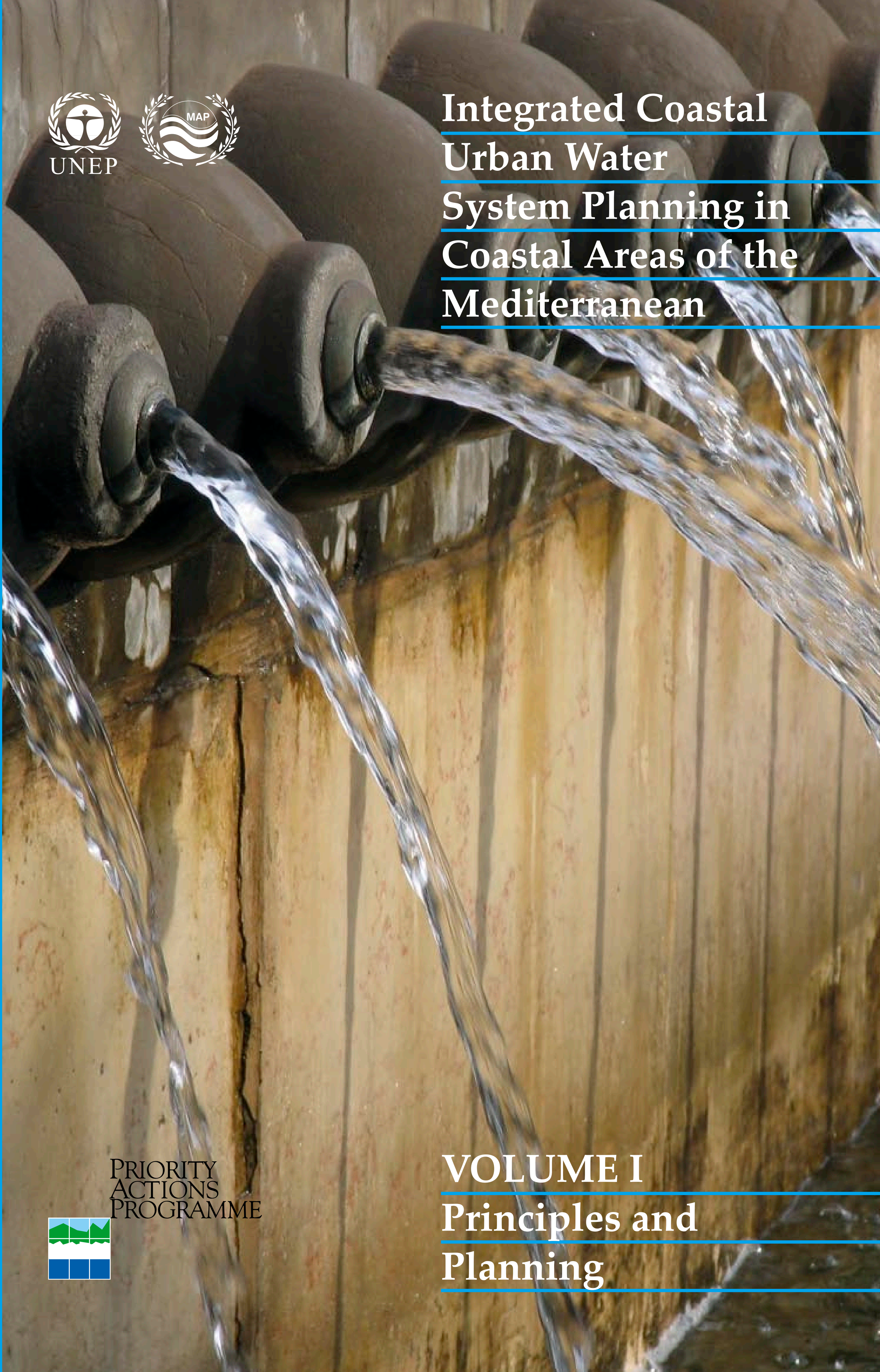

UNEP

MAP

Integrated Coastal Urban Water System Planning in Coastal Areas of the Mediterranean

VOLUME I

Principles and Planning

PRIORITY ACTIONS PROGRAMME

Background Information

The preparation of these Guidelines was commissioned by PAP/RAC from Dr. Giorgos Kallis, as Report Coordinator and Author and Research Associate at the Environment and Spatial Planning Laboratory of the University of Thessaly.

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- **ADVISOR** (*Integrated Evaluation for Sustainable River Basin Governance*), Energy and Sustainable Development Programme, EVK1-CT-2000-00074.
- **PRINWASS** (*Barriers to and Conditions for the involvement of Private Capital and enterprise on water supply and sanitation in Latin America and Africa*), International Cooperation - Developing Countries (INCO-DC) Programme, EVK1-CT-2000-00074.

