



*Ministry for the  
Environment and Territory*

# Water Programme

for Africa, Arid and  
Water Scarce Zones

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United Nations  
Educational,  
Scientific and  
Cultural Organization

UNESCO  
Intergovernmental  
International Hydrological  
Programme (IHP)



# Presentation

Since the beginning of man, societies have been dependent on water. Their livelihood has always depended on the ability to manage and share this rare resource. This is today particularly true in some parts of Africa and in arid zones where surface water resources can be scarce and groundwater resources non-renewable.

The UNESCO International Hydrological Programme (IHP) accords particular importance to the integrated management of water resources in arid and semi-arid regions. The rational management of water resources in arid zones and the protection of the environment require a solid scientific and technological basis. Therefore, UNESCO-IHP gives particular focus to the dissemination of best practices and capacity building in water resources.

UNESCO-IHP not only provides the necessary support for prospective studies in the area of water resources in arid and scarce zones, but also federates on the international level the drive for education, information, and training. Since education is a vital issue that lies at the very heart of the process of sustainable development, then education has to address all issues of water and place itself at the service of water.

Moreover, education and capacity-building programmes must take fully into account the cultural values and culture-based traditions and techniques that are preconditions for successfully tailored local water management.

At this scope the UNESCO-IHE Institute for Water Education based in the Netherlands, together with the UNESCO RCTWS regional center in Cairo, dedicate a substantial component of their programmes to human capacity building for water professionals in the arid zones.

The latest developments on the international scene – the Millennium Development Goals and the Implementation Plan of the World Summit on Sustainable Development – reconfirmed the critical nature of water problems, stressing the meeting of human needs and setting key targets on access to safe water and improved sanitation.

In response to these challenges, UNESCO and the Italian Ministry for the Environment and Territory (IMET) have joined efforts to contribute to the achievement of the UN MDGs. They have launched the “Water Programme for Africa, Arid and Water Scarce Zones,” which seeks to examine and develop the potential for sustainable management of water resources, to become a catalyst for protecting the fragile environment of water scarce regions, and to foster regional peace and development through dialogue, cooperation, and participatory management.

We wish to thank the Department for Environmental Research and Development of the Italian Ministry for the Environment and Territory for having proposed its support and its partnership.

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# Foreword

“The human right to water is indispensable for leading a life in human dignity. It is a prerequisite for the realization of other human rights...”; the Declaration of the United Nations on November 26th, 2002, poses a milestone on the path to achieving sustainable development, underlying the vital role of water for human health and survival. Moreover, the right to water is the first to focus explicitly on the responsibilities that governments have in delivering clean water and adequate sanitation services to all.

Over the last 30 years, numerous major conferences and international agreements have provided the broad background for today's water resources policies and decision-making. In the last decade, many international conferences have discussed and agreed on steps required to speed up the implementation of Agenda 21.

The United Nations Millennium Declaration further affirmed in 2000 the role of water as a key to sustainable development and the urgency of immediate action, and the World Summit on Sustainable Development recognized in 2002 that water and sanitation are inextricably linked to the eradication of poverty and to the achievement of sustainable development, and hence the need to provide focus and impetus to action in the water area, of increasing access to water and sanitation by the poor.

In addition to the role that improving access to domestic water and sanitation plays, water's role as a resource for agriculture, energy and industry is essential to fighting poverty and hunger. Energy services that allow for heating, cooking and illumination are not only a blessing to the activities of daily life, they are also critical inputs to agriculture and the types of small-scale productive activities that are a significant component of the rural economy in poor areas. Similarly, access to key factors of production, including water, is critical to the viability of activities that can act as a ladder out of poverty.

People in arid areas are uniquely vulnerable not only to drought and other natural disasters, but also to economic and social changes. Achieving sustainable development has particularly significant implications for reducing poverty and hunger. Limited and unreliable access to water is a determining factor in agricultural productivity in many regions, a problem rooted in rainfall variability that is likely to increase with climate change. Today, under-performing irrigation systems and poor water management practices worsen the water shortages that already exist in many countries.

For the world's poorest citizens, the right to safe water supply and adequate sanitation remains a promise unfulfilled. Millions of people still lack access to safe water supply and to basic sanitation and every year many of them die from diseases associated with inadequate water supply, sanitation and hygiene.

Meeting the components of the Millennium Development Goals referring to water and sanitation is necessary for real progress against poverty and to avoid temporary or permanent environmental deterioration.

In order to reach them it will take a combination of strong national action—guided by nationally prepared and owned strategies and action plans—complemented and supported by international action.

