

# Urban

# water

# management



United Nations  
Educational, Scientific and  
Cultural Organization



International  
Hydrological Programme  
of UNESCO

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# and **Urban** water management

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# 1. Why Urban Water Issues are important

**New approaches**, even a new mentality, are required with a sense of urgency to successfully face current urban water challenges – especially in developing countries.



R

apidly expanding large cities in the developing world are confronted with extreme conditions: dense population concentration further exacerbated by high rates of rural migration and large income disparities between the wealthier and poorer segments of the population. The poor often only have access to substandard, subsidized water supplies at exorbitant prices

when they are not served by the water supply network.

Urban water problems are growing around the world. Widespread mismanagement of water resources, growing competition for the use of freshwater, degraded sources – sometimes by pollutants of unpredictable effects – only heighten the depth of these problems. The situation is further exacerbated by an explosive growth of urbanization – particularly in the developing world – and the formation of megacities through massive internal migration to the cities provoking an uncontrolled, unplanned expansion. Over half of the world’s population will live in cities by year 2010. Improving freshwater management, access to safe drinking water and basic sanitation in the urban environment in developing countries now commands a greater sense of urgency and is seen as a necessary pre-condition for health and success in the fight against poverty, hunger, infant mortality and gender inequality.

Although cities in industrialized countries are facing problems with aging infrastructure, which causes underperformance in urban water systems, there is a reluctance to adopt innovative approaches. Securing access to water supply and sanitation is a serious urban problem in the developing world. These problems can only be addressed properly through a concerted effort which involves scientific, social and institutional approaches. New paradigms – reflecting integrated management of all components – are emerging, which emphasize both water reuse and water conservation approaches as well as on demand management practices.



Source: Nature & Resources, UNESCO

### The global urban water setting

The world’s population is becoming increasingly urbanized. Between 1990 and 2000, the global population increased by 15% (from 5.27 to 6.06 billion), while the urban population grew by 24% (from 2.29 to 2.85 billion). The percentage of people living in cities thus went from 43.5% in 1990 to 47% by 2000 (source: World Health Organization (WHO) and United Nations Children’s Fund (UNICEF)). In developed countries, the percentage living in cities in 2000 reached 76%, while in less developed regions it was 40%, but growing rapidly (source: United Nations). The latest projections show that by 2010 over half of the world’s population will live in urban centers. The world’s largest megacities can be found increasingly in developing countries. Table 1 shows the world’s twelve largest cities in 1980, 2000 with projections for 2015. Tokyo is the largest city throughout this period, but while it held the lead alone in 1980, several developing country cities will close the gap by 2015. In 1980, five of the twelve most rapidly growing cities were in industrialized countries. By 2015, however, this number would go down to two.

The ever-growing urban population tends to be concentrated in larger cities. The number of cities in the world with over one million inhabitants grew from 234 in 1980, to 411 in 2000, and is projected to reach 564 in 2015. This trend is similar for both developed and developing regions, but is comparatively more pronounced in the latter.



**Table 1.** The Twelve Largest Urban Agglomerations Ranked By Population (in millions): 1980, 2000 and 2015

Rank	1980		2000		2015	
	City	Population (millions)	City	Population (millions)	City	Population (millions)
1	Tokyo	21.9	Tokyo	26.4	Tokyo	26.4
2	New York	15.6	Mexico City	18.1	Bombay	26.1
3	Mexico City	13.9	Bombay	18.1	Lagos	23.2
4	Sao Paulo	12.5	Sao Paulo	17.8	Dhaka	21.1
5	Shanghai	11.7	New York	16.6	Sao Paulo	20.4
6	Osaka	10.0	Lagos	13.4	Karachi	19.2
7	Buenos Aires	9.9	Los Angeles	13.1	Mexico City	19.2
8	Los Angeles	9.5	Calcutta	12.9	New York	17.4
9	Calcutta	9.0	Shanghai	12.9	Jakarta	17.3
10	Beijing	9.0	Buenos Aires	12.6	Calcutta	17.3
11	Paris	8.9	Dhaka	12.3	Delhi	16.8
12	Rio de Janeiro	8.7	Karachi	11.8	Metro Manila	14.8

Europe and North America's high water supply and sanitation coverage seems to indicate that there are no pressing urban water problems in these regions. However, there are certainly difficulties linked to failing infrastructure. Some major problems are:

- Aging of underground utilities, causing deterioration of water quality in distribution systems, and leakage of wastewater from old sewers, causing adverse trends in the groundwater table;
- Insufficient capacity to cope with increased loads, causing frequent spills of combined sewer overflows, jeopardizing the quality of receiving water bodies;
- Flooding of settlements located in floodplains;
- Stormwater pollution (ignored in the past);
- Reluctance to accept innovative solutions based on source control (industrial and stormwater);
- Low priority or lack of care for urban streams and other urban water features; and
- Inappropriate institutional frameworks for efficient integrated urban water management.