This report has drawn upon an earlier draft report prepared by Professor Jure Margeta, Study Coordinator and co-author, Professor Ernest Azzopardi, Mr. Iacovos Iacovides and Mr. Michael Sevener.

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List Of Acronyms (Volumes I and II)

BOD	Biological Oxygen Demand
BOO	Build, operate and own
BOT	Build - Operate - Transfer
CAS	Chemically Assisted Sedimentation
CBA	Cost Benefit Analysis
CEA	Cost Effectiveness Analysis
CEC	Council of the European Communities
CIRIA	Construction Industry Research and Information Association
COD	Chemical Oxygen Demand
COMEC	Commission of the European Communities
COSLA	Convention of Scottish Local Authorities
DBMS	Database Management System
DIPs	Deliberative Inclusion Processes
DMAE	Departamento Municipal do Agua e Esgoto, Porto Alegre, Brazil
DSS	Decision-Support Systems
DWP	Department of Water and Power, Los Angeles
EEA	European Environmental Agency
EIA	Environmental Impact Assessment
EMAS	Eco-Management and Auditing Scheme
EMASESA	Municipal Water Company of the city of Seville
EPA	Environmental Protection Agency, USA
EU	European Union
EU WFD	EU Water Framework Directive
FAO	Food Agriculture Organisation
GIS	Geographic Information Systems
GWP	Global Water Partnership
IA	Integrated Assessment
IAURIF	Institute for Urban Planning and Development of the Paris Ile-de-France region
ICZM	Integrated Coastal Zone Management
IEMA	Institute of Environmental Management and Assessment
ILI	Infrastructure Leakage Index
IPPR	Institute for Public Policy Research
IRP	Integrated Resource Planning
IRR	Internal Rate of Return
ISD	Indicators for Sustainable Development
ISO	International Organisation for Standardisation
IUWSMCA	Integrated Urban Water System Management in Coastal Areas
IWA	International Water Association
LCA	Life Cycle Assessment
MAP	Mediterranean Action Plan
MCDA	Multi-criteria Decision Aid
MCSD	Mediterranean Commission on Sustainable Development
MED	Multi-Effect Distillation
MSF	Multi-Stage Flash
NPC	Net Present Cost
NPV	Net Present Value
OECD	Organisation for Economic Cooperation and Development
OFWAT	Office for Water Services, England and Wales
PAHO/WHO	Pan American Health Organisation, Regional Office of WHO
PAP/RAC	Priority Actions Programme Regional Activity Centre
PCE	Parliamentary Commissioner for the Environment (New Zealand)
PLCs	Public Limited Companies
PPPs	Public Private Partnerships
PSR	Pressure-State-Responses
RO	Reverse Osmosis
ROCE	Return on Capital Employed
SWOT	Strengths-Weaknesses-Opportunities-Threats (analysis)
SDR	Sustainable Development Records
SEA	Strategic Environmental Assessment
SETAC	Society of Environmental Toxicology and Chemistry
SIA	Social Impact Assessment
STOA	Scientific and Technological Options Assessment, EU
THM's	Trihalomethanes
TOC	Total Organic Carbon
TSS	Total Suspended Solids
TVM	Time Value of Money
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
UNEP/GPA	Global Programme of Action
UNEP-IETC.	UNEP International Environmental Technology Centre
UNESCO	United Nations
US CMSER	US Commission on Marine Science, Engineering and Resources
UWDM	Urban Water Demand Management
VC	Vapour Compression
VEWIN	The Netherlands Waterworks Association, Vereniging van Waterbedrijven in The Netherlands
WB	World Bank
WDCC	The Western Drought Coordination Council
WHO	World Health Organisation
WRI	World Resources Institute
WSUD	Water Sensitive Urban Design
WTA	Willingness to Accept
WTP	Willingness to Pay

PREFACE

The Priority Actions Programme Regional Activity Centre (PAP/RAC) of the Mediterranean Action Plan (MAP) has been implementing a number of activities in the field of coastal water resources management as a priority issue.

PAP has been concentrating its efforts on the provision of assistance to Mediterranean States in implementing the objectives set out in Chapter 18 of "Agenda 21", a policy document on water resource issues adopted by a significant number of governments. The recommendations of the United Nations Conference on Environment and Development (Rio, 1992) formed the basis of the Mediterranean Water Charter (Rome, 1992), and were fully endorsed by the Tunis Conference (Tunis, 1994) in the Agenda "MED 21".

As one of the activities comprising the priority action on coastal water resource management, MAP/PAP prepared the "Guidelines for an Integrated Approach to the Development, Management and Use of Coastal Water Resources".

In line with the priority issues and the general principles of "Agenda 21" and Agenda "MED 21", as well as the Barcelona 1995 Euro-Mediterranean Conference, and in tandem with the activities of the Mediterranean Commission on Sustainable Development (MCSD), one of the activities of MAP/PAP was the preparation of PAP's "Guidelines for Integrated Coastal Urban Water System Planning in Coastal Areas of the Mediterranean".