Keeping in mind that the bulk of the problem lies in mobilizing people at local and regional level and involve them to the solution of the problems, governments have to recognize the importance of MDGs as a national priority for the strategic planning of national development.

Yet international agencies and third countries, which share the commitment to the MDGs can clearly play a key supporting role to help countries realize their own nationally determined goals, strategies and action plans.

In this perspective, the Italian Ministry for Environment and Territory entered a partnership with UNESCO International Hydrological Programme in order to advocate and mobilize international support, and provide additional resources. The “Water Programme for Africa, Arid and Water Scarce Zones” is intended to contribute to the attainment of the Goal #7 of the Millennium Declaration, by fostering the integration of principles of sustainable development into country policies and programmes, strengthening the institutions, increasing the availability for water resources and augmenting sanitary conditions.

With the support to this Programme, the Italian Ministry is reaffirming its strong commitment to the promotion to international partnerships towards the achievement of global sustainable development, as already started in Central and Eastern Europe, the Mediterranean Region, China, Latin and South America, and in the Pacific Islands.

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## Italian Ministry for the Environment and Territory (IMET)

The Ministry for the Environment and Protection of the Territory performs State functions and tasks regarding protection of the environment, the territory, and ecosystems, with particular regard to the following issues:

- a) identification, conservation and improvement of natural protected areas, protection of biodiversity and biosecurity, flora and fauna, implementation and management, subject to the competence of the Presidency of the Council of Ministers and Foreign Affairs, of the Washington Convention on International Trade in Endangered Species of Flora and Fauna (CITES) and relative EU regulations, protection of the sea and the coastal environment, and environmental communication;
- b) waste management and reclamation of polluted sites; protection of water resources and the relative management, subject to the competence of the Ministry of Agricultural and Forest ;
- c) promotion of long-term policies for sustainable development at national and international level;
- d) supervision, monitoring and restoration of environmental conditions that meet fundamental public interests and have a positive environmental impact, with particular reference to the prevention and elimination of environmentally harmful violations, and prevention of and protection from air, noise and electromagnetic pollution and industrial risks;
- e) protection and clean-up of the territory in accordance with natural and environmental values.

The structure of the Ministry for the Environment and Protection of the Territory was recently changed to encourage the Ministry's role as a driving force for sustainable development rather than a Ministry of prohibitions and restrictions. The Ministry is divided into six departments and two commissions, the Commission for Evaluating Environmental Impact and the Technical Scientific Commission.

The departments are the following:

- Department for the protection of nature
- Department for the quality of life
- Department for environmental research and development
- Department for environmental protection
- Department for soil protection
- Department for Ministry's internal services

## UNESCO International Hydrological Programme (IHP)

The United Nations Educational, Scientific and Cultural Organization (UNESCO) established the International Hydrological Programme (IHP) in 1975. The IHP is the single intergovernmental programme of the UN system devoted to the scientific study of the hydrological cycle and to formulating strategies and policy for the sustainable management of water resources. IHP was conceived as an evolving programme, ready to adapt to society's needs and transformations. It is implemented in six-year phases, in order to promptly identify emerging problems, alert decision makers, raise public awareness, and provide the necessary resources to respond with appropriate actions. Considering that properly managing and protecting our planet's water resources are prerequisites of sustainable development, UNESCO has decided to give a high priority to the IHP as a prominent UNESCO vehicle for meeting the UN Millennium Development Goals (MDGs).

Water education and the advancement, sharing, and application of scientific knowledge are the pillars of sustainable development.

As a chief component of UNESCO and its mandate, education is a major objective for IHP. IHP Water Education and Training (WET) activities emphasise institutional capacity building, research, and information networking, especially at the university, postgraduate and continuing professional education levels, reaching a wide community of water specialists and the general public. IHP has created a network of university chairs and regional and international training centers. The centers are a cornerstone of UNESCO's strategy to improve scientific understanding of the water cycle and water resources management.

### *UNESCO-IHE Institute for Water Education*

The UNESCO International Institute for Infrastructural, Hydraulic and Environmental Engineering (UNESCO-IHE), situated in Delft, Netherlands, is contributing to the meeting of water-related capacity building needs of developing countries and countries in transition. In recent years the number of participants in postgraduate courses at UNESCO-IHE in Delft, originating from more than 100 developing countries and countries in transition, has steadily increased. An average of 400 participants attend the MSc or PhD programmes, and a further 240 have attended UNESCO-IHE's short courses and special programmes. Annually, approximately 200 professionals participate in the six jointly implemented MSc programmes at UNESCO-IHE's partner universities in Colombia, Ghana, Kenya, Palestine, Yemen, and Zimbabwe. A far larger number will also participate in special programmes, short courses, and (PhD) research at UNESCO-IHE's partner universities and institutes, further increasing the number of professionals in the global network.