## BOX

### Urban Areas and Rural Settlements

The rapid increase of urban areas and rural settlements produces serious environmental problems that influence global, biochemical, and hydrological cycles – as well as the climate. In 2000, approximately half of the world's population lived in urban areas. By 2025, this percentage is expected to reach 56%. However, in the same period the freshwater available per capita will decline sharply in urban zones. Urban expansion has also several adverse effects on groundwater – including depletion, land subsidence and pollution. Not only is there quality degradation of water resources but the competition with other users (i.e agriculture) has become more acute.



## BOX Urban Habitat Hydrology

The world's population lives predominately in urban environments, resulting in several social, ecological and water management challenges. A number of the issues to be addressed include erosion and sedimentation, floods brought on by urbanization, problems of fresh and salt water interaction in both surface water and groundwater environments, as well as consideration and development of appropriate water resource management strategies for small islands. The interference of urban development in coastal zones, islands and/or mountainous areas further increases the magnitude of the problems to be tackled.

UNESCO's IHP and MAB Programmes are implementing joint activities on water and associated ecosystems with a special focus on the relationship between urban aquatic habitats and water resources under different climatic and socio-economic conditions. In order to improve urban water management integrating aquatic biodiversity and habitats, UNESCO is presently working on the preparation of a set of guidelines and a scientific publication on these issues.

### Urban Water Issues: Developed Versus Developing World

Water-related environmental problems that cities are facing can be grouped broadly into four overlapping and interacting categories: (i) access to water and sanitation infrastructure and services; (ii) urban wastewater pollution; (iii) resource degradation; and (iv) water-related hazards. In developed countries, categories (i) and (iv) are either under control or less prevalent categories (source: Tejada-Guibert and Maksimovic, UNESCO-IHP). Cities in developing countries and lower-income urban areas often face all four sets of problems, which are frequently exacerbated because they occur simultaneously and with higher intensity over longer periods of time.

Urban water management facilitates the sustainable provision of specific services, including water supply, flood protection and drainage, wastewater treatment and disposal, and maintenance of water-based amenities. While in developing countries there is a need for enlarging the supply capacity, in developed countries the focus tends to be on reducing further growth of withdrawals by demand management, water saving, and wastewater reuse and recycling. Urban water management has to accommodate the relatively new function of protecting

receiving waters as a recreational, aesthetic, environmental and ecological amenity.

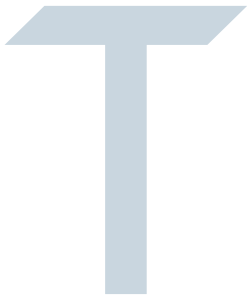
Integrated water management means the application of a long-term policy for developing water resource uses in a sustainable and socially balanced manner. An implementation strategy needs to be developed, which recognises the existing legislative, administrative constraints and other conditioning factors. Urban areas with their specific management problems and solutions represent only sub-elements of river catchments, while their management has to support the overall catchment planning. New paradigms in order to solve increasingly acute urban water problems need to be developed and applied.

This section has adapted concepts appearing in Chapter 6 "Urban Water Issues – an International Perspective" by J.A. Tejada-Guibert and C. Maksimovic in AGU Water Resources Monograph Series, Volume 16, 2004.

# 2. Who we **Are** and **Why** **UNESCO** is Involved in **Fresh Water**







The UNESCO International Hydrological Programme (IHP), established in 1975, is the only global intergovernmental programme of the UN system devoted to scientific study of the hydrological cycle, devoting considerable efforts to formulating policy-relevant strategies for the sustainable management of water resources.

UNESCO's IHP is an evolving programme, ready to adapt to the needs of a changing society. In order to respond promptly, the Programme is implemented in six-year phases, reflecting the priority issues in fresh water resources.

Today, integrated water resources management poses not only scientific, but also technical, socio-economic, cultural, and ethical challenges. IHP is a multidisciplinary programme at the forefront of the expansion of the knowledge-base in water resources, and is therefore a prominent vehicle in meeting the UN Millennium Development Goals (MDG) (see Box 3).