READERS' GUIDE

What are these Guidelines about?

Water management is a key factor for sustainable urban development in coastal areas. By the same token, the sustainable urban development of coastal regions is necessary for the sustainable management of scarce Mediterranean water resources.

Coastal cities in the Mediterranean are facing significant problems relating to the management of their water resources. Pollution, scarcity, droughts and floods are becoming more frequent and are triggering tensions and conflicts, both within cities and between cities and rural areas. The existing infrastructure is ageing while its replacement is costly. Continuous urbanisation, especially in peri-urban areas, poses costly demands for new infrastructure.

Urbanisation pressures are particularly intense on the coast. Assorted activities and competing uses are concentrated in a narrow coastal zone (settlements, infrastructure, various economic activities, ecosystems, etc.). Coastal water resources have particular characteristics that merit a special approach due to the complex interaction between surface waters, groundwater and sea water.

Urban water management in coastal Mediterranean settlements is currently approached as a series of separated tasks: drinking water supply, sewage management and drainage. Many of the current problems are the result of a fragmented approach. There is a need to move to a more integrated management approach whereby the three tasks are managed together and furthermore, in close coordination with urban development and management, coastal zone management and water resource management at the river basin level.

These Guidelines aim to:
- Sensitise all those in coastal zone and urban management and water resources management to urban water management issues
- Sensitise all those involved in urban water system management to coastal zone and urban management and water resources management issues
- Provide a framework of reference for Integrated Urban Water System Management in Coastal Areas (IWSMCA)

While there is much information and guidance about separate urban water management tasks, the issue of integration has received less attention. These Guidelines seek to rectify this situation. The coastal urban water system is addressed as a whole and explicit guidance is provided for its integrated management and planning, taking into account the particular features of Mediterranean coastal urban settlements.

The Guidelines are divided into two volumes. Volume I presents the principles and planning for urban water system management, while the Volume II presents the most important instruments and tools. Our intention is to facilitate a broader use of these Guidelines. Volume I thoroughly explains the problems relating to integrated urban water system management, while the Volume II presents the tools and techniques needed for management in more detail. Accordingly, the Volume I is intended for all those who wish to get to know the problems of integrated urban water system management, while the Volume II is intended for those who wish to engage in the solutions to these problems.

In this document you will find:
- An identification of the main problems caused by urbanisation to coastal water resources in the Mediterranean (Chapter 2)
- A definition of an integrated "coastal urban water system" (Chapter 1) and a detailed presentation of its components, processes and outputs (Chapter 3)
- A definition and explanation of Integrated Urban Water System Management in Coastal Areas (IUWSMCA) (Chapter 1) and guidance on the main implementation tasks (Chapter 4)
- A framework for implementing a planning procedure for IUWSMCA (Chapter 5)
- Guidance on how to integrate urban water system management and planning with urban land-use, river basin and coastal zone management and planning (chapters 4 and 5)

The tools and instruments for management and planning are briefly presented in chapters 4 and 5. More specific guidance for selected instruments and tools is provided in the Volume II of these Guidelines. This includes information and guidance on how to:

- Choose between private and public models of organisation
- Design the legal framework
- Design appropriate water tariffs
- Implement a water demand management programme
- Organise and execute a public participation process
- Manage risks

The Volume II also presents tools supporting decision-making and performance assessment, and presents and appraises new multi-functional technologies for urban water management.

The Guidelines should be seen as a general reference tool, while detailed descriptions of urban water infrastructure (water supply systems, wastewater systems, drainage systems and others), urban systems, water resources and natural processes and their interactions can be found in specialised scientific literature. Detailed descriptions of management and planning methods and techniques, as well as information on specific tools can also be found in specialised literature.

Who are these Guidelines for?

These Guidelines are intended for practising engineers, urban planners, natural and social scientists, water resource managers and urban water managers. In particular, these Guidelines will be of use to:

- policy makers at a national and urban level, active in the field of water resource management, urban water system management, coastal management or urban planning
- public or private water utilities responsible for urban water supply, waste and storm sewage services, storm drainage and the management of water bodies in urban Mediterranean coastal areas
- practitioners, academics and students in the field of urban water management
- other individuals or organisations active in urban water policy and management

Key messages

1. The conventional ("big pipes in - big pipes out") paradigm of urban water management characterised by responsive, sectoral, state-subsidised infrastructure works, is no longer able to address problems. The need exists for an **integrated approach**.

2. The coastal urban water system includes the three urban water infrastructures (water supply, wastewater and drainage) together with urban water bodies, coastal seawaters, marine resources and ecosystems, river basin water resources and dependant ecosystems and urban activities and land-uses. The geographical boundaries of the system are those of the **urban basin** (or catchment), consisting of land and sea areas and the boundaries. An integrated approach requires that this coastal urban water system is **managed as a whole**.