UNESCO and IMET have joined efforts to contribute to the achievement of the UNMDGs.



The UN Millennium Development Goals, the World Summit on Sustainable Development (Johannesburg, 2002), and the World Water Forums have brought together the key freshwater issues of the world today. These issues must be translated into scientific challenges as well as subsequent programmes and projects.

More than 1.2 billion people worldwide lack access to a safe water supply, and almost 2.5 billion people lack basic sanitation. More than five million people die each year from water-related diseases that are mostly preventable.

Water problems are most acute in Africa where it is estimated that 300 million people (UN-WWAP, UNESCO 2003) are affected by water shortages. Adequate management of its water resources is crucial for the future of the African continent.

Water is central to sustainable development, and solving water problems means progress across all dimensions of sustainable development: economic, social, and environmental. This is particularly relevant in arid and water scarce zones where there are countries with no perennial rivers, streams, or permanent surface freshwater, and where rainfall is scarce, infrequent, or unequally distributed during the year.

UNESCO and the Italian Ministry for the Environment and Territory (IMET) have thus identified integrated water management in Africa as a priority, particularly in arid and water scarce zones.

Technology transfer combined with improving the use of existing and new scientific knowledge are essential to achieving water-related MDGs. The level technical of knowledge in itself is crucial to the strengthening of good governance in the water sector. UNESCO and IMET have joined forces to secure adequate training capacity and the dissemination of information regarding best practices on the most important issues related to water resources in arid zones.

### Water Resources and Environmental Sustainability in Arid and Water Scarce Zones

In most arid countries the scarcity of renewable water supplies poses a serious threat to sustainable, coupled, and balanced socio-economic growth and environmental protection (UNESCO 2000). The northern part of Africa with its coastline

on the Mediterranean basin is one of the regions of the world where the scarcity of water resources constitutes a major obstacle to sustainable development. In most of these countries water policy and water conservation are crucial for development, and great efforts are required to improve unconventional water production techniques. Countries in Northern Africa and the Middle East depend heavily on the capacity of national and regional institutions to manage water resources in a





sustainable manner. If the Horn of Africa area includes some of the driest places in the world, then the Asia region also experiences water shortages in much the same way that arid or semi-arid areas do. At first sight it would appear that monsoon systems create plentiful water resources in swiftly running rivers. Nevertheless, in the Eastern Asia region, monsoon weather systems create extreme seasonal changes with large variations in rainfall between seasons. This can generate water scarcity conditions during certain periods of the year. Overdevelopment of existing water resources, specifically groundwater, can severely impact the area and create serious conditions of desertification in the Eastern Asia region. This situation is often compounded by water pollution that generates sanitation problems.

In these regions the potential for using water more efficiently should be increased. It is necessary to improve water efficiency and conservation technologies. Re-using water can be cheaper and more sustainable. Using renewable energy technology should be emphasised.

Current predictions (UNWWAP 2003) indicate that more than 20 developing countries will experience chronic, physical water shortage by 2025. Most of these countries are found in Africa and the Middle East, and they are already confronted with shortages in their water supplies.

Fresh, clean water is a primary requirement for both humans and the environment. Due to the pronounced climatic variability in arid zones, with their extremely varying temporal and spatial precipitation patterns, the conservation and sustainable use of freshwater resources is essential for human, plant, and animal life. Environmentally sustainable use of freshwater resources needs to be addressed and based upon both traditional technologies and scientific knowledge.

Moreover, the interrelationships of freshwater, used water, sanitation, and human health are important in dry lands and hold the key to sustainable development. Providing healthy living conditions for flora, fauna, and humans in view of an adequate water supply and quality cannot be underestimated.

Particular attention has to be given to groundwater, because it is the most important and often the only source of freshwater in dry areas. Groundwater storage helps compensate for the impact of runoff variability. If this crucial resource is neglected and depleted, several arid regions will face a development crisis. Many of the fragile ecosystems found in these countries depend on groundwater resources, and such systems have significant economic, social, ecological value. Effective strategies are needed to address desertification, adapt to climate change, and maintain ecosystems for biodiversity, especially in wetlands. Land degradation can also be improved through better groundwater management. Therefore, groundwater resources management and protection are crucial in the arid zones.