IHP supports actions, particularly in developing countries in furthering local scientific, technological, and institutional capacities needed for the sound management of water resources.

## BOX

### The Millennium Development target for water supply and sanitation

#### Sound water resources management and development is a key to achieving all of the Goals.

World leaders adopted the Millennium Declaration at the United Nations Millennium Summit in September 2000. The Millennium Development Goals emerged from the Declaration as an integrated set of time-bound targets for extending the benefits of globalization to the world's poorest citizens and making real progress by 2015, in tackling the most pressing issues that face developing countries: income poverty, hunger, disease, lack of adequate shelter, and exclusion – while at the same time promoting gender equality, education, and environmental sustainability. They also include basic human rights – the rights of each person on the planet to health, education, shelter, and security. (UN Millennium Project 2005)

Under the Millennium Development Goal 7: Ensure environmental sustainability is Millennium Development target 10: **halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation.**

It is an enormous challenge, particularly for sanitation, to reduce by half the number of people without safe drinking water and basic sanitation between the baseline year of 1990 and the target year of 2015. According to the latest report of the WHO/UNICEF Joint Monitoring Programme, meeting the sanitation target globally will require that an additional 1 billion people in cities and 900 million people in rural areas gain access to basic sanitation services.

The contribution to the achievement of the MDGs has been incorporated as part of the planning principles of the most recent phases of IHP. In the area of Urban Water Management, the activities of the programme all contribute to the objectives of Target 10 under Goal 7. For instance, there are activities that focus on data requirements for integrated urban water management, their collection methodology and quality control; new generation of urban groundwater management analytical tools considering quantitative and qualitative aspects; urban water management in different climates, including the humid tropics and arid and semi-arid zones; a fully new analysis and characterization of urban water conflicts. All of the activities include a significant component on capacity building easily accessible to interested users. The scope of the programme puts a special emphasis on cities in developing countries (a brief description of IHP's on-going activities is given in pages 12 and 13).

# 3. How **UNESCO** is **Responding** to **Integrated Urban Water** **Management Issues**



## UNESCO's IHP Plans

The Sixth Phase of IHP (2002-2007) – Water Interactions: Systems at Risk and Social Challenges – is based on the fundamental principle that freshwater is as essential to sustainable development as it is to life, and that water, beyond its geophysical, chemical, and biological functions in the hydrological cycle, also has social, economic and environmental values that are inter-linked and mutually supportive.

Under Theme 3 Land Habitat Hydrology, Focal Area 3.5 is concerned with Urban and rural settlements. Some of the major objectives of this Focal area are:

- To address the processes and strengthen research into urban water systems' interactions in particular climate regions;
- To develop and apply appropriate modelling tools for analysis of interactions;
- To create conditions for multidisciplinary interactions, for the appropriate transfer of knowledge and technology, and for running training programmes for water managers, urban planners and sanitary specialists;

The Seventh Phase of IHP "Water Dependencies: Systems under Stress and Societal Responses" will become operational from 2008 to 2013. Under Theme III: Ecohydrology and Environmental Sustainability, Focal Area III-3 will address urbanization pressures, sustainable cities, towns and villages and urban water management issues related to water and sanitation for megacities.

## The Marseille Symposium and Statement

The International Symposium on "Frontiers in Urban Water Management: Deadlock or Hope?" held in Marseille, France, on 18-20 June 2001 and organized with numerous national and international partners, was the concluding event for the Fifth Phase of IHP urban water activities.

A significant output of the symposium was the Marseille Statement, in which participants set out what they considered to be essential actions in the area of urban water issues. Among

## BOX

### The Regional Centre on Urban Water Management (RCUWM-Tehran, Iran)

The importance of urban water management and increased concerns over water as a critical global issue led international organizations, countries in the region and UNESCO's IHP to establish the Regional Centre on Urban Water Management (RCUWM-Tehran) in Tehran – Iran. This Centre is a regional scientific organisation focusing on Urban Water Management, which takes climatic and other specifics of the region into account. The potential impact of the centre would be to further international scientific and technical cooperation in the region. RCUWM's mission is to transfer applicable scientific knowledge, increase know-how and capacity in all dimensions of Urban Water Management as well as to undertake activities that enhance human welfare in the region.

The functions of RCUWM-Tehran are to promote scientific research, create and develop networks for scientific, technical and policy information exchange, develop and coordinate cooperative research activities on urban water management, organise knowledge and information transfer activities; develop a strong programme of information and communication of technology, provide technical consulting, effective capacity building activities, and advisory services in the region and beyond; as well as produce technical publications and other media activities.