3. Managing the coastal urban water system as a whole requires **three progressive levels of integration**. Firstly, integration between the management of water supply, wastewater, drainage and urban water bodies. Secondly, integration of the management of the three urban water infrastructures with the management of water resources at the river basin level, urban land-use and infrastructure management, and coastal zone (water, resources and land-uses) management. Thirdly, integration of the goals of urban water management into regional, national and international sectoral policies (economic, social, etc.).

4. Options for the **merging** of utilities responsible for water supply, wastewater and drainage should be considered where economically and managerially feasible and beneficial. A long term partnership (**forum**, **council**, **committee** or other) for IWSMCA should be instigated. This should include managers from the urban water utilities and representatives from public agencies and public or private utilities involved in water resource (river basin) management, urban water bodies management, urban land-use planning, urban utility services, and coastal zone management. The partnership should also include other social actors involved in or affected by urban water management. The task of the partnership should be to co-ordinate the monitoring, planning and management activities.

5. The partnership should prepare a 10-20 year **Master Plan** for IWSMCA. This plan should outline basic system needs and goals, provide an analysis of the main problems substantiated by key data, identify a list of alternative measures/projects (technical and non-technical) and propose a strategy for the optimal combination of measures. Measures should be selected on the basis of an integrated use of evaluation tools, such as Cost/Benefit (or Effectiveness) Analysis, Environmental (or Social) Impact Assessment, Risk Assessment and Multi-criteria Decision Aid. Several other **thematic** and/or **sectoral plans** may be developed together with the Master Plan. Direct input from **stakeholders and the public** is crucial in the making and implementation of the plans.

6. **The sustainable management** of the urban water system should be based on a systemic and **proactive** approach utilising **socio-economic conditions**, **ecosystem services** and respecting **ecological limits**. The emphasis should shift away from water supply to **demand management** and from end of pipe pollution treatment to proactive **pollution control at the source**. Flood mitigation should shift away from reactive infrastructure works to small scale, multiple-use projects and urban planning interventions. Urban stream, lakes, ponds and the coast should be re-naturalised and integrated into the urban environment of the future. **Risk management plans** and procedures should be implemented to control drought, pollution, flood or other hazards and to respond effectively to emergencies when they occur.

7. Urban land-use planning should be based on the principles of a "**Water Sensitive Design**". Land-use and urban form policies should support goals related to stormwater management, pollution control and efficient water use. Small to medium-scale stormwater and wastewater projects can be integrated in the urban landscape and provide valuable aesthetic features (e.g. retention reservoirs). Urban water bodies should become an important part of the urban landscape. Urban water managers should collaborate with colleagues in urban planning to achieve shared goals. Equally, urban planners and other utility managers should contribute to urban water management. Such links can be strengthened by collaboration in planning and by undertaking joint projects of mutual interest. The sharing of common data can strengthen such links.

8. The coastal urban water system plan should be positioned within an overall **river basin management plan**. Urban water managers should be active participants in river basin decision forums. Similarly, river basin authorities should have an active role in urban water system planning and management.
9. Decisions for water supply, drainage and pollution control should take into account goals relating to the sustainability, quality of coastal waters and the health of related terrestrial and marine ecosystems. Urban water systems should be closely linked with planning and management efforts under an **Integrated Coastal Zone Management**. Representatives from urban water utilities should actively participate in any related ICZM decision forum.

10. **The funding** of urban water services is essential if planning and management goals are to be achieved. Public, private or mixed water utilities are all able to achieve a sustainable revenue and investment policy. A comprehensive, long term **investment (assets) plan** should be prepared and potential sources of funding (internal, e.g. tariffs, and external, e.g. State funding, donor organisations, banks) should be identified. The plan should provide the basis for an application for external financing.

11. **Water tariffs** should be designed so as to secure sufficient revenue for the funding of operations and investments. Sufficient funding is crucial to the achievement of sustainable urban water development. **Advanced tariff** designs, as applicable to each case, should be implemented to balance economic (efficiency), social (fairness and affordability) and environmental (water saving and pollution control at source) goals. **Seasonal** (summer or dry year) and **social tariffs** should also be considered.

12. **Public participation** should occur throughout the planning and management process. **Public access to all information** should be explicitly safeguarded. **Consultation** should form an integral part of all key decisions (e.g. new projects, price reform, etc.). Active engagement can be promoted by the use of **deliberately inclusive tools and processes** in decision-making.

13. A comprehensive **legal framework** governing the coastal urban water system should be instituted at a national level. Its basis should be a **Water Resources Law** and a **Water Services Law**. The first should regulate water use rights, allocation of water resources and quality standards/pollution control requirements. The second should cater for service and customer standards and tariff-setting. Environmental, public health, administrative and competition law may take care of any remaining issues.

GLOSSARY

Aquifer
A subsurface layer or layers of rock or other geological strata of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstraction of significant quantities of groundwater.