Historically societies in arid zones have evolved using traditional farming methods that involved rain-fed agriculture and limited withdrawal of groundwater. However, with the introduction of modern farming methods, irrigation canals, electric pumps, combined with the growth of population, towns and cities, the environmental balance has completely changed. There is now greater risk of salt accumulation in the soil and groundwater contamination from fertilizers, and urban and industrial waste. Therefore, the assessment of surface and groundwater resources needs to be carefully carried out, and their interactions understood for optimal development and conjunctive use. Several methods and technologies for rain water harvesting, artificial recharge of groundwater, conjunctive use, wastewater re-use, application

of renewable energy technology, and recycling are all potentially beneficial for arid areas.

## The Development of Appropriate Techniques

The pilot projects that have been selected by UNESCO and IMET share many characteristics that make them comparable for establishing and duplicating similar water management policies, which can also help other regions of the world that face the impact of desertification.

The joint UNESCO/IMET action contributes to the improvement of the knowledge on appropriate techniques. Water needs could be supplemented by water harvesting and water re-use. Renewable energies could also be used for irrigation and desalination. Therefore, special attention should be given to using non-conventional water resources and reusing properly treated wastewater. Conjunctive use of surface water, groundwater artificial recharge, and even wastewater can provide effective solutions for regional water resources development, particularly when based on the comparative advantages of each resource.

For effective and sustainable management in arid and semi-arid regions, national scientific and technical capacities first need to be strengthened. The above issues have been considered by UNESCO and IMET in formulating the WPA Project and determining its objectives.

## Project Objectives

The overall aim of the project is to contribute to achieving the objectives set forth in the Millennium Development Goals. Thus, the WPA Project objectives include:

- to contribute to the achievement of water security in water-stressed environments by providing rural and urban populations with freshwater
- to satisfy water needs for nature and food production with more efficient, integrated water management
- to alleviate poverty by providing adapted water and sanitation services

To achieve these objectives the WPA Project will set up regional training capacities, pilot projects, and technical workshops. The WPA Project will facilitate the improvement of knowledge on new technologies and focus on four main themes:

- wastewater treatment for re-use of drainage water for irrigation
- integrated water resources management
- managing groundwater recharge
- exploitation of brackish water and desalination

UNESCO will contribute to the WPA Project in an effort to strengthen the capacity of national institutions, create reinforced technical capabilities, and develop training pilot projects that can serve as examples of best practices.

The project will focus on capacity building, regional coordination and integration, dissemination of best technological practices, as well as good governance practices.

As such, the individual activities considered within the project are not isolated activities, but part of integrated, long-term, multi-sectoral programmes, where each activity complements others within the existing national and regional programmes.

This action-oriented process will contribute to the development, replication, and up-scaling of best practices. It will focus on the develop-

ment and implementation of demand-driven locally and nationally-owned priority projects. It will consider the priorities expressed in the African initiatives such as AMCOW and New Partnership for Africa's Development (NEPAD). It will work in consultation with the respective water resources and environmental ministries, the universities, and the UNESCO-IHP National Committees of the countries involved in the project.

The project activities will contribute to:

- facilitating sustainable and integrated management of water resources
- investigating alternatives and non-conventional sources of water and encouraging their use to better match the water demand and supply in water scarce zones
- promoting healthy living conditions by analysing the supply and quality of freshwater resources in the context of sanitation and human health
- helping to support efforts of national institutions working in the targeted regions to strengthen conservation of their natural resources, protect the environment through better management of surface and groundwater resources, facilitate education and training programmes on conjunctive use of water resources, and increase knowledge sharing capacity
- supporting on-going national and regional capacity building programmes, with emphasis on South-South collaboration for the transfer of environmentally-sound technology and expertise, including the incorporation and development of traditional knowledge
- establishing guidelines and recommendations on water resources management policies through regional seminars and setting up "best practices" to ensure knowledge transfer to other arid and semi-arid regions of developing countries; holding regional workshops that involve local stakeholders, government officials, and private institutions
- demonstrating the effectiveness of managed aquifer recharge in providing seasonal storage of water

## Geographical Scope

The areas and countries of interest include those participating in the New Partnership for Africa's Development (NEPAD), in particular North African countries with coastlines alongside the Mediterranean Sea, Red Sea and Gulf of Aden. Particular attention will be devoted to Algeria, Yemen, Ethiopia, Somalia, Eritrea, and Egypt. Also, a case study on land degradation and desertification will be developed in Vietnam where remediation measures will be the objective of a pilot project. Appropriate case studies and pilot projects will be developed with the goal of duplicating good examples and establishing a network of arid and water scarce area specialists that could exchange competencies and "savoir-faire."