RCUWM-Tehran Workshop on "Promotion of Women's Participation in Water Management", 23-24 Feb 2005



the proposals, the statement included: "Define strategies and tactics for the appropriate implementation of integrated urban water management in all countries, including best management practices and procedures for the rehabilitation of systems" and "Develop and strengthen institutions for integrated urban water management, by enhancing public information and awareness, transparency of procedures, education, and public involvement in decision-making". The Statement also issued a recommendation to develop educational programmes and to "establish and strengthen regional centres of excellence on urban water management, such as the new UNESCO Regional Centre on Urban Water Management in Tehran, particularly in countries in transition and developing countries".



A book, *Frontiers in urban water management: Deadlock or hope*, describing the state of the art in urban water management and pointing out promising directions, particularly for cities in the developing world, was presented by IHP at the symposium in June 2001. Over twenty international experts contributed to this volume.

## Urban Water Management activities in IHP

IHP has an active programme to generate approaches, tools and guidelines which will allow cities to improve their knowledge and analysis of the urban water situation, and thereby to draw up more effective urban water management strategies. Nine major topics were identified and outlined for development during IHP-VI (2002-2007):

- Data requirements management for integrated urban water management
- Processes and interactions in the urban water cycle
- Towards sustainable urban groundwater management
- Integrated urban water system interactions: Complementarity among urban water services
- Integrated urban water modelling and management under specific climates
- Urban water security, human health and disaster prevention
- Urban aquatic habitats in integrated urban water management
- Socio-economic and institutional aspects in urban water management
- Urban water education, training and technology transfer

## BOX

### Urban Water Resources in Western Africa

UNESCO supported the formation of a monitoring system to evaluate deterioration in the quality of groundwater resources in some of the larger cities of Western African countries. The project's aim is to set up a regional observatory of aquifers' vulnerability and early warning contamination for urban and "peri-urban" water supply and to develop methodologies

for optimal monitoring of the contamination of surface and groundwater aquifers in African urban areas.

This is a joint activity developed between UNEP-DEIA&EW, as the lead agency and UNESCO/IHP, as partner for the implementation of the project. UNCHS/Habitat (executing agency of the project on Water for African Cities) and ECA (UN Economic Commission for Africa) are also involved as regional and political partners.

# BOX

## Water in Mexico City

Mexico City is located in a closed basin at an elevation of 2,240 meters above sea level (masl). The city's 19 million inhabitants belong to two political entities: the Federal District and the State of Mexico. The City uses 69 m<sup>3</sup>/s of water (62 m<sup>3</sup>/s is distributed in bulk with 7 m<sup>3</sup>/s pumped directly from the aquifer for irrigation). Sixty-seven percent of the water comes from the aquifer, 21% from the Cutzamala River (in the Valle de Bravo at 1,200 masl and 150 km of distance), 10% from the Lerma aquifer (located in the Toluca Valley at 2,300 masl and 70 km away) and



Main Drain Collector which handles stormwater and wastewater flows from 60 to 300 m<sup>3</sup>/s from Mexico City.



2% from springs and runoff. Average per capita water use is 331 L/d. Since the majority of the water comes from the aquifer, overexploited by approximately 21 m<sup>3</sup>/s, soil subsidence in some areas reaches up to 30 cm/yr.

Eighty percent of the water is used for municipal purposes, 15% for irrigation and 5% for private purposes. The Federal District has 23 municipal wastewater treatment plants, with 19 at a secondary level and 4 at a tertiary level. The total amount of treated water is 4.8 m<sup>3</sup>/s: 54% of it is used to fill lakes and channels as well as for irrigation of 6,500 ha of agricultural land, 33% is infiltrated to subsoil, with 8% reused in industry and 5% in the commercial sector. In addition to the aforementioned plants, there is also private infrastructure (industrial, sports clubs, etc.) and other governmental institutions (the Federal Electricity Commission (CFE), and the National Defense Ministry (SEDENA) specifically). There are 44 registered plants that treat and reuse water at their own facilities, mainly for irrigation of gardens or for cooling in electric generation plants. It is thus estimated that overall, 6.5 m<sup>3</sup>/s are reused within the City.