Coastal zone
The part of the land affected by its proximity to the sea, and that part of the sea affected by its proximity to the land as the extent to which man's land-based activities have a measurable influence on water chemistry and marine ecology.

Coastal water
The surface water on the landward side of a line, every point of which is at a distance of one nautical mile on the seaward side from the nearest point of the baseline from which the breadth of terrestrial waters is measured, extending, where appropriate, up to an outer limit of transitional waters.

Combined sewer
A sewer system that carries both sewage and stormwater.

Conservation (water)
A socially beneficial reduction in water use or loss.

Decision support system
A coordinated pool of people harnessing devices or other resources that analyses data and presents it so that users can make decisions more easily.

Ecosystem services
Functions performed by ecosystems ensuring that natural cycles, processes and energy flows continue to provide an environment that supports life, including human life.

Ecosystem
A biological system comprising a community of living organisms and its associated non-living environment.

Effluent
Liquid discharges from sewage treatment or industrial plants.

Externality
Profit or cost which is not included in the price of goods and services exchanged on the market.

Full cost of water
The sum of capital, operational and external costs of water services.

Groundwater
Water within geologic formations below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil that can emerge at the surface through wells and springs.

Hazard
A potentially damaging physical event, phenomenon and/or human activity, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

Land-use plan
A plan that allocates social and economic activities in the urban space.

Marginal cost
The incremental cost of producing an additional unit of a good or service.

Master Plan
A long-range (10-20 years) planning document with strategic and action elements.

Potable (water)
Water safe or suitable for drinking.

Privatisation
The permanent or temporary sale of parts of urban water systems to private entities.

Risk
The probability of harmful consequences, or expected losses resulting from interactions between natural or human induced hazards and vulnerable conditions.

River basin
The area of land from which all surface run-off flows through a sequence of streams, rivers and

possibly lakes into the sea at a single river mouth, estuary or delta.

Sewage/foul sewer
A sewer system that carries wastewater.

Sludge
A semi-fluid mass of sediment resulting from the treatment of water, sewage and/or other wastes.

Storm sewer
A sewer system that carries stormwater.

Stormwater
Rainfall that does not infiltrate the ground or evaporate.

Sub-basin
The area of land from which all surface run-off flows through a series of streams, rivers and, possibly, lakes to a particular point in a water course (normally a lake or a river confluence).

Surface waters
All standing or flowing water on the surface of the land (e.g. streams, rivers, polders, lakes).

Tariff
A system of procedures and elements that determines a customer's total water bill.

Urban area
A generally regular and recognisable agglomeration of buildings and thoroughfares, where people live, work and engage in many of their social activities.

Urban basin
The sub-basin(s) occupied or used for the water supply of an urban area.

Urban ecosystem
The associated system of humans, living organisms and built artefacts that comprise a city.

Urban water cycle
The natural and managed pathway that water follows in an urban ecosystem in gaseous, liquid or solid form.

Urban water demand management
Policies or measures which serve to control or influence the amount of water used in a city.

Urban water services
The functions provided by the constructed system of water supply, wastewater and stormwater infrastructure.

Urban water system
The natural, modified and human-built elements of the urban water cycle that exist in towns and cities in the Mediterranean coast.

Urbanisation
A process of increasing occupation of free land by buildings associated with an increase in the proportion of people living in towns and cities.

Utility (urban water)
A public or private entity involved in the provision of urban water services.

Wastewater
Water containing waste including greywater, blackwater or water contaminated by waste contact, including process-generated and contaminated rainfall run-off.

Wastewater recycling
Reuse of treated urban effluents.

Water sensitive urban design
Land-use design incorporating features that improve the management of water.

1. INTRODUCTION

This chapter explains the purpose of these Guidelines. Firstly, the urban water problems addressed are outlined. The need for an integrated management is then justified. Ongoing initiatives on urban water management in the Mediterranean and the rest of the world are briefly reviewed, highlighting the gaps that the present document tackles. The concepts of an "urban water system" and "integrated urban water system management in coastal areas" are then introduced and explained.

1.1 WHY IS INTEGRATED URBAN WATER SYSTEM MANAGEMENT NEEDED IN MEDITERRANEAN COASTAL AREAS?

In the coastal regions of Mediterranean countries, 61% of the population live in urban areas (Blue Plan, 2001). This percentage is likely to grow considerably in the future. Water is a vital element for city life. Its supply is crucial to the health and wellbeing of the people, for the urban landscape and the environment. Water also constitutes an essential input into economic production and development.

Water management in most urban areas is governed by a dated engineering paradigm developed in the early 20th century. In this linear model, water is drawn from wherever it is found - distance not being a major consideration. It is treated, distributed, and then disposed of together with stormwater, rapidly and at a distance from the city. This model has assumed abundant water resources, ever rising demand and the ability to collect, treat and dispose of any amount of storm or polluted waters. It has relied on large infrastructures such as reservoirs, distribution and drainage pipes, enlarged as necessary to accommodate growth in the urban area.