In all these regions, UNESCO-IHP has established a consultation mechanism with water and environment related institutions. IHP is convening regional coordination meetings periodically to evaluate priorities in the areas of Integrated Water Resources Management (IWRM) and protection of the environment. The results of these consultations have been considered when defining the objectives of the WPA Project designed to respond to regional needs.

## Duration of the Project

September 2004 to June 2006

## Funding

The project, "Water Programme for Africa," is financed by the Italian Ministry for the Environment and Territory.

## Executing Agency

UNESCO-IHP is acting as the executing agency. UNESCO is also cooperating with UNEP GPA in implementing some of the project activities in various selected countries.





UNESCO and IMET joint action aims at securing adequate training capacity and the dissemination of best practices related to water resources in arid areas.

## ACTIVITY 1: The Regional Training Programme at the UNESCO's RCTWS Center in Egypt

### Background

In many countries inadequate information sharing and the lack of technical capacity and training are major causes of ineffective and unsustainable water resources management. This requires urgent attention if institutional capacities are to be built up at all levels.

UNESCO-IHP considers capacity building to be a strategic element in sustainable development, as well as a long-term ongoing process. Capacity building is viewed as the process of gaining technical, managerial, and institutional knowledge and insight in relation to the socio-economic structure, cultural standards, and values of the society concerned.

A fundamental goal of capacity building is enhancing the capability to evaluate and

address crucial questions related to policy choices and modes of implementation among development options.

Each region and each country have specific characteristics and requirements with respect to its water resources situation and institutional framework. Therefore, a tailor-made training program is proposed to cover many of the requirements of arid countries and water scarce zones that share similar problems.

### Regional Training Courses

The training will be provided to technicians from arid and water scarce zones, particularly from African countries.

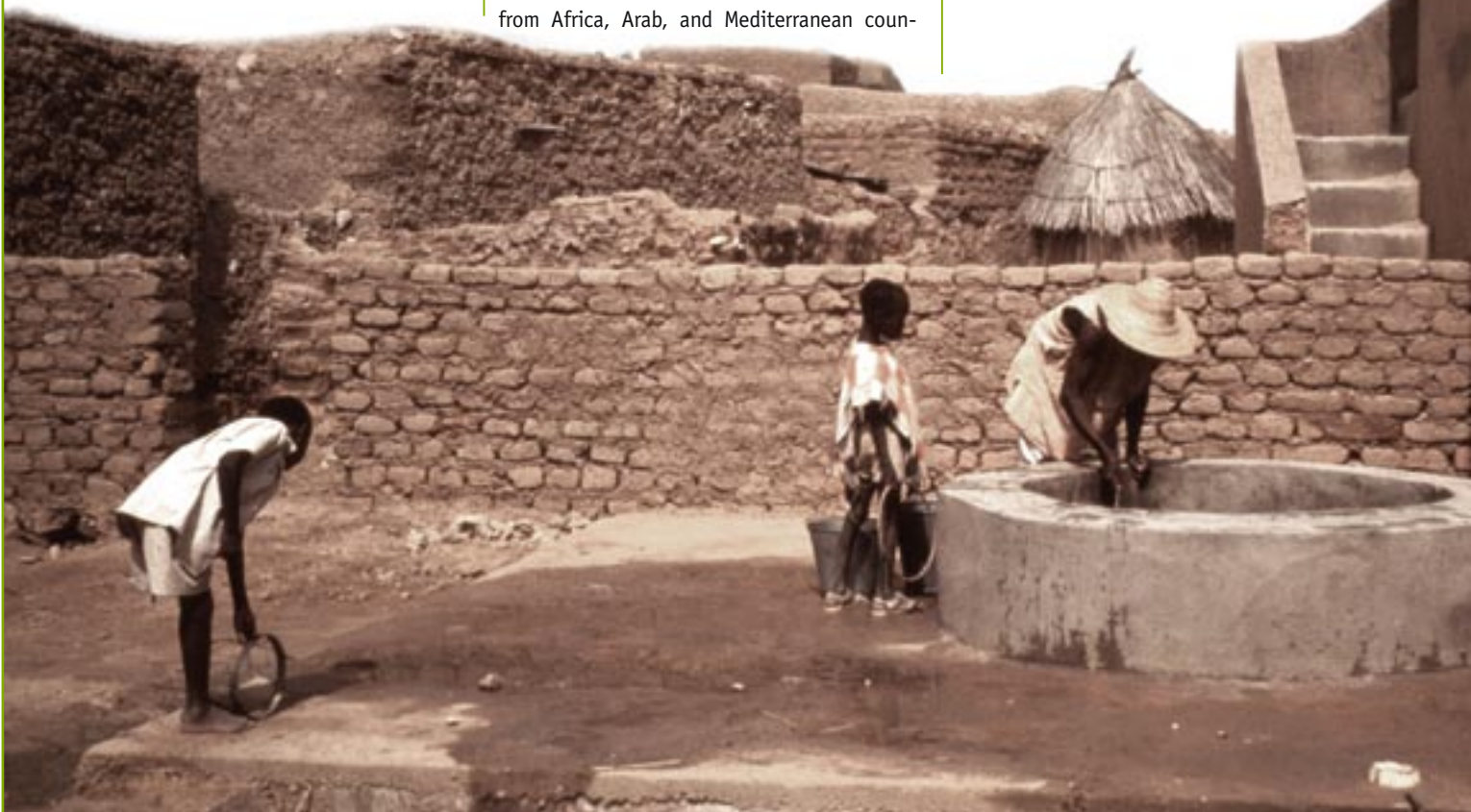
The training activities will be organized at the Regional Center for Training and Water Studies (RCTWS) for arid and semi-arid regions located in Cairo, Egypt. The center is operating under the auspices of UNESCO. An agreement was signed in December, 2001, between the Egyptian government and UNESCO to allow the center to provide training for continuing professional self-development to participants from Africa, Arab, and Mediterranean coun-

