quality in some of the rivers had been noted by the Department of Environment and Natural Resources (DENR) due to domestic, agricultural and industrial pollution. This agency periodically monitors the quality of water in these rivers and classifies them according to the best use of such quality of water. As early as 1986, it has already tagged some 37 rivers as polluted in varying degrees. Some 158 rivers and 6 bays nation-wide have already been classified as of end of 1992.

3. Groundwater

The availability of groundwater varies among the regions according to a number of factors such as geology of the basin, precipitation and permeability of the aquifer. A rough estimate of possible groundwater storage and safe yield by regions based on the results of nation-wide geo-resistivity survey conducted by the National Water Resources Board in 1980 are indicated in Table 2. On a nation-wide basis, the estimated storage is about 251,000 MCM while the aggregate safe yield is about 142MCM/day.

Groundwater recharge is estimated as 10% of the annual rainfall.

4. Groundwater quality

The quality of groundwater depends on the location and degree of exploitation in the locality. Most of the deepwells located near coastal areas experience saline intrusion due to overexploitation of the groundwater resources. Areas where saline intrusion has already been noted are the Metro Manila Area, Cebu City and the coastal areas of Bulacan and other provinces.

B. Water uses

Water use may be consumptive or non-consumptive. When water is withdrawn from the source as rivers and not returned to the stream for further use as in domestic water supply, irrigation and similar uses, the use is considered consumptive. On the other hand, if the water is withdrawn and returned later for downstream use as in hydropower generation, the use is considered non-consumptive. In-stream uses such as navigation, recreation and fisheries are considered non-consumptive.

1. Agriculture

Philippines agriculture, being one of the largest single contributor to the economy, remains one of the biggest users of water. Water withdrawal for agriculture consists of the requirements of irrigated rice and other crops including livestock. As of 1990, the estimated withdrawal for agriculture is in the order of 249 MCM per day. A great portion of this is for irrigated rice crops involving about 1.528M hectares. The estimate of rice crop irrigation diversion requirements ranges from 1 to 2 litres per second per hectare depending on the soil condition.

2. Domestic and municipal water supply

The major factors affecting domestic and municipal water requirements are growth in population and the per capita consumption which also depends on the standard of living, social customs and habits, accessibility of supply and water availability.

Current domestic and municipal water demand in Metro Manila is estimated at 175 litres per capita per day (LPCD). In the provinces, the requirements are estimated at 120 - 130 LPCD. In appropriating water for domestic and municipal use, the NWRB uses 250 LPCD as the average per capita requirement nation-wide. Based on this assumption, the estimated total domestic and municipal requirement for 1990 is 15.17 MCM per day.

3. Industrial water use

The use of water for industries ranges from manufacturing to mining and cooling of boilers and is very much less than agriculture. Water use per industry is based on the type, size and number of industrial plants, production and water requirement per unit of production. No studies or surveys however have been made due to funding and time constraints. The estimated requirement for 1990 for manufacturing and mining therefore were based on an update of the 1976 data resulting to about 133 MCM.

4. Non-consumptive use

Hydropower generation is the main non-consumptive user of surface water. With several big and small hydropower plants nation-wide with aggregate capacity of 2214MW, most them located in Luzon island, the estimated usage of water for generating power is around 110MCM/day.

C. Projected water demand

1. Agriculture

With the irrigation goal to extend the coverage of the irrigated land to 1.97 million hectares to sustain cereal need of the growing population by year 2000, the total withdrawal for agriculture would reach around 402MCM/day.

2. Domestic and municipal use

The goal is to provide potable water supply to 90 percent of the population by 2000. With an estimated population of around 72M by year 2000, the estimated requirement would amount to 23MCM per day.

3. Industrial use

The industrial sector as it increases in number and corresponding output to meet the demand of a growing market will require more water to support the growth of production. The estimate withdrawal for the industries by year 2000 is estimated at 194MCM/day.

4. Non-consumptive use

Hydropower will remain the biggest non-consumptive user with some 2214MW existing hydropower plants and additional hydropower plants lined up for implementation beyond 1997. However, due to the long gestation period for these types of projects, the estimated requirements of these plant will amount to about 111.5MCM/day.

D. Comparison of water availability and water use

1. National outlook

On a national basis, the Philippines has adequate water resources to meet projected demands up to beyond the year 2000. Surface runoff alone amounting to some 833MCM/day, with availability of 80 percent of the time is more than sufficient to meet the expected withdrawal of about 507MCM/day by the year 2000 (Figure 3). The present withdrawal is about 287 MCM/day and is utilised by three major water using sectors. Agriculture is the heaviest water user which indicates that the country's economic growth from the water resources sector will depend greatly on agricultural development. The ratio of dependable water supply to water demand in year 2000 is projected at 1.6. If groundwater is included, the supply - demand ratio is 1.9 (figure 4).

2. Regional Outlook

On a regional basis, the outlook is less optimistic. Comparison of surface water available 50 and 80 percent of the time with the current and projected withdrawal (Table 3) shows that 3 regions namely, Central Luzon, Western Visayas and Central Visayas Regions will probably have long - run water problems in the future in so far as supply adequacy is concerned. Figure 4 shows graphically the water supply - demand situation by region under the dependable water supply situation. All these indicate the possibility of water supply deficiencies in the future unless effective water management measures are formulated and implemented soonest.

III. INTEGRATED WATER RESOURCES MANAGEMENT

A. Institutional and legal framework

In the Philippines, there are about 32 agencies dealing one way or the other with each of the sectors of water resources such as water supply, irrigation, hydropower, flood control, navigation, fishery, pollution, etc. However, the overall responsibility for its management lies with the government in as much as all waters belong to the State.

For purposes of administrative supervision, these water resources agencies are placed under 12 departments of the national government (Figure 5). The water resources activities of these agencies are coordinated by the National Water Resources Board, a central coordinating and regulatory agency created in 1974 by virtue of a Presidential Decree No.424. This agency is mandated to implement the provisions of the Philippines Water Code, the primary legislative tool for water resources management in the country. The Code was promulgated in 1976 through Presidential Decree No.1067. The water code and its implementing rules and regulations contain the basic water policies that govern the ownership, appropriation, utilisation, exploitation, development, conservation and protection of water resources.

B. Projects integration and co-ordination

Basin as well regional framework plans were prepared for the entire country in the 1980s as an indispensable tool for co-ordination. Of the 53 framework plans prepared, 12 were regional and 41 were basin framework studies. The reports provide a framework for planning development in each planning area covering the physical setting, water and land resources, socio - economic situation, population and environment considerations. It also provide sectoral recommendations regarding water supply and sewerage, irrigation, flood control and drainage, land use management, power, etc.

C. Water resources development programs

1. Water supply

The government provides three levels of water service depending on what is economically feasible for a given area. As a matter of policy, each of these levels of service have corresponding agencies implementing them. These levels of service are Level I (point sources designed to serve an average of 50 households) Level II (communal faucets designed to serve an average of 100 households) and Level III (a water works system with individual household connections). As of December 1993, about 42M or 68% of the total population of the country of 62M have access to public potable water supply systems. Consistent with the Medium-Term Development Plan, it is targeted that by year 2000, about 90 percent of the total population of 72M shall be served by potable water supply.

2. Irrigation

Irrigated land area in the country cover an aggregate area of about 1.528M hectares which is approximately 49 percent of the total potential area to be irrigated of 3.126M hectares. Of this, about 47 percent are covered by national irrigation systems, 38 percent by communal systems and the rest by private systems. The irrigation goal is to extend the coverage of the irrigated land to 1.97M hectares to sustain the cereal need of the growing population by the year 2000.

3. Hydropower

A total of 14,367MW of hydropower potential have been identified in 293 sites nation-wide. This includes some 2,214MW of existing hydropower plants at the start of 1993 in Luzon, 8874MW out of 10,100MW of hydropower potential remain to be developed in the future, while in the Visayas, there are around 638MW of untapped hydropower resources. Mindanao still has 2,641MW identified and not yet harnessed. The current program contemplates the addition of 1872MW hydro power projects for 1994 and the rest are programmed beyond 1997.

4. Sanitation and sewerage

As of 1992, about 46MW or 74 percent have access to sanitary toilet facilities. Service coverage was only about 82 percent of households in urban areas and 64 percent of households in rural areas. The program for sanitation aims to reduce morbidity due to water-borne and sanitation-related diseases. To achieve these reductions, the program envisions the attainment of sanitation secondary targets which contribute in the reduction and control of communicable diseases.