These centralised water supply and wastewater disposal processes saved many lives by improving drinking water and sanitation services. Conditions have changed, however, and the limits of this linear model have been reached in many Mediterranean urban areas for several reasons:

- An increasing frequency of extreme climatic irregularities and events such as droughts and floods, all with negative impacts
- A growing demand for water, which in many cities reaches the limits of developed sources
- The rising, often prohibitive cost of new water supply works such as dams or transfer systems
- Intensifying reaction against the environmental impacts of large hydraulic infrastructures and a growing interest in the maintenance of "environmental flows"
- The significant percentage of water lost in storage and transport coupled with the high and rising cost of replacing and renewing ageing infrastructures
- The pollution of drinking water sources by industry, agriculture and domestic sewage has been responsible for notable failures of urban mains supplies as well as public health epidemics
- The deteriorating aquatic environments resulting from water supply works, drainage interventions or wastewater discharges coupled with the increasing local and international social interest in the ecological, recreational and aesthetic values of water
- The rising cost of extending infrastructure systems to expanding outer suburbs

Coastal cities in particular face special problems. Intensifying urbanisation, urban sprawl in peri-urban areas and the growth of tourism burden limited coastal water resources. The over-abstraction of groundwater causes seawater intrusion, land subsidence and damage to terrestrial and aquatic coastal ecosystems. The need of coastal cities to transport their water from a distance often impacts negatively on distant inland users and environments. Located at the downstream end of river basins, they suffer the impacts of upstream pollution, abstractions or storm overflows. Coastal cities are often close to important ecological sites (delta estuaries, wetlands, etc.) and wastewater effluent discharges from the cities contribute to the deterioration of these sensitive coastal environments.

Urbanisation and economic development inflict pressures on water resources and the aquatic environment. In turn, the impacts from these pressures are threatening the long term sustainability of urban development (Figure 1.1). Responses to problems fail because they focus on remedial action on the impact side. An integrated approach is needed in order to jointly address both the roots and the impacts of the problems (Figure 1.1).

A short-sighted focus on operational aspects of the infrastructure inhibits the implementation of such an integrated, multi-faceted response. In urban water management as currently practised, there is scant concern for the broader interdependencies between water resources, land, ecosystems and society. New technologies with multiple environmental, economic

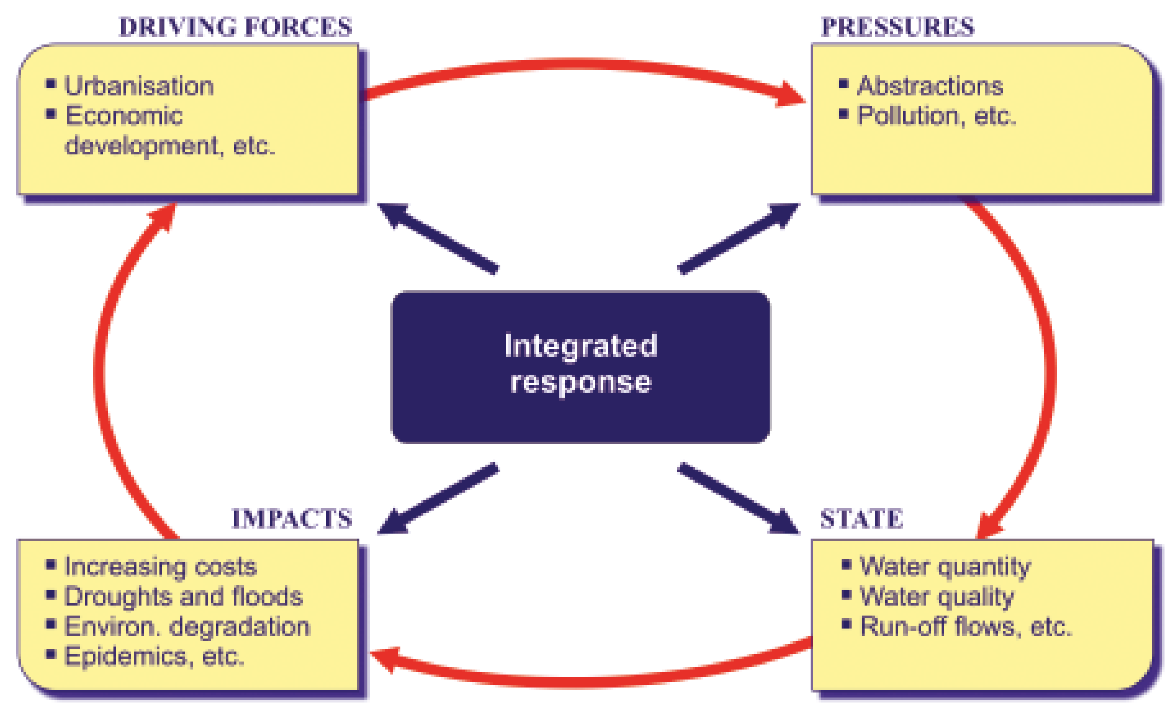


Figure 1.1
Driving forces, pressures, state and impacts on urban water resources and the need for an integrated approach

and social advantages are available. Their adoption, however, is inhibited by sectoral and fragmented responsibilities. The inability to address problems owes much to the limited domain of the agencies responsible for urban water services and the presence of several fragmented and conflicting competencies with remits to deal with various aspects of the urban water system.

In order to combat urban water problems, the existing linear, reactive and fragmented management model is no longer sufficient. The need exists to develop new approaches, structures, processes and instruments that can take into account the intimate functional links between the various parts of the urban water cycle and between the urban water cycle and the interdependant development and environmental processes in urban areas, the river basin and the coast.

1.2 WHAT IS ALREADY BEING ADDRESSED?

International institutions and agencies such as the World Health Organisation (WHO), UNESCO, the Global Programme of Action for the Protection of the Marine Environment (UNEP/GPA), the World Bank (WB), the Global Water Partnership (GWP), the European Union (EU) and others have developed several programmes and activities that directly or indirectly affect urban water management in coastal Mediterranean areas. Box 1.1 summarises the main initiatives.

These initiatives cover distinct parts and issues important to the urban water cycle. There is no policy, however, nor a document outlining such a policy, that **comprehensively** addresses the entire urban water system, and the related issues, problems and aspects of present and future urban water system management. In particular, the interface between urban water management and urban land-use/development, water resource management at the river basin level and coastal zone management, has received scant attention. Furthermore, there is an absence of **targeted reference material for coastal urban areas**, and particularly for **Mediterranean** coastal areas.

These gaps are addressed by the present Guidelines. These Guidelines should be seen as a complement or as an integrating framework to more precise guidance on specific tasks and tools, such as the recently published UNEP/MAP/GEF guidance documents on sewage treatment and disposal, the management of industrial wastewater, etc. (see Box 1.1 on the UNEP/MAP/GEF initiative).

BOX 1.1
INTERNATIONAL INITIATIVES RELEVANT TO URBAN WATER MANAGEMENT

Mediterranean Commission on Sustainable Development (MCSD)
The MCSD is a forum for dialogue and proposals for the Contracting Parties of the Mediterranean Action Plan. It is an advisory forum and consists both of national experts and civil society representatives. "**Management of water demand**" and "urban management and sustainable development" are two of the eight priorities of the MCSD. Each subject is taken up by a work group run by two task managers with technical support from MAP and the Regional Activity Centres. Recommendations have been produced for the management of water demand.

World Health Organisation (WHO)
WHO has produced several technical documents on water, sanitation and public health including its well known drinking water standards. The *Protection of the Human Environment - Water and Sanitation* programme has generated guidelines and technical documents relating to the operation, maintenance and optimisation of urban water supply and sanitation systems.

UNESCO
The International Hydrological Programme-VI (2002-2007) has specific *Urban Water Management Components*. These are expected to deliver manuals and guidelines on: urban water data management; water and environment sensitive urban development; modelling, planning and management tools; the selection of future technologies; management in specific climates; management of urban aquatic habitats and water amenities; the socio-economic and institutional aspects of urban water management; and consolidated sets of teaching materials and training tools, tested and applied in selected countries. A recently published volume (Maksimovic and Tejada-Guibert (2001), based on a UNESCO international conference, presents a state-of-the-art urban water management model.

UNEP/MAP/GEF
A Strategic Action Programme (SAP MED) to address pollution from land-based activities, implementing the provisions of the UNEP Global Programme of Action (GPA) in the Mediterranean region, was adopted by the Contracting Parties to the Barcelona Convention in 1997 as a follow up to the provisions of the revised Land-Based Sources (LBS) Protocol. In order to assist the Mediterranean Countries in the implementation of SAP MED, a three year GEF project "Determination of priority actions for the further implementation of the SAP for the Mediterranean Sea" was implemented by MAP in a partnership between the MED POL Programme, the MAP Regional Activity Centre and WHO/EURO. The project consists of numerous activities including the preparation of guidelines and plans on actions relevant to urban water management such as the reduction of BOD input into waters, pollution monitoring, sewage treatment and disposal, the management of industrial wastewater, etc.

World Bank
The WB has funded several water and sanitation projects in developing countries and has published numerous reports on projects, guidelines for financial matters in the water sector, and toolkits for water and sanitation.

Global Water Partnership (GWP)
GWP membership extends to all Mediterranean countries and includes several Mediterranean networks such as the Blue Plan, the Centre for Environment and Development for the Arab Region & Europe (CEDARE), the MedWet Initiative on wetlands, the Mediterranean Information Office for Environment, Culture and Sustainable Development (MIO-ECSD) and the **Mediterranean Water Network** (MWN) set up after the **First and Second Mediterranean Water Conferences**. The GWP has issued guidelines on integrated water management, the funding and regulation of water services and the economics of water.

European Union
Several of the provisions of the **European Water Framework Directive** will affect water management in urban areas. At the Johannesburg Summit, the European Commission committed to a **European Water Initiative** consisting of development aid for water service projects and research in third countries as well as bilateral projects between EU Member States and Third Countries (a special **Mediterranean Water Initiative** was initiated under the auspices of the Greek Government). Integrated urban water management was a priority in the 5th EU Framework Research Programme and it remains a key thematic issue in the ongoing **6th Framework Research Programme** (under the Water Cycle component of the Global Change and Ecosystems Programme).

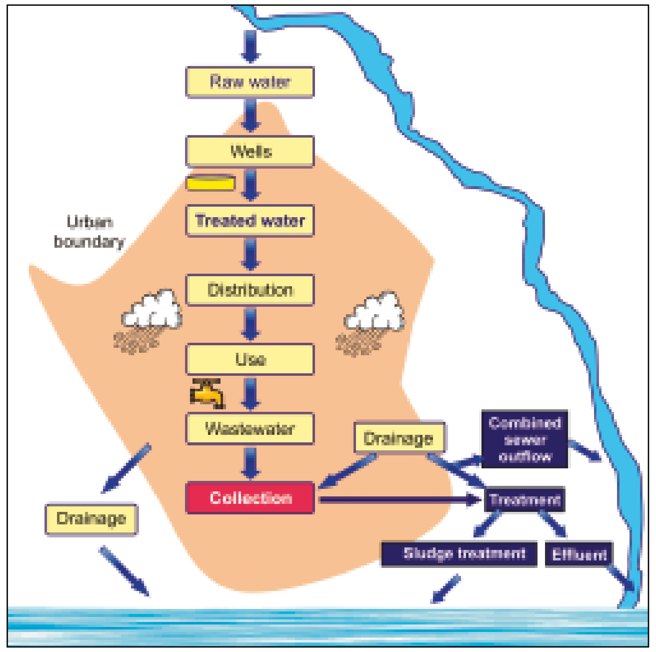


Figure 1.2
The urban water system

1.3 THE URBAN WATER SYSTEM IN COASTAL AREAS

Urban water systems are the natural, modified and human-built elements of the urban water cycle that can be found in towns and cities along the Mediterranean coast (Figure 1.2). Systems provide water to support human life, health, hygiene, safety, recreation and amenities.

The natural system includes the network of streams, rivers, groundwater, seawater, wetlands, estuaries, and coastal and marine areas. The built system includes the water intake, water supply pipes, pump stations, service reservoirs, distribution networks, water treatment plants, sewage network, concrete channels, drains, wastewater treatment plants, overflows, wastewater and stormwater pump stations and outfalls (PCE, 2000) (Box 1.2). This built system is part of the broader **urban infrastructure system**. **Water services** are the functions provided by the built system of water supply, wastewater and stormwater infrastructure.

The **urban water cycle** includes the natural hydrological cycle, but is not confined to it. It also includes urban water flows from the provision of freshwater and the collection and treatment of wastewater and stormwater through the modified and artificial systems (Figure 1.3). The cycle begins with precipitation falling on the basin of the urban area and its water sources. Water is extracted from natural streams, aquifers or other sources, usually stored in reservoirs and then processed to potable quality before delivery through an extensive pipe system to residential, commercial (including tourism) and industrial developments. Used water transports wastes through a network of sewers to treatment plants, which process water and discharge cleaner effluent into receiving waters. Rainfall falling on the city contributes to the urban basin's stormwater that is collected by an extensive drainage system for disposal (treated or untreated) into receiving waters (Coombes and Kuczera, 2002).

Water is not the only element circulated and flowing through the urban water system. Natural substances (in particular carbon, nitrogen, phosphorous and potassium) enter it, essentially as digested food, and are transferred via the wastewater treatment plant or directly by surface run-off to the receiving water body (Butler and Maksimovic, 2001). Unfortunately, besides these "natural substances" many other "non natural substances" today enter into this cycle, altering the characteristics and usability of the waters. This is particularly pertinent to urban stormwater and industrial wastewaters.

BOX 1.2
COASTAL URBAN WATER SYSTEM ELEMENTS

- Drinking water sources
- Drinking water production infrastructure
- Distribution and storage infrastructure
- Urban water uses
- Stormwater drainage infrastructure
- Stormwater overflow, disposal and treatment infrastructure
- Sewage system
- Wastewater treatment units and outfalls
- Reuse infrastructure
- Receiving waters and the coastal sea
- Urban surface and groundwater
- Channels, weirs, intake and/or pumping stations, etc.
- Estuaries, deltas, wetlands and coastal marine resources, etc.