tries, in the areas of irrigation, drainage, water resources development and management. The training programme will be built in cooperation with the UNESCO-IHE Water Education Institute and will benefit from the cooperation of the Acacia Institute.

## ACTIVITY 2: Human capacity enhancement for effective water resources and land management in Eritrea — Horn of Africa

### Background

More than 90 million people live below the international poverty line of one dollar per day in Eritrea, Ethiopia, and Somalia. As a truly natural resource based phenomena, better management of land and sustainable water resources management mean survival. Uncontrolled drought, food and water insecurity, combined with desertification and land degradation, continue to threaten human security in the region. The problem is intrinsically linked to the lack of technical and managerial capacity to deal with







natural resources management. The achievements of the Millennium Development Goals are directly linked to better stewardship of land and water resources. They are also contingent upon expanding and improving the region's pool of qualified human resources and financial capacity, as well as overcoming problems associated with inadequate and ill-equipped higher educational institutions.

In arid areas water largely determines the pattern of settlement. Health and nutrition depend on adequate supplies of acceptable quality water, and water is a key component for most economic activities.

## Objectives

The objective of the training courses is to provide managers and technicians with insights and techniques and familiarise them with new strategies for managing water scarcity, water harvesting systems, wastewater treatment and re-use, and groundwater recharge enhancement techniques. A second goal of this activity is to bring together professionals from different backgrounds and countries to study water scarcity related issues, exchange experiences, and stimulate networking in the Horn of Africa.

### ACTIVITY 3: Regional workshop on desalination systems supplied by renewable energies; pilot project and national strategy in Yemen

## Background

Meeting the increasing demand for freshwater is the major challenge for water authorities worldwide, and specifically in arid regions. Very often groundwater (fresh or brackish) is the only source of drinking water in arid regions. With excessive pumping groundwater tables in these regions are rapidly declining, and water quality is

also deteriorating. In many instances, fresh groundwater has become brackish due to salt intrusion.

Proper utilisation of groundwater sources and desalination technologies could provide the freshwater required in this region. Desalination technology is applied in many areas of the world to provide freshwater from brackish or seawater sources. During the last thirty years, desalination has developed into a major water resource in many arid areas of the world, particularly in the Middle East. As the cost of desalination technology decreases, it is gaining attention in water scarce regions. Therefore, a strong need exists for capacity building in the field of groundwater flow and recovery, groundwater treatment, and desalination, in order to share knowledge of fundamental principles, state-of-the-art treatment processes, and leading edge technologies with regional professionals.

## Objectives

A technical workshop and a training seminar will be organized in Yemen in cooperation with the Ministry of Water and Environment. The workshop will aim to improve existing knowledge about desalination technologies and the use of renewable energies, to strengthen dissemination of information, and to enhance regional and national capacities with respect to these techniques.