5. Flood control

The different measures for protection against floods may be classified into two, structural and non-structural. Structural measures include dikes, river walls, diversion channels, river training works, control structures, etc. In the country, structural measures are more commonly employed. There are about 5147 existing flood control, drainage and shore protection facilities as of December 31, 1991, 265 of which are dikes involving 1,007,752 meters. Between 1990 and 1993, there were 3711 projects completed and 226 on-going.

Complementing the above are extensive implementation of small water impounding management projects in the upper reaches of rivers to arrest destructive floods as well as to utilise the reservoirs for various uses. There are 47 existing small water impounding projects and 123 mini-dams as of December 1991. Between 1990 and 1993, about 27 of such projects are on-going.

6. Water pollution

The main sources of water pollution in rivers are attributed to agricultural activities, industrial operations and domestic wastes. Of the more than 400 principal rivers nation-wide, some 37 rivers at certain portions of their lengths have been tagged as polluted in varying degrees. In Metro Manila, all waterways are polluted by 215 firms of which only 137 have water pollution control device.

Of the designated 74 water quality monitoring stations in various parts of the country, 63 percent showed that water quality has already deteriorated beyond beneficial use at that station, 47 percent of river stations and 60 percent of coastal stations showed water quality lower than the worst classification.

D. Water use regulation

To rationalise the utilisation, development, conservation and protection of the nation's water resources, regulation of water use is pursued within the context of the Water Code of the Philippines. This is essentially effected through administrative concession or the "permit system" whereby all water appropriators of surface or groundwater for all purposes except single family domestic use must apply for a water right. Such right is evidenced by a document known as the "Water permit". Table shows the status of the granting of water rights by regions and by source as of June 1994.

To protect existing water resources from the adverse effects of projects on the quality of water, it is now required for a water right applicant to get n Environmental Compliance Certificate (ECU) prior to granting of a water right.

E. Water crisis management committee

The occurrence of droughts in 1982 - 83 and 1986 - 87 caused recurrent water shortage adversely affecting domestic water supply in Metro Manila and agricultural output nation-wide. This made it imperative for the government through the Secretary of Public Works and Highways to create an Inter-agency Committee on water crisis management to monitor, co-ordinate and evaluate the quantity, allocation and releases of water from the major multipurpose reservoirs for the various stakeholders in order to mitigate the effects of possible droughts. In anticipation of the recurrence of drought, the Committee adopted an action program consisting of several contingency / short term measures as well as long-term measures for implementation by the various agencies. The Chairman of this committee is the head of the Metropolitan Waterworks and Sewerage Authority with members coming from the various water related implementing agencies. Since its creation, the Committee has been meeting regularly having in its agenda the weather situation and outlook, the status of multipurpose reservoirs and status of irrigation and domestic water supply served by the major multipurpose reservoirs.

IV. ISSUES AND CONCERNS

The following are some of the major issues and concerns in water resources:

1. Insufficient co-ordination of different institutions doing water-related activities due to lack of manpower.
2. Lack of comprehensive basic planning due to lack of planning data.
3. Lack of updated assessment and information due to lack of integrated database on water resources.
4. Degradation of water resources as a result of human activities (watershed exploitation, pollution, overexploitation of groundwater, etc.)
5. Lack of awareness on the policies on water resources management.

It could be noted that the major area of concern in the water resources sector is not so much on the scarcity of water but more on instituting better co-ordination among the implementors, more rational and better management practices of the resource. On the other hand, efficient management of the resource is not possible without an accurate assessment needed to plan comprehensively the sustainable development of the resource. A realistic plan can only be formulated if deficiencies in the data system, technical inadequacies, funding limitations and institutional weaknesses are adequately addressed.

In the final analysis, an efficient data system, accurate water resources assessment, formulation of a comprehensive water management plan, stronger co-ordination among implementors and better management practices could probably solve most of our water problems.

Fortunately, the government is responding positively to these various issues and concern on water resources which are going to be addressed during the Water Summit to be held in December this year to formulate a national policy framework on water resources management.

TABLE 1.
AVAILABLE WATER (SURFACE RUNOFF)

Region	Water resources region	Annual flow available (MCM) Percent of time	
		50%	80%
I	Ilocos	27,000	15,400
II	Cagayan Vallay	65,500	47,400
III	Central Luzon	32,500	19,000
IV	Southern Tagalog	91,500	50,600
V	Bicol	29,100	16,900
VI	Western Visayas	17,000	11,900
VII	Central Visayas	16,600	10,400
VIII	Eastern Visayas	59,000	36,800
IX	Southwestern Mindanao	27,000	19,200
X	Northern Mindanao	37,900	26,900
XI	Southeastern Mindanao	39,000	23,100
XII	Southern Mindanao	37,200	26,200
Total		479,300	303,800

TABLE 2
GROUNDWATER RESOURCES

Region	Water resources region	Estimated storage (MCM)	Safe yield (MCM/day)
I	Ilocos	1,366	7.26
II	Cagayan Vallay	11,850	27.67
III	Central Luzon	54,700	16.16
IV	Southern Tagalog	37,000	15.20
V	Bicol	4,500	9.27
VI	Western Visayas	55,242	11.26
VII	Central Visayas	1,700	3.04
VIII	Eastern Visayas	8,400	12.57
IX	Southwestern Mindanao	14,700	4.94
X	Northern Mindanao	15,950	15.73
XI	Southeastern Mindanao	9,750	9.80
XII	Southern Mindanao	36,000	8.90
Total		251,158	141.80

Note: Only the identified water bearing aquifers with estimates are included

TABLE 3
COMPARISON OF AVAILABLE WATER AND DEMAND
(IN MILLION CUBIC METERS PER DAY)

NO.	WATER RESOURCES REGION	SURFACE RUNOFF		GW S.YIELD	TOTAL AVAILABLE		TOTAL DEMAND		SUPPLY/DEMAND RATIOS Based on Mean		Based on Dependable	
		50 %	80 %		50%	80%	1990	2000	1990	2000	1990	2000
I	ILOCOS	74.00	42.00	7.26	81.26	49.26	13.36	23.92	6.08	3.40	3.69	2.06
II	CAGAYAN VALLEY	179.00	130.00	27.67	206.67	157.67	23.55	47.05	8.73	4.39	6.70	3.35
III	CENTRAL LUZON	89.00	52.00	16.16	105.16	68.16	40.47	72.68	2.60	1.45	1.68	0.94
IV	SOUTHERN TAGALOG	251.00	139.00	15.20	266.20	154.20	43.27	83.02	6.15	3.21	3.56	1.86
V	BICOL	80.00	46.00	9.27	89.27	55.27	24.39	36.22	3.66	2.46	2.27	1.53
VI	WESTERN VISAYAS	47.00	33.00	11.26	58.26	44.26	23.34	32.73	2.44	1.78	1.86	1.35
VII	CENTRAL VISAYAS	45.00	28.00	3.04	48.04	31.04	10.45	21.37	4.60	2.25	2.97	1.45
VIII	EASTERN VISAYAS	162.00	101.00	12.67	174.67	113.67	17.30	24.89	10.10	7.02	6.57	4.57
IX	SOUTHWESTERN MINDANAO	74.00	53.00	4.94	78.94	57.94	16.61	21.90	4.75	3.60	3.49	2.65
X	NORTHERN MINDANAO	104.00	74.00	15.73	119.73	89.73	21.92	41.32	5.46	2.90	4.09	2.17
XI	SOUTHEASTERN PANGASINAN	107.00	63.00	9.30	116.30	72.80	27.78	48.20	4.20	2.42	2.62	1.51
XII	SOUTHERN MINDANAO	102.00	72.00	8.90	110.90	80.90	24.10	54.37	4.60	2.04	3.36	1.49
	TOTAL	1314.00	833.00	141.90	1455.90	974.90	287.04	507.67	5.07	2.87	3.40	1.92