The remaining wastewater (40 m<sup>3</sup>/s) is sent through three artificial exits that discharge to the North in the Tula Valley. Wastewater is reused – without any treatment – at this site for irrigation of the Mezquital Valley in Tula, Chiconautla and Zumpango. It is also used to fill the Endhó Dam (1.6 m<sup>3</sup>/s) which stores water for irrigation.



### Activity 1

#### Data requirements management for integrated urban water management

##### Objective

Reliability and availability of data is a prerequisite for quality urban water analysis of performance planning of rehabilitation and management. The project aims to establish a consistent methodology for data gathering, processing, and quantification of uncertainty and application under specific climate conditions.



### Expected results

Set of guidelines on “Data Requirements for Integrated Urban Water Management” including guiding principles, detailed recommendations on processes and protocols and illustrative case-studies.

The final publication of the guidelines is foreseen for 2006.



### Activity 2

#### Towards sustainable urban groundwater management

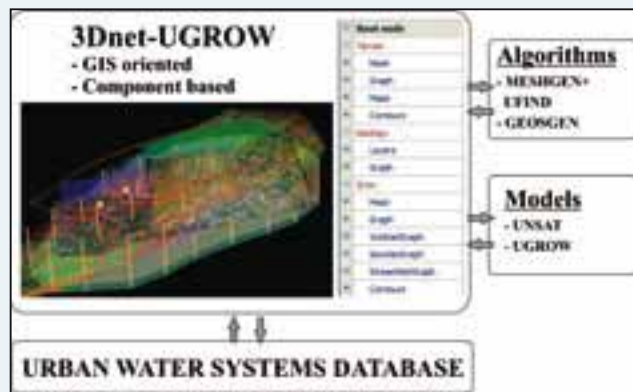
##### Objective

To develop a new generation of modelling, planning and management tool: UGROW (Urban Groundwater Management Model) which includes quality and quantity components.

UGROW has the capabilities for reflecting the role and the interactions of groundwater in the urban environment for sustainable integrated water management strategies.

A supporting volume is under production on guidelines on urban groundwater management, including the use of analytic tools as well as training and awareness raising material for urban planners and managers, water managers and the public at large on urban groundwater issues.

The first phase of UGROW was released in 2005, comprising the quantity component developed and the quality component. The incorporation of the quality component is being completed in 2006. A book on integrated urban groundwater management is foreseen to be published in 2007.





### Activity 3

**Integrated urban water modelling and management under specific climates: humid tropics (HT), arid and semiarid climates (ASA), cold climates (CC) and temperate climates (TC)**

#### Objective

Strengthening the analytical framework for integrated urban water management under specific climates, with a special focus on developing countries.

#### Expected results

Books addressing the specificities of urban water management in each climate, modelling tools and teaching materials for each climate.

A group of authors is working on a publication for each climate. The content for each publication was established during the workshops related to integrated urban water management in specific climates:

- **Humid tropics , Foz do Iguacu, Brazil, in April 2005.**
- **Arid and semi-arid zones, Cairo, Egypt, in November 2005.**
- **Cold climates, Trondheim, Norway, in November 2005.**

**The outline for the publication on integrated urban water management in a temperate climate, as well as the plans for the teaching material, will be formulated during the workshop to be held in Belgrade in May 2006.**

### Activity 4

**Urban water education, training and technology transfer**

#### Objective

Strengthening the ways and means of providing urban water education and training. The new paradigm in integrated urban water management requires top-level decision-makers, urban water and environmental professionals to have access to up-to-date knowledge and technologies. The project will

compile existing as well as create new training tools, including the provision of basic management knowledge for municipal professionals.

#### Implementation mechanism

A series of training courses and awareness-raising events (including briefing sessions for high-level decision-makers).

#### Expected results

Consolidated sets of training tools tested and applied in selected courses at various levels

### Centers on Urban Water Management under the auspices of UNESCO

IHP has a network of regional and international centers, which are a key element of UNESCO's strategy to improve scientific understanding of the water cycle and water resources management. Two centers concerned with Urban Water Management issues are currently in operation, with a future center in the pipeline:

- Regional Center on Urban Water Management (RCUWM) in Tehran, Iran (see Box 4)
- International Research and Training Center on Urban Drainage (IRTCUD) in Belgrade, Serbia and Montenegro
- Regional Center on Urban Water Management for Latin America and the Caribbean in Cali, Colombia (to be established)

The designation employed and the presentation of material throughout the publication do not imply the expression of any opinion whatsoever on the part of UNESCO in particular concerning the legal status of any country, territory, city or area or of its authorities, or the delineation of its frontiers or boundaries.

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