### ACTIVITY 4: Regional workshop on integrated water resources management in North Africa — Algeria

## Background

The present water situation in North African countries is precarious. Population growth and economic development have overwhelmed traditional water management practices, and people suffer from water scarcity and water



pollution to varying degrees. Where water has been relatively abundant, individual sectors have developed and used water with little regard. However, as demands have increased, water quality has deteriorated affecting other users as well as the environment. Coastal aquifers have been overpumped and contaminated by seawater intrusion. Current fragmented approaches often fail to take account of competing demands for water and of the need to protect this common resource. Moreover, as limits on economically renewable water are approached, conservation and reallocation increasingly become the only feasible alternatives to expensive drilling, desalination, and other non-traditional sources.

Over the past decades, the challenge of crop production and protection from torrential floods in arid zones has been met by studying existing systems of water storage, conveyance, root zone infiltration, and groundwater recharge processes. In addition, further improvement of these processes has led to greater technical efficiency. Dissemination of information on existing practices and trends is an essential component in further devel-



opment of water resources in arid zones. The importance of this area has been given priority in many international programmes, such as those of UNESCO and FAO.

Water-related development in North Africa and along the Mediterranean coastline is linked to agriculture and tourism that require huge quantities and/or a high quality of water. In the region, under specific climatic conditions, and as a result of human activities, saline intrusion is occurring in coastal areas further threatening economic development.

## Modules

- Water harvesting
- Sanitary wastewater treatment and re-use
- Role of groundwater recharge in integrated water resources management

## ACTIVITY 5: Fight against desertification; groundwater artificial recharge in Vietnam

### Background

The Binh Thuan province is located along the coastal plain in the lower part of Central Eastern Vietnam, and its principal city is Phan Tiet, 200 km from Ho Chi Minh City. The area of the province is approximately 8,000 km<sup>2</sup> with a population near one million.

Before 1975 the area was covered by a dense forest that was abruptly cut down to make room for rice pads that were never well-developed. As a result, massive desertification took place. Due to uneven rainfall distribution, the period between December and March is characterised by very little precipitation, and the area suffers from considerable water shortage during the dry season.

In order to fight desertification, best practices on remediation techniques to restore aquifer systems and groundwater storage capacity will be developed.

## Objectives

- to build up an experimental pilot project in the sand dune area of Binh Thuan province, Vietnam, as an example of artificial recharge in the Southeast Asia region
- to critically assess methodologies and the effectiveness of the marginal of groundwater recharge technologies
- to transfer knowledge and experience of augmenting groundwater resources by artificial recharge to scientists, especially young scientists
- to inform governments, donors, and NGOs about the role of artificial recharge in water supply and groundwater management so that informed decisions can be made
- to increase the water supply to communities periodically affected by long standing droughts
- to store water during the dry season in the sub-surface aquifer system

## Modules

- Technical workshop
- Training courses (abroad or in the country)
- Pilot projects



Appropriate techniques including indigenous knowledge and adequate capacity building programmes are needed to fight desertification.

## Wastewater Treatment and Re-use

UNESCO-IHP and the International Association of Hydrological Sciences (IAHS) have included wastewater treatment and re-use in their programmes and are contributing to better knowledge of this topic. In many parts of the world, future water supplies are at risk. The water needs will certainly increase in the years to come. Using almost the same water and land resources, more food must be grown for 800 million people malnourished today and the two billion more expected worldwide by 2025.

One way to meet the growing water demand is the re-use of pre-treated wastewater. This is an efficient way to conserve regional water resources, recycle nutrients, and prevent pollution of surface water.

However, developing countries often lack the financial resources necessary to invest in wastewater treatment. In addition, they often have difficulty following strict water quality guidelines for wastewater irrigation, which are established to guarantee crop quality and prevent health risks from pathogenic organisms. An integrated approach is needed (groundwater resources, wastewater production, wastewater (pre) treatment, wastewater re-use), to find optimal solutions with respect to food security, cost-effectiveness, environmental load and health risks (500 p., J. Sten-Voorden *UNESCO-IHP report 2003*).

Several case studies in different countries clearly demonstrate that the present state of wastewater treatment and disposal and partial re-use on agricultural soils can cause significant environmental problems. The strengthening of local institutions and capacities are needed to overcome these difficulties.

Therefore, there is a need to further develop and adapt treatment systems to local climatic and cultural conditions. Training courses are necessary and information needs to be made available to educate and train students in this complex field.

## Exploitation of Brackish Water

Brackish groundwater, characterised by chlorinities varying between 250 and 20,000 ppm, is found all over the continents. Though its volume may be as large as the freshwater volume, brackish water has received very little attention until now, apart from being a mere problem. Water and food scarcity and new treatment technologies force us to re-evaluate this long neglected resource.