PHILIPPINES
WATER RESOURCES REGIONS

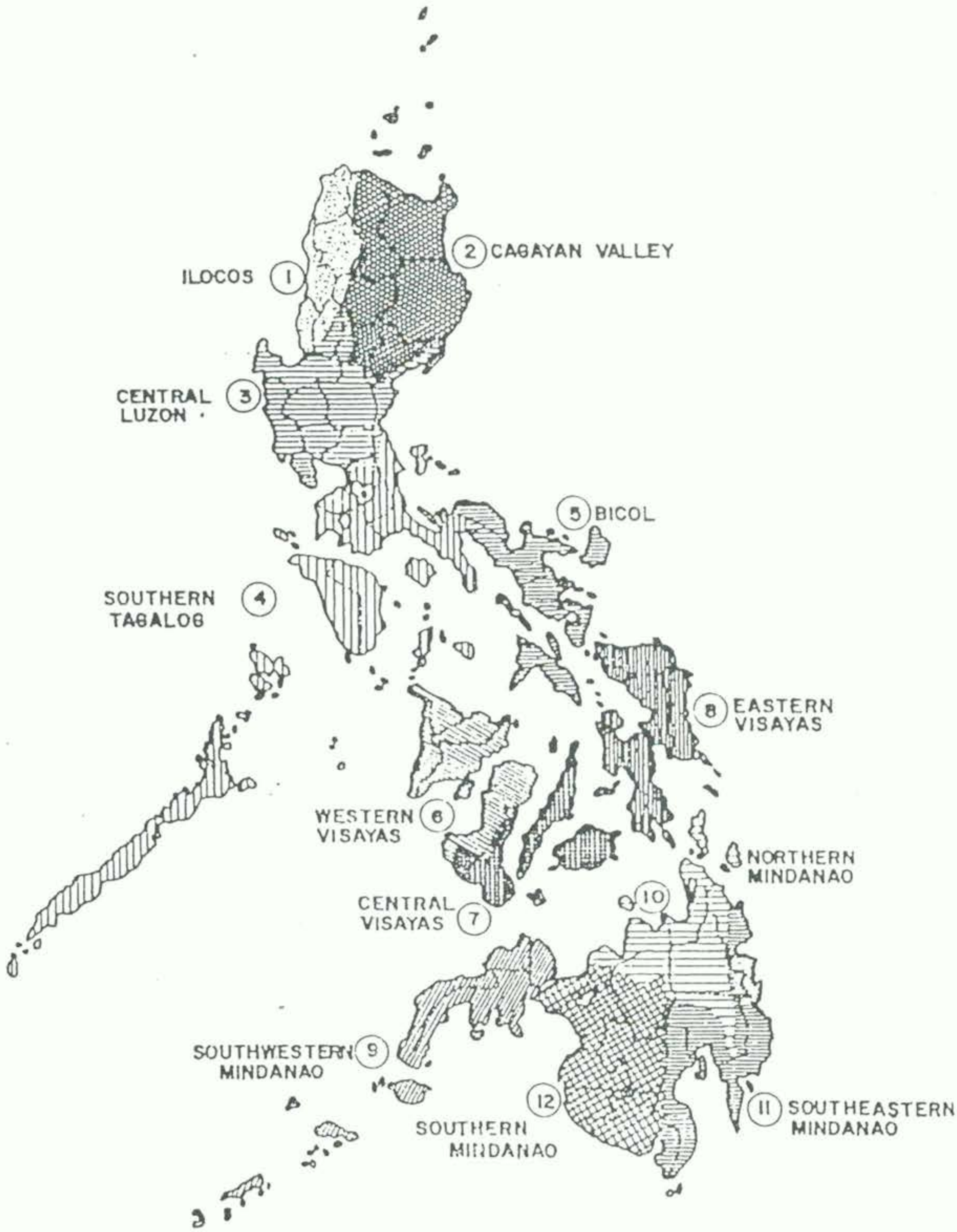
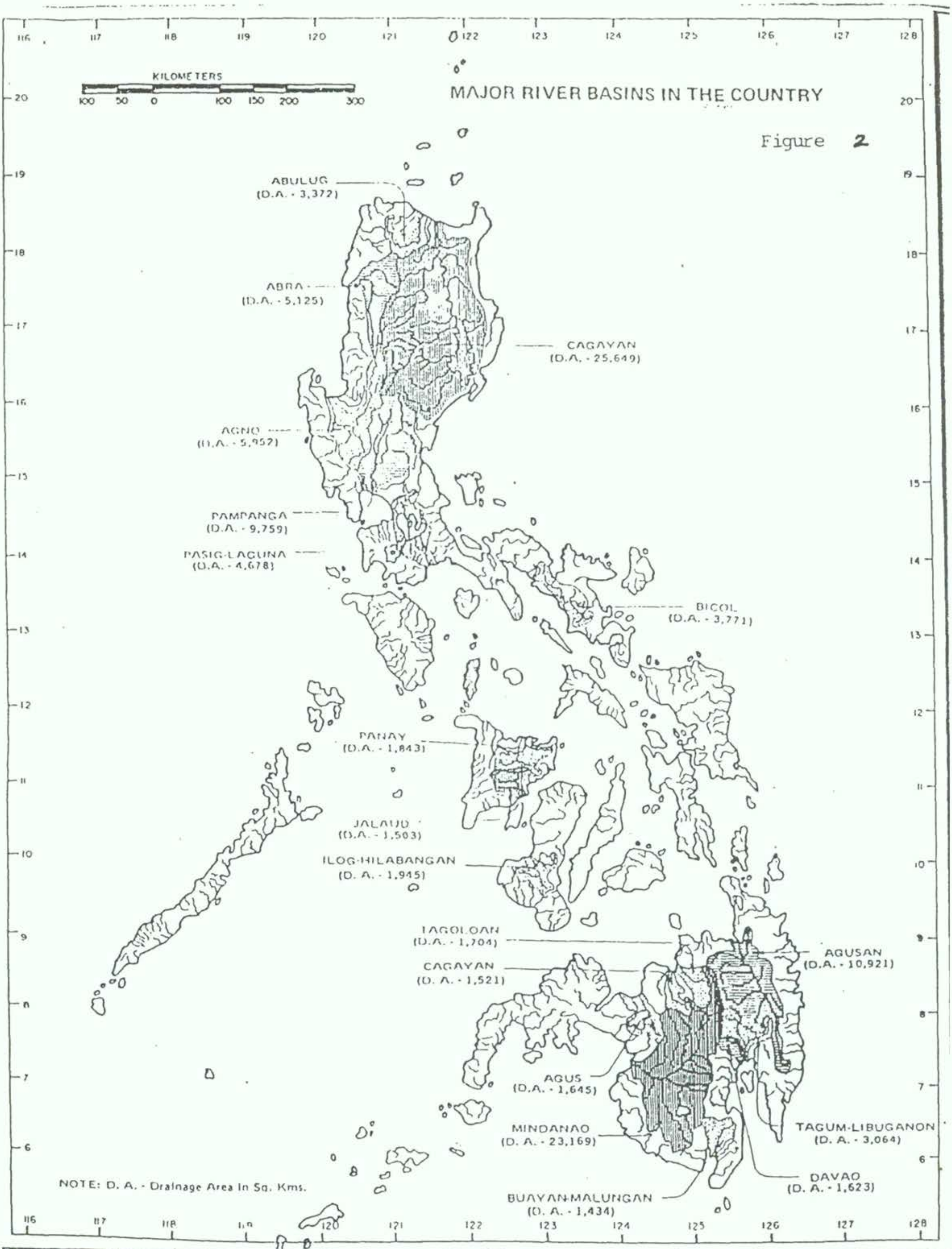


FIGURE 1


KILOMETERS
100 50 0 100 150 200 300
MAJOR RIVER BASINS IN THE COUNTRY
Figure 2
ABULUG
(D.A. - 3,372)
ABRA
(D.A. - 5,125)
CAGAYAN
(D.A. - 25,649)
AGNO
(D.A. - 5,952)
PAMPANGA
(D.A. - 9,759)
PASIG-LAGUNA
(D.A. - 4,678)
BICOL
(D.A. - 3,771)
PANAY
(D.A. - 1,843)
JALAUD
(D.A. - 1,503)
ILOG-HILABANGAN
(D. A. - 1,945)
TAGOLOAN
(D.A. - 1,704)
CAGAYAN
(D. A. - 1,521)
AGUSAN
(D.A. - 10,921)
AGUS
(D.A. - 1,645)
MINDANAO
(D. A. - 23,169)
TAGUM-LIBUGANON
(D. A. - 3,064)
DAVAO
(D. A. - 1,623)
BUAYAN-MALUNGAN
(D. A. - 1,434)
NOTE: D. A. - Drainage Area in Sq. Kms.

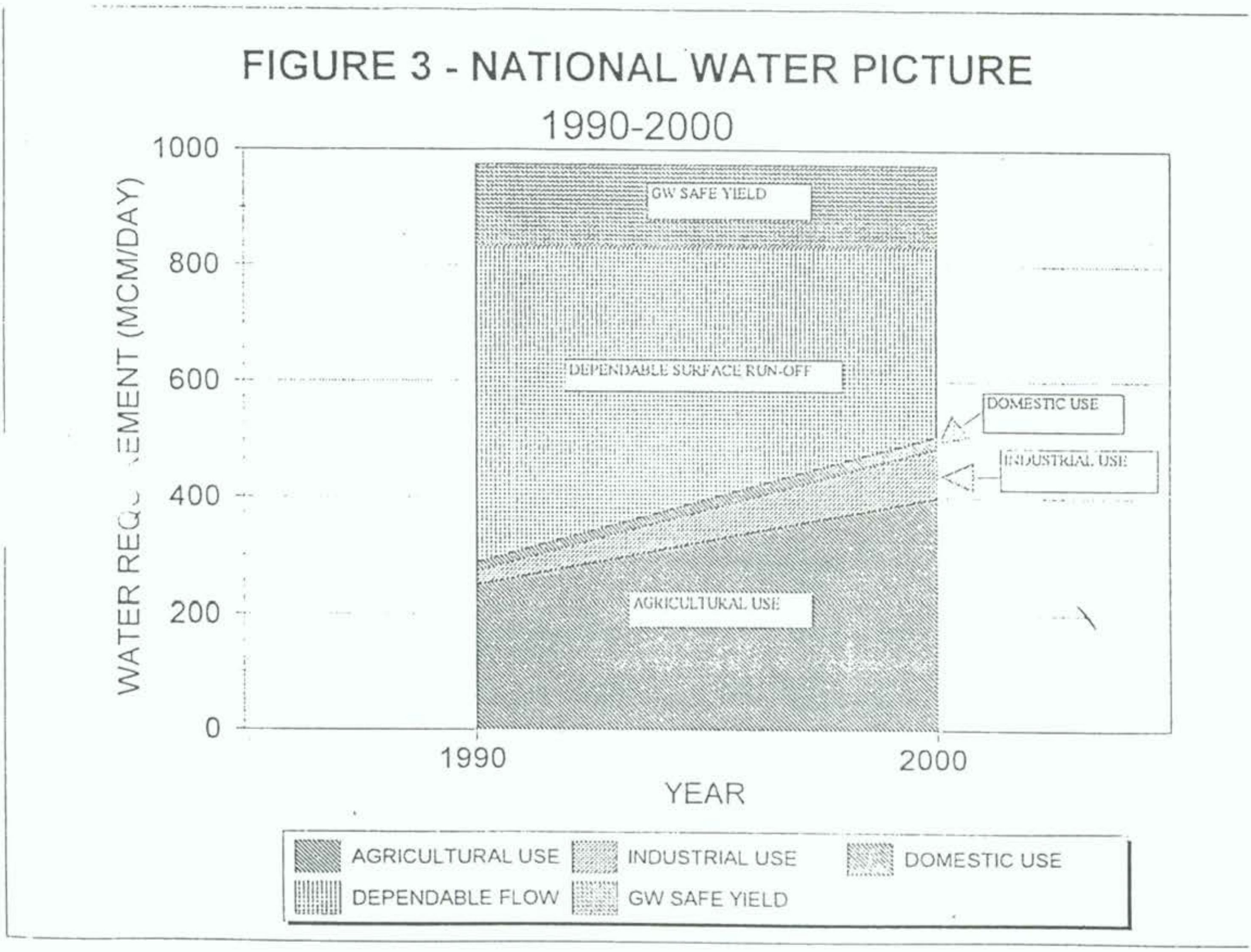
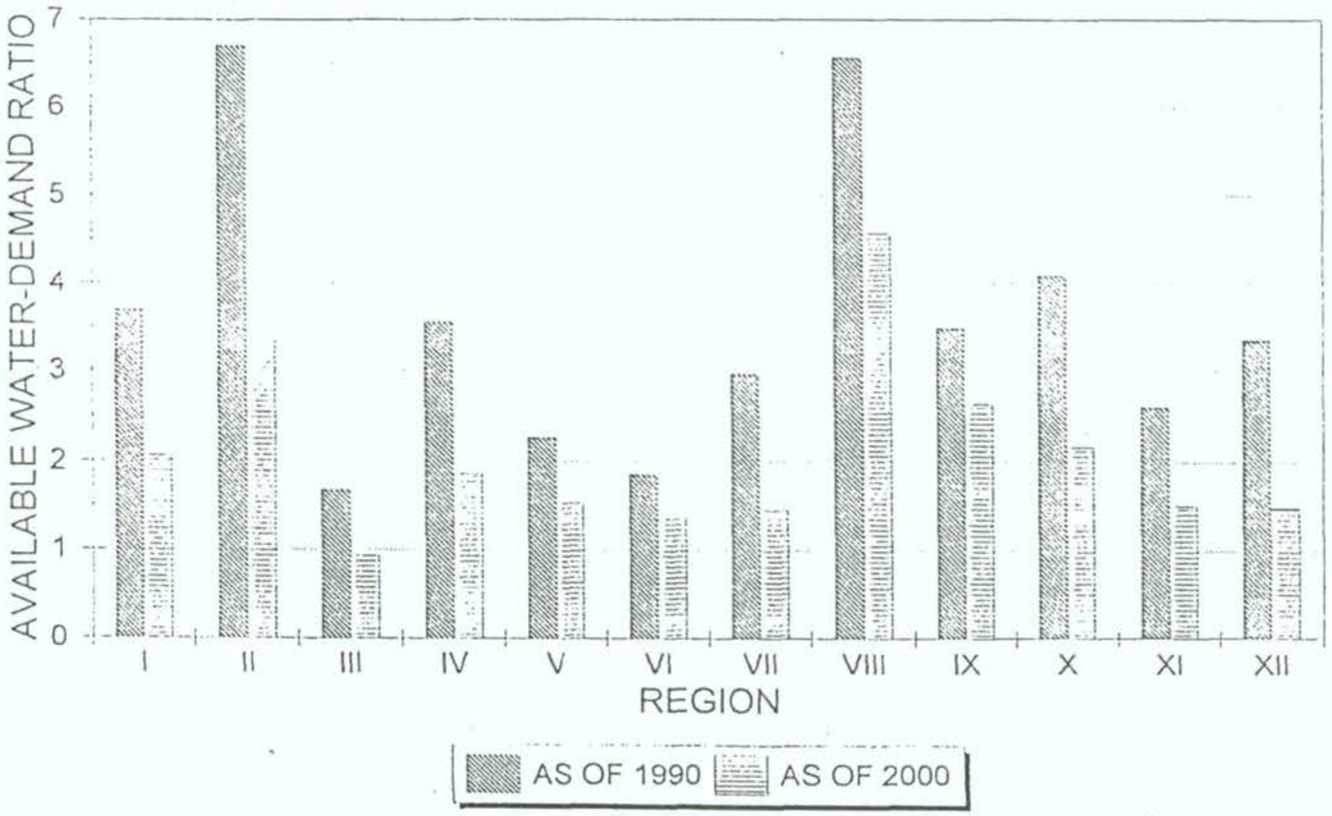
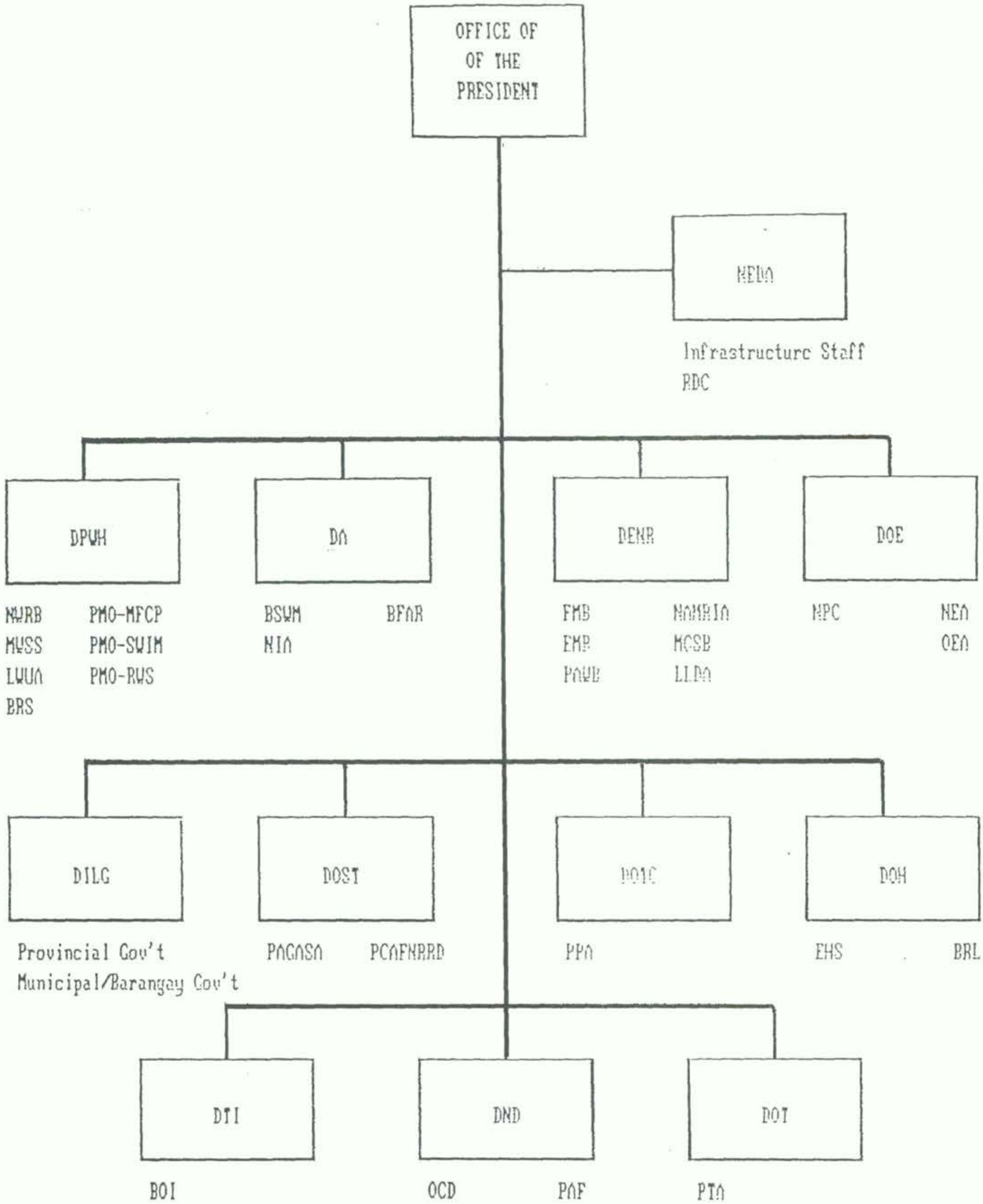


FIGURE 3 - NATIONAL WATER PICTURE
1990-2000
1000
800
600
400
200
0
WATER REQ EMENT (MCM/DAY)
GW SAFE YIELD
DEPENDABLE SURFACE RUN-OFF
DOMESTIC USE
INDUSTRIAL USE
AGRICULTURAL USE
1990
2000
YEAR
AGRICULTURAL USE
INDUSTRIAL USE
DOMESTIC USE
DEPENDABLE FLOW
GW SAFE YIELD

FIGURE 4

SUPPLY-DEMAND RATIO DEPENDABLE





WATER RESOURCES MANAGEMENT EXECUTING

AND COOPERATING AGENCIES

FIG. 5

WATER RESOURCES ASSESSMENT AND INTEGRATED MANAGEMENT- WATER SUPPLY AND POLLUTION CONTROL IN THAILAND

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Hydrology programmes have long been established in Thailand. The Thai National Committee on IHP has participated in the UNESCO hydrological programmes since the beginning of the IHD until the present IHP.

Surface water is known as the most important source of water for various uses of human beings. The potential of surface water throughout the country is approximately 180,000 million cubic meters annually. At present, water crisis are widely found. Agriculture yield gradually declines due to the degradation of soil by the processes of soil erosion and sediment transportation. The measures for conservation of resources are essential both in the upper watershed and also in the lower watershed

Water resources development has been established in the social and economic development plan from the first national development plan to the seventh plan. The policy supports the increase of efficient use of water resources, assessing the basic needs of people and of the establishment of a standard information system of water resources. However, the resources development frequently impacts on environmental quality. The living standard of people will indicate the stability of security as well. Therefore, the government has tried its best to develop and conserve water resources in order to improve the quality of life as the basic need for people and reduce the constraints of the nation.

1. INTRODUCTION

Water is one of the most important resources in Thailand. Over the past 10- 15 years the growth of the agricultural sector in Thailand has increased in area of crops planted without any consistent increase in yield. Land use patterns and crop types have also been diversified. Cultivated area is mainly utilised under rainfed conditions for annual crops without a systematic pattern and regularity depending on the physical and socio- economic conditions of each location. The deterioration of environment, especially natural forest in each region has changed hydrological characteristics in quantity and quality of river discharge.

At present, water crisis are widely found. Agriculture yield gradually decline according to the degradation of soil properties by the processes of soil erosion and sediment transportation. The measures for prevention and conservation of natural resources are essential both in the upper watershed and also to manage the sediment problems in the lower watershed.

2. PHYSICAL CONDITIONS

2.1. Physiographic regions

Thailand is situated in the tropical zone between 5°40'- 20°3'N. and 97°70'- 105°40'E. longitude. On the physiographic point of view, the six physiographic regions have been divided. It is found that the hydrological characteristics of Thailand vary from region to region and those can be described into 6 regions:

1) The north and west continental highland
2) The Northeast plateau
3) The central plain
4) The central highland
5) The Southeast coast
6) Southern peninsula

2.2. Climate

Climate in Thailand is classified into 2 types according to the Department of Meteorology which are tropical monsoon climate in the south, and small part in the east, rain forest climate in the lower south and savannah climate in most part of the country.

The climate in Thailand is mainly determined by the monsoon regime. In general, the main wet season with almost 80% of the total rainfall occurs in the period from May to September, corresponding with the Southwest monsoon, August or September being the wettest months. The Northeast monsoon from November to February brings fresh, cool air to the northern parts. In the north and the Northeast, rainfall is practically nil during December. Rainfall in the January-March period rarely exceeds 50mm per month. The mean annual rainfall ranges from 1,000 to 1,500mm over much of the country, and only in the south and Southeast it exceeds 2,000mm.

3. NATIONAL POLICY

Water resources development has been validated in the social and economic development plan since the beginning of the nation development plan. Government policies were set and validated in the 7th National Economic and Social Development Plan.

The plan comprises 2 main parts;

(1) Water resources

1) Formulate the water resource development plan on the basis of watershed system.

2) The medium size scale of water resource development has to be determined in correspondence with hydrology, geography and environmental impact.

3) The small scale of water resource development must be distributed throughout the areas of less rainfall and outside the irrigation area.

4) The project of water resource development which has already been constructed must be participated by the NGO on the administration and technical point of view.

5) Strengthening the establishment of a national organisation on water resources administration and management under the act, in which emphasis must be put on the watershed system.

6) Seeking the raw water for the water supply system as well as set up a standardise of water quality.

7) Supporting the study on potential of groundwater and formulating the master plan of groundwater development.

8) Support the management of water resources information system for an establishment of water policy.

9) Improvement of water cost from irrigation both for agricultural sector and outside an agricultural sector.

(2) Water pollution

In order to control the water quality to the proper standards, the BOD of water should not exceed 4mg/litre in the following areas:-

1) Lower Chao Phraya from the river mouth to the km.no.100 in Bangkok and the nearby area,

2) Lower Ta Chin river from the river mouth to km.150 in Nakorn Pratom and Smutsakorn provinces,

3) The tourist area of Pattaya, Chonburi and Phuket,

4) Canals, ponds and natural lakes in the big cities with water pollution problems such as Sakolnakorn, Khon Kaen, Hadyai- Songkhla and Chiangmai provinces.

4. POTENTIALS AND PROBLEMS

4.1. Potentials

The 3 main sources of water can be described as follows;

(1) Rainfall

Most of the rainfall during a year is from the Southwest and Northeast monsoon. The others are from the depression and typhoon from the gulf of Thailand and the South China sea. Distribution of rainfall from region to region is varied according to the topographical condition and distance from the sea or ocean. The average annual amount of rainfall is shown in table 1.

Table 1. Rainfall in the regions

Region	Annual amount of rainfall (mm)
North and Central	1,250
Northeast	1,350
East	2,300
West	1,380
South	2,500

(2) Surface water

Surface water is the most important item in the water balance. The runoff process will occur after the saturation and infiltration process. Surface water is varied accordingly with rainfall and catchment area. The other factors comprise of vegetative cover, soil permeability, infiltration rate and topographical condition. Potential of surface water from watersheds throughout the country is approximately 180,000 million cubic meters annually as shown in table 2.

(3) Groundwater

The largest sources of groundwater in Thailand are found in the lower basin of the central plain especially in Bangkok and surrounding provinces. Beside from the Chao- Phya basin, potential of groundwater are also found at the Ping basin in Chiangmai, Lamphoon, Wang basin in Lampang. Other sources are found at the Mekong river bank in Nongkhai and Nakonpanom. In the southern part, potential of groundwater will be found along the gulf of Thailand.

Table 2 Runoff from the region

Region	Watershed	Annual runoff (MCM)
North	Salwin	6,000
	Mekhong	10,000
Northeast	Mune	27,000
	Others	15,000
Central	Chao Phya	18,000
East	Bang Pakong	12,500
	Others	11,500
West		17,000
South	West coast	19,000
	East coast	44,000
Total yield is about		**180,000**

4.2 Problems of water resource

The problems of water resource can be identified as follows;

(1) Insufficiency

Problems of water shortage or insufficiency are gradually realised even in the rainy season, especially, in the north-eastern and northern regions. Problems are also known as the long deficit period during rainy season especially in the Northeast. In coastal areas of the eastern region, insufficiency of water is widely found not only on human use and agriculture but also in promotion of industry for the Eastern Sea Board projects.

(2) Fluctuation of water regime

This problem has been rapidly occurred in accordance with the change of environment in the upper watershed. This impact have caused not only in the upper watershed but also in the lower basin. This is due to the change of natural vegetation from deforestation. In the past, surface water was quite normal in term of hydrograph or water regime either in the rainy season or dry season. But at present, the rapid rate of flow during the rainy month is quite high with quite low base- flow after the rainy season. During this decade, an evidence of water shortage in the dry season is quite significant which have caused many serious problems throughout the regions.

(3) Water quality

Quality of surface water is gradually declined in comparing with the other sources of water. Problems of sediment and chemicals transportation are seriously found in the north and Northeast with the high concentration of toxicity. Most of the watersheds have the tendency of increasing the problems of water quality and the other forms of water pollution.

4.3. Classification of development project

(1) Large scale project

This type of project can be considered on the big river system with more than 100,000 rai (16,000 ha) of benefit area. The construction need longer period than 5 years within the range of budget from 500 to 1,000 million baht.

(2) Medium scale project

This type of project can be considered from the benefit area of more than 1,000 rai (160ha). The period for construction is about 2- 5 years for the budget ranging from 50 to 100 million baht.

(3) Small scale project

This project level is constructed for consumption and reducing the flood. The benefit area would be 300 rai (150 ha.). Construction can be done within 1 to 2 years for the budget of about 10 million bath.

5. WATERSHED

5.1. Watershed classification

By the regulation, in which the criteria for watershed classification are based on five stable parameters; slope; elevation; landform; soil and geology. It was agreed among the concerned agencies and approved by the cabinet to have watershed areas in Thailand classified and mapped in five numeral classes (WSC). These are briefly described by watershed classification Committee (1983) as follows:

WSC1: Protected or Conservation Forest and Headwater Source:

This class is proposed to be divided into 2 subclasses

- WSC1A: includes areas of protected forest and headwater source area, annually located at high elevation with very steep slopes. These areas must remain in permanent cover.

- Wsc1B: denotes areas of similar physical features and environment as WSC 1A, but where portions of the area have already been cleared to agricultural use occupied by villagers. These areas require special soil conservation and protection measures and where possible should be reforested.

WSC 2: Commercial Forest

This class comprises areas of protected and/ or commercial forest (mainly commercial). For most part, these areas are located at higher elevation with steep slopes. Landforms are less erosive than WSC 1. Areas may be used for agroforestry.

WSC 3: Fruit- tree Plantation

This class covers upland areas with rather steep slopes and less erosive landforms. These areas are usually used for fruit tree plantation or certain agricultural crops, and may be used for commercial forest, agroforestry, grazing or other permanent uses. They require soil conservation measures.

WSC 4: Upland Farming

This class covers describes areas of gently- sloping lands for row crops, fruit trees, and grazing with moderate need for soil conservation measures.

WSC 5: Lowland Farming

This class groups gently- sloping to flat areas, used for paddy field or other agricultural uses with few restriction.

There are, however, several other methods to come up with the land use plan such as land capability and/ or land suitability classification.

5.2. Watershed system and basin code

The national committee has proposed the standard basin and subbasin codes for Thailand. Standard basin maps are constructed by the use of 1:500,000 map. The name and area of 25 watersheds and watershed classes are shown in table 3 (see next page)

5.3. Watershed in the regions

From region to region, the main watershed can be described as follows;

(1) Northern region

Total area of watersheds in the northern region are 132,000 sq.km.(approx.). Major watersheds in the north consisting of;

- Ping, Wang, Yom and Nan watersheds, the system of Chao- Phya basin,
- Pai and Khun- Yuam watersheds, the system of Salwin basin in Burma.
- Kok and Chan watersheds, tributaries of the Mekong basin.

The potential of water resources in this region are about 29,800 mcm.annually.

(2) North-eastern region

The total area of watersheds are about 161,390 sq.km. which consisting of the 2 main watersheds namely Chee and Mune.

- System of Chee watershed comprising of Nam Pong and Lam Pao, while the Mune watershed comprising of Lam Takhong, Tam Praplerng, Lam Plaimas, etc.
- The other tributaries flow directly through the Mekong river such as Huai- Banghee, huai- Sai, etc. annual run- off are about 30,400 million cubic meters.

(3) Central region

The total area of Chao Phya basin are about 79,500 sq.km included the lower basin of Mae klong, Bang Prakong and also Pa Sak watersheds. The total runoff in the central region are about 23,400 million cubic meters.

(4) Western region

The Kwai-Yai and Kwai-Noi watersheds are the upper catchment of the Mae-Khlong river basin. At the lower part of Mae-Khlong basin, it connected to the Chao Phya basin

The other watersheds in the southern part of this region are Petchburi and Pranburi catchments.

(5) Eastern region

Total area of watersheds in the eastern region are about 37,400 sq.km. The 2 major systems can be distinguished.

- The first one is the coastal watershed consisting of Rayong, Prasae, Chanburi, Khlang and Weru watersheds.

The other system is the Bang-Prakong river situated in the northern part of region. Total annual runoff are about 39,900 million cubic meters.

(6) Southern region

Total area of watersheds are about 69,400 sq.km. The east-coast and west-coast watersheds can be physically distinguished. In general, there potential of water from the western watershed is quite limited, because the catchments are small with the short distance of river system. The eastern watershed consisting of the Chumporn, Langsuan, Tapee, and Phumdung watersheds with many small catchments.

6. WATER RESOURCES DEVELOPMENT

(1) Large and medium scale

Large and medium scale of irrigation project until 1991 were recorded as shown in Table 4.

Table 4. Irrigation project at large and medium scale

Region	No. of project	Storage capacity (MCM)	Irrigation area (M.rai)
North	190	23,113.88	3.64
Northeast	260	4,007.98	2.69
Central, East and West	167	2,081.43	12.37
South	78	72.60	1.89
Total	**695**	**29,275.89**	**20.59**

Excluded: Storage dam constructed by EGAT and other agencies

(2) Small scale

Small scale of irrigation project until 1991 are shown in Table 5

Table 5. Small scale irrigation project

Region	No. of project	Storage capacity (MCM)
North	190	23,113.88
Northeast	260	4,007.98
Central, East and West	167	2,081.43
South	78	72.60
Total	**695**	**29,275.89**

7. CONSERVATION AND MANAGEMENT

Direct measures are undertaken in the upper watershed not only for the prevention of erosion and soil conservation but also for controlling sediment problems in the lower watershed. Different agencies are responsible for different activities as follows:

(1) Forest land

The Royal Forest Department has responsibility for managing and protecting forest land in the upper watershed areas. This mostly involves a country wide programme of reforestation in the mountainous area as the upper watershed in order to control erosion and sedimentation.

(2) Rivers and reservoirs

The Royal Irrigation Department, the Energy Development and Promotion and the Electricity Generating Authority of Thailand are the 3 main agencies responsible for the river systems, and reservoirs. Most of their activities involve engineering work.

(3) Agricultural Land

There are many agencies involved in work related to conservation and management as part of their agricultural development activities. Their activities primarily aim to increase crop yields rather than to prevent soil erosion and sediment transport.

(4) Rural development programme

Activities within rural development programmes both directly and indirectly involve the development and conservation of natural resources. These are undertaken under the responsibility of the local administration at the province, district and village level as set in the national policy for rural development.

(5) Special projects

Several types of special projects are developed under specific programmes. The goals of such projects are depending on the national policy and political situation.

1) His Majesty the King's Projects

In many areas, serious deforestation and land degradation occur, leading to soil erosion problems. Ultimately problems related to the use of inappropriate agricultural practices can no longer be avoided. In this respect, there is a need to improve the practice of shifting cultivation, especially in the northern and north-eastern regions. Several projects have been developed on the initiative of His Majesty the King to tackle these problems. Such projects always follow an integrated watershed management approach. The objective is not only soil and land improvement but also to increase the range of potential cash crops by introducing promising new ones. As an example, some varieties of temperate fruits and flowers have been introduced to replace existing lower value cash crops and opium, thereby providing increased benefits to farmers.

2) Poverty area development projects

One of the most significant social problems in Thailand is the migration of people from the rural areas to the cities, especially to Bangkok, in search of jobs. A way to reduce this problem is to strengthen rural development projects in order to stabilise and improve the situation for rural people in their home areas. The government has initiated a project entitled "Development of Poverty Areas" to promote job opportunities in the rural areas. Project activities consist of village improvement works, reclamation of degraded farm ponds, building of irrigation systems and conservation measures.

3) Project for national security purposes

In rural area where there are rather poor communication and transportation facilities, the social and economic conditions are known to be critical. Such areas might be easily penetrated and influenced by insurgents, causing security problems for the nation. These areas have been registered for special projects for the purpose of promoting national security. For example, in order to develop the border areas, self-help village defence projects have been established in conjunction with development schemes to combat past and present low income levels.

4) Political projects

One category of special projects are those handled by members of parliament. They prefer to initiate projects in their own province not only to improve the quality of life but also to have a better understanding of the people in their area. Some projects aim to make use of the local natural resources but others are mainly to provide benefits to the politician by creating a favourable impression with the people.

8. CONCLUSION

Water are the most important resources as the basis for Thailand's social and economic development, especially with regard to the agricultural products. The main agricultural cash crop is paddy rice in the lowlands whereas a wide variety of cash crops are grown in the uplands. Thailand, like other developing countries has been facing critical problems of increasing demand for food. The farmer has been severely limited by the fact that, irrigation system is not sufficient to cover large areas. Yield increase-related technologies are also primarily available in limited units. Forests in the hill and mountain of many million hectares were opened up for upland crop cultivation at rapid rate in all regions during the past two decades. While soil erosion tends to be more serious problem as well as the sediment transportation. Problem of water shortage or insufficiency are gradually realised even in the rainy season, especially, in the north-eastern and northern regions. Quality of surface water is also gradually declined.

At present, the role of national development plan concerns closely with agriculture development, which frequently impact on an interaction of forest area and agricultural area. Watershed quality deals with various environmental factors. Those are hydrology, soil, climate, geology, geomorphology and vegetation as well as socio - economic factors. The increasing of economic development will cause more degradation of watershed. The deterioration of environment, especially vegetation cover have changed hydrological characteristics in quantity and quality of river discharge. During wet season, there will be more water supply while the dry season, there will be less and lack of water. Agriculture yield, gradually decline not only according to the soil properties but also the chemicals and fertiliser loss from the catchment by the processes of soil erosion and sediment transportation.

Conservation and development of water resources are processes that benefit mankind both at the present and in the future. So that the end-product of resources conservation and development will becomes the improvement of the quality of life of the people.

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OUTCOMES ON WATER SUPPLY AND POLLUTION CONTROL AS ADOPTED BY THE MEETING

Introduction:

The workshop considered issues related to water resources management in Vietnam. These included:

Administrative
- water law and legal aspects of water management
- institutional frameworks
- the process of gaining government approval to implement actions relating to water resources management

Technical
- Overall assessment of water resources, including quality and quantity for irrigation, domestic use, industrial use, navigation, fisheries, etc.

Two concluding parallel working group sessions were held on the issues of water supply and pollution control, the results of which have been adopted by the meeting as follows:

In Vietnam, pollution problems related to surface and groundwater in big cities are caused by discharge of untreated effluents from industries and households. Contamination of water bodies in rural areas is stemming mainly from application of agricultural inputs such as fertilizers and pesticides.

There are more than 4,000 reservoirs in Vietnam. Problems related to the management of reservoirs include eutrophication, pollution, sedimentation and infestation with various weeds. Weeds also cause problems to water intakes, pumping stations and open canals in the Red River delta.

Surface water contamination is a problem, especially for fishery, irrigation, drinking water and domestic water use. The main polluters are textile industries and discharge of sewage from big cities such as Hanoi. An inventory of the pollution sources is lacking. There is a lack of equipment for laboratory analyses.

The formulation of strategies for groundwater protection in Vietnam is of crucial importance since drinking water in the big cities is extracted from deeper aquifers. Salt water intrusion in the aquifer of Ho Chi Min City has made it impossible to use this resource since 1960.
Salinisation is a regional issue and is caused by salt water intrusion, deforestation and improper irrigation practices.

In the region, often monitoring and pollution control in the rural areas are not efficiently implemented. In Australia, urban and rural activities have had an impact on water quality. In recent years there has been public concern about algae bloom in inland waters and treated sewage effluent discharged to both inland and coastal waters. In the Philippines there is still a lack of an updated and accurate assessment of water resources needed for comprehensive basin planning due to an insufficiently integrated database on water resources.

Recommendations:

Training courses should be organized on:

- assessment, planning and management of water resources;
- chemical analysis of water samples including analysis of heavy metals, organic compounds such as dioxin;
- eutrophication, sedimentation, watershed management and other water quality related issues of lakes and reservoirs;
- assessment and management of groundwater quality.
- purification of drinking water

A comprehensive inventory of pollution sources should be prepared for specific regions in Vietnam.

Strategies should be developed to protect the current and potential groundwater sources. Risk mapping of aquifers used for drinking water is necessary. Groundwater quality monitoring should be expanded and improved in many parts of Vietnam, especially in the Hanoi region. A strategy to control and prevent salt water intrusion in the coastal zones should be developed.

Apply effective measures to prevent water weeds affecting operation of water intakes and pumping stations.

Networks should be installed for surface water quality monitoring to provide early advice on toxicants to people involved in aquaculture, and to other users.

Exchange of knowledge and information in the region should be promoted, as many of the issues countries face are similar.

Improved communication on available hydrological and laboratory equipment should be encouraged.

Environmental Impact Assessment methods as tools for planning and evaluation should be applied and made compulsory by law (Malaysia is ready to share its experiences).
Public participation including the private sector should be encouraged in the sensible use and protection of the water resources.

Equipment for laboratory analysis of water samples should be made available, both for central laboratories and for field analysis.

Pilot projects and advisory missions on specific water management issues should be encouraged.

Concrete project proposals :

A regional training course on water quality in lakes and reservoirs dealing with issues such as eutrophication, sedimentation, watershed management.

National training courses in the region on chemical analysis of water samples , analysis of heavy metals, dioxin, purification of drinking water, as deemed necessary.

Project for the improvement of the quality of data from the existing groundwater monitoring network in North Vietnam, including development of a strategy for groundwater quality management and protection. Training of staff is envisaged.

Regional training course on the management of trans-boundary river basins .The course aims to enhance international co-operation in the framework of the Helsinki Rules and other relevant international agreements.

Phased projects to review hydrometeorological networks. All phases should cover:

- water resources information, the amount and accuracy of the data
- the spread of stations across the catchments
- training of staff to operate the network and process the information
- institutional arrangements for management of the network, and use of data by decision makers

The project will address:

- capacity building
- technology and equipment required
- the establishment of data banks

Phase 1: inventory of current information systems:

- the current water quantity and quality data. This review would include suitability of equipment and capabilities of staff.
- processing of the data, including storage and analysis
- dissemination of information, including a review of the purposes and goals of the data users.

Note: The inventory should be developed to be consistent with the work on the IHP River Catalogues, the Asian FRIENDS, the GEWEX Monsoon Experiment as well as other regional initiatives.

Phase 2: Definition of the short and long term objectives of the hydrometeorological network.

Phase 3: Identification of the gaps between current information and long term objectives

Phase 4: Recommendations on the strategy to fill these gaps and meet the long term objectives.

AGENDA

Tuesday 8 November

SESSION 0: Opening Session

08.30 - 10.00h:

1. Dr. Nguyen Duc Ngu, Director General Hydrometeorological Service of the S.R of Viet Nam
2. Prof. Nguyen Viet Pho, Chairman Viet Nam National Committee for the IHP
3. H.E. Tran Nhon, Vice Minister, Ministry of Water Resources
4. Mr. Mark Brussel, Representative of UNESCO

Keynote Presentation by Mr. Guy Le Moigne, World Bank, Washington:
Water Resources Policies and Strategies

10.00 - 10.30h: Coffee Break

SESSION 1: Presentations by experts from International Organisations

10.30h:

1. UNESCO, Mr. Mark Brussel, Associate Expert for Hydrology
   Integrated Water Resources Management in relation to IHP-V
2. UNDP/Hanoi, Mr. Rolf Herno, Programme Officer
   Environment and Natural Resources Management
3. UNDP/World Bank Water and Sanitation Programme, Mr. Richard Pollard
   Drinking Water Supply and Sanitation in the Context of Water Resources Management: Preparing Sector Strategies

12.15 - 13.30h: Lunch

13.30h:

4. Mr. Johan Verboom, UNEP Consultant
   Major Problems in Integrated Water Resources Management

SESSION 2: Reports on Water Resources Assessment and Integrated Management in Vietnam

14.00h:

1. H.E. Mr. TRAN NHON, Ministry of Water Resources
   - *Water resources service product must be a commodity*
   - *Methods for calculating irrigation fee*
2. Prof. Nguyen Viet Pho, Chairman National IHP Committee "Water Resources and *Water Uses Assessment and Management in Viet Nam"*

15.00 - 15.30h: Tea Break

3. Mr. NGUYEN HUU NHAN, Sub-institute of Hydrometeorology in Ho Chi Minh City
   Computer Modelling for Monitoring of Oil Pollution Downstream of Dong Nai River Induced by Oil Pollution on 8 May 1994
4. Dr. CAO DANG DU, Institute of Meteorology and Hydrology -
   Flash Flood and Regionalisation of Flash Flood With Various Probability

16.30h: End of the Day

<u>**Wednesday 9 November**</u>

08.30h:

* UNEP, Mr. Gerhart Schneider, Programme Officer Freshwater Unit (rescheduled from session 1)
Assessing risks of eutrophication of a lake by calculating organic and nutrient loads from its catchment.

SESSION 3: Country Reports

09.15h:

1. Mr. Barry Sheedy, Melbourne Water, Melbourne, Australia
2. Mr. Zi-Kai Xu, Nanjing Institute of Hydrology and Water Resources, Ministry of Water Resources, Nanjing, China

10.35 - 10.55h: Coffee Break

3. Ms. Henny Maria, Research Institute for Water Resources Development, Bandung, Indonesia
4. Prof. K. Takeuchi, Yamanashi University, Department of Civil and Environmental Engineering, Kofu, Japan

12.15 - 13.15h: Lunch

* UNEP, Mr. Gerhart Schneider, Programme Officer Freshwater Unit (rescheduled from session 1)
Rationale and possible strategies for combatting aquatic weeds.

14.00h: (continuaton Session 3)

5. Mr. Hanapi Mohamad Noor, Drainage and Irrigation Department, Kuala Lumpur, Malaysia
6. Mr. Melchor Baltazar, National Water Resources Board, Manila, Philippines

15.20 - 15.40h: Break

7. Mr. Manu Srikhajon, Department of Land Development, Bangkok, Thailand

17.00 - 17.10h:

Mr. Mark Brussel, Associate Expert for Hydrology, UNESCO/ROSTSEA
Introduction sessions 4 and 5 (working groups), framework for discussion

17.10h: End of the Day

<u>Thursday 10 November</u>

SESSION 4: Working Group I: Pollution Control

08.30 - 10.30h:

Chairman: Mr. Hanapi Mohamad Noor, Malaysia
Rapporteur: Mr. Schneider, UNEP

SESSION 5: Working Group II: Water Supply

08.30 - 10.30h:

Chairman: Mr. Melchor Balthazar, Philippines
Rapporteur: Mr. Richard Pollard, UNDP/World Bank Water and Sanitation Programme

10.30 - 11.00h: Break

11.00 - 12.00h: Continuation working groups

12.00 - 13.30h: Lunch

SESSION 6: Presentation of results of working groups followed by discussion

13.30 - 14.30h:

Chairman: Mr. Guy Le Moigne, World Bank
Rapporteurs: Messrs. Mark Brussel and Johan Verboom

14.30 - 15.00h: Break

15.00 - 15.30h: Adoption of recommendations and plans for action

SESSION 7: 15.30 - 16.00h: Closing Ceremony

<u>Friday 11 November:</u>

FIELD TRIP TO HOA BINH RESERVOIR AND HYDROPOWER PLANT

07.00h Departure from hotel

09.30h Arrival at Hoa Binh Reservoir
Presentation on planning and management aspects of the reservoir and its various objectives, in relation to integrated water management

12.00 - 13.00h: Lunch

13.00 - 14.30h: Boat trip on the reservoir

15.00 - 17.30h: Return to Hanoi

LIST OF PARTICIPANTS

1. Prof. NGUYEN DUC NGU, Director General Vietnam Hydrometeorological Service (HMS)
2. Dr. TRINH VAN THU, Deputy Director HMS
3. Prof NGUYEN VIET PHO, Chairman Vietnam National Committee for the IHP
4. Dr. TRAN NHON, Vice Minister, Ministry of Water Resources
5. NGUYEN VAN QUANG, Director, Division of International Cooperation, HMS, member Vietnam National Committee for the IHP
6. Dr. HOANG NIEM, Director, Institute of Meteorology and Hydrology, member Vietnam National Committee for the IHP
7. DOAN VAN TUOC, Deputy Director, Division of Science and Technique (HMS), member Vietnam National Committee for the IHP
8. Dr. DOAN QUYET TRUNG, Deputy Director, Department of Hydrometeorological Forecasting (HMS), member Vietnam National Committee for the IHP
9. Dr. NGUYEN TAL, Ministry of Education and Training, member Vietnam National Committee for the IHP
10. Dr. VO CONG NGHIEP, Vietnam Geological Survey, member Vietnam National Committee for the IHP
11. Dr. NGUYEN THUONG HUNG, National Center for Natural Sciences and Technology Research, member Vietnam National Committee for the IHP
12. LE VAN SANH, First Secretary and member Vietnam National Committee for the IHP
13. DUON GIOI, Director, Department of Network Operation (HMS)
14. NGUYEN TRUNG, Director, Office of HMS
15. Dr. DAO VAN LE, Department of Hydrometeorological Forecasting (HMS)
16. Dr. TRAN DUC HAI, Institute of Meteorology and Hydrology (HMS)
17. LE XUAN DAI, Director, Division of Science and Technique (HMS)
18. Dr, DAO DUC TUAN, Division of Science and Technique (HMS)
19. NGUYEN QUY CHI, Division of Finance and Planning (HMS)
20. NGUYEN HOANG QUANG, Deputy Director, College of Meteorology and Hydrology (HMS)
21. NGUYEN HUONG KY, Division of Staff and Training (HMS)
22. PHAM DINH AN, division of International Cooperation (HMS)
23. Dr. TRINH TRONG HAN, Polytechnic institute.
24. DO DINH KHOL, Institute of Meteorology and Hydrology (HMS)
25. Dr. CAO DANG DU, Institute of Meteorology and Hydrology (HMS)
26. Dr. VU VAN TUAN, Secretary, Vietnam Environment and Water Resources Association (EWRA), member Vietnam National Committee for the IHP
27. DINH TIEN TRUC, Department of Water Management, Ministry of Water Resources (MWR)
28. VU TIEN LUC, Chief of Section, Institute of Water Resources Planning
29. NGUYEN VAN SU, Division of Science and Technique, Ministry of Aquaculture.
30. NGUYEN DONG LAM, Depertment of Science and Technique, Ministry of Heavy Industry.
31. Dr. DO CAO DAM, Hanoi University of Water Resources
32. TRAN VAN SON, Ministry of Agriculture
33. DANG THE HUNG, Vietnam National Committee for UNESCO
34. NGUYEN NHAN QUANG, Vietnam Mekong Committee
35. NGUYEN CONG THANH , UNDP/World Bank Water and Sanitation Program, National County Officer

International participants

36. Mr. MARK BRUSSEL, Associate Expert for Hydrology, UNESCO OFFICE Jakarta, (ROSTSEA)
37. Mr. GERHART SCHNEIDER, Programme Officer, UNEP, Nairobi.
38. Mr. GUY LE MOIGNE, Senior Water Resources Advisor, the World Bank, Washington
39. Mr. RICHARD POLLARD UNDP/WB Water and Sanitation Programme, Jakarta
40. Mr. JOHAN VERBOOM UNEP Consultant
41. ROLF HERNO Programme Officer UNDP HANOI
42. Mr. MARSHALL L. SILVER, Chief Technical Advisor Vietnam Water Disaster Mitigation
43. Ms. MEI XIE, Natural Resources Division The World Bank.
44. Mr. BARRY SHEEDY Project Manager National Water Quality Management Strategy, Australia
45. XU ZIKAI, Chief of Water Resources Section, Nanjing Institute of Hydrology and Water Resources.
46. HENNY MARIA, Hydrological associate technician, Experimental station for Hydrology, Indonesia.
47. Mr. KUNIYOSHI TAKEUCHI, Professor of Civil Engineering, Yamanashi University Japan.
48. Mr. HANAPI MOHAMAD NOOR, Senior Engineer, Planning and Evaluation Division, Department of Irrigation and Drainage, Malaysia
49. Mr. MELCHOR BALTAZAR , National Water Resources Board , Philippines
50. Mr. MANU SRIKHAJON, The Department of land Development, Thailand