Brackish groundwater may arise from the following processes:







- (i) seawater intrusion;
- (ii) salt dissolution near evaporitic rocks;
- (iii) water evaporation; and
- (iv) groundwater pollution.

The larger brackish groundwater reservoirs are the result of natural processes like seawater or brine dissolution, evaporation and seawater intrusion, which have been occurring for thousands of years. In other cases, the processes are man-made, for example, groundwater pollution, evaporation after changed land use, and seawater intrusion due to excessive pumping. Brackish groundwater may occur in coastal regions, as expected, but also far into the interior of the continents, especially in semi-arid regions.

With improved desalination techniques, production of drinking water from brackish groundwater has become economically viable and is certainly competitive to seawater desalination. During the last decade, several water supply systems based on brackish groundwater have become operational in Jordan and Egypt. In this century the demand for irrigation water will also dramatically increase, and in this respect, brackish groundwater may become a valuable resource. Application of desalinated groundwater has proved to be economically viable for the production of high value cash crops in some cases. However, there is a much larger scope for the application of brackish and saline groundwater. It can be used for the production of salt tolerant crops, fodder, and trees. This extensive form of biosaline agriculture would also be attractive for rural populations. UNESCO and the ACACIA institute are working to improve knowledge in this field.

## Desalination

In arid countries where water shortages are particularly severe, desalination technology has been developed to a point where it can serve as a reliable water source at

a price almost comparable to that of the conventional sources.

The experience in western Asian countries demonstrates that desalination can be a strategic option that can contribute to satisfying water supply requirements.

Desalination techniques can be considered in establishing national water policies. They can be thought of as one of the available tools to avoid stressing freshwater resources. Nevertheless, they should always be considered as just one of the components of an integrated water resources management process developed in conjunction with water conservation strategies (UNESCWA).

Development and application of appropriate technologies are needed, along with an enhanced knowledge of the use of renewable energies. Capacity building programmes are also needed to strengthen national institutions capable of coordinating and managing such technologies together with the complex schema of water policies. Cooperation between countries and exchanging experiences are also fundamental elements.

## Managing Aquifer Recharge

Natural recharge to aquifers is vital for replenishing discharges from the aquifer, whether they result from natural or man-made activities. When more water is removed from an aquifer than is replenished by recharge, the groundwater level falls and storage is depleted. Recharge occurs periodically, usually seasonally, even in temperate climates, but less frequently in arid and semi-arid regions. Recharge is either natural (mainly via direct rainfall infiltration into permeable soils, but also from surface flow), or can be managed (by contour ploughing, building bunds/dams, ponds, diversion channels,

and wells to enhance recharge), or may be incidental (irrigation, wastewater disposal, leaky pipes in cities, or clearance of deep rooted vegetation).

In arid countries groundwater is often the unique reliable water source. Aquifers provide a store of groundwater that can play a vital role, if utilised and managed effectively. Rainwater harvesting and management of aquifer recharge, often known as artificial recharge, contribute to the maintenance of the above benefits, particularly if practised as part of a wider approach to water resource management that addresses demand and quality dimensions, as well as supply aspects (*UNESCO-IAH Managing Aquifer Recharge* – September 2002).

There are many methods for enhancing recharge to aquifers. One method used for recycling water is artificial recharge. Artificial recharge has considerable potential for adding water quantity to an aquifer, achieving water quality improvements, re-pressurising depleted aquifers, and preventing saline intrusion.

Factors to consider in all schemes of artificial recharges are also complex. These include quantity, quality and timing of available water for recharge, the department and storage capacity of aquifers, local hydrological conditions, native groundwater quality, and land availability.

The availability of local technical expertise to construct, operate, monitor, and maintain these techniques is particularly relevant in arid and water scarce countries.







Arid and semi-arid areas face globally the greatest pressures to deliver and manage freshwater resources.

Problems of water scarcity are exacerbated by population growth, expansion of agricultural activities, salinity increases and agricultural/urban pollution. It is recognised that this is not only an issue of resource availability, but of equity in water management. Moreover, many arid regions are the focus of potential conflicts over water scarcity and there is a need to develop strategies to support peace and security.

Improved scientific understanding, co-operation and data sharing provide ways of better water management and of supporting conflict resolution.

Some countries have already developed scientific and technical knowledge to mitigate against water scarcity. Others have reapplied traditional technologies to conserve water. Scientific understanding of water related issues is gradually becoming integrated with other aspects of water resource management.

There is a widespread need to raise awareness of water scarcity with all end users including the general public.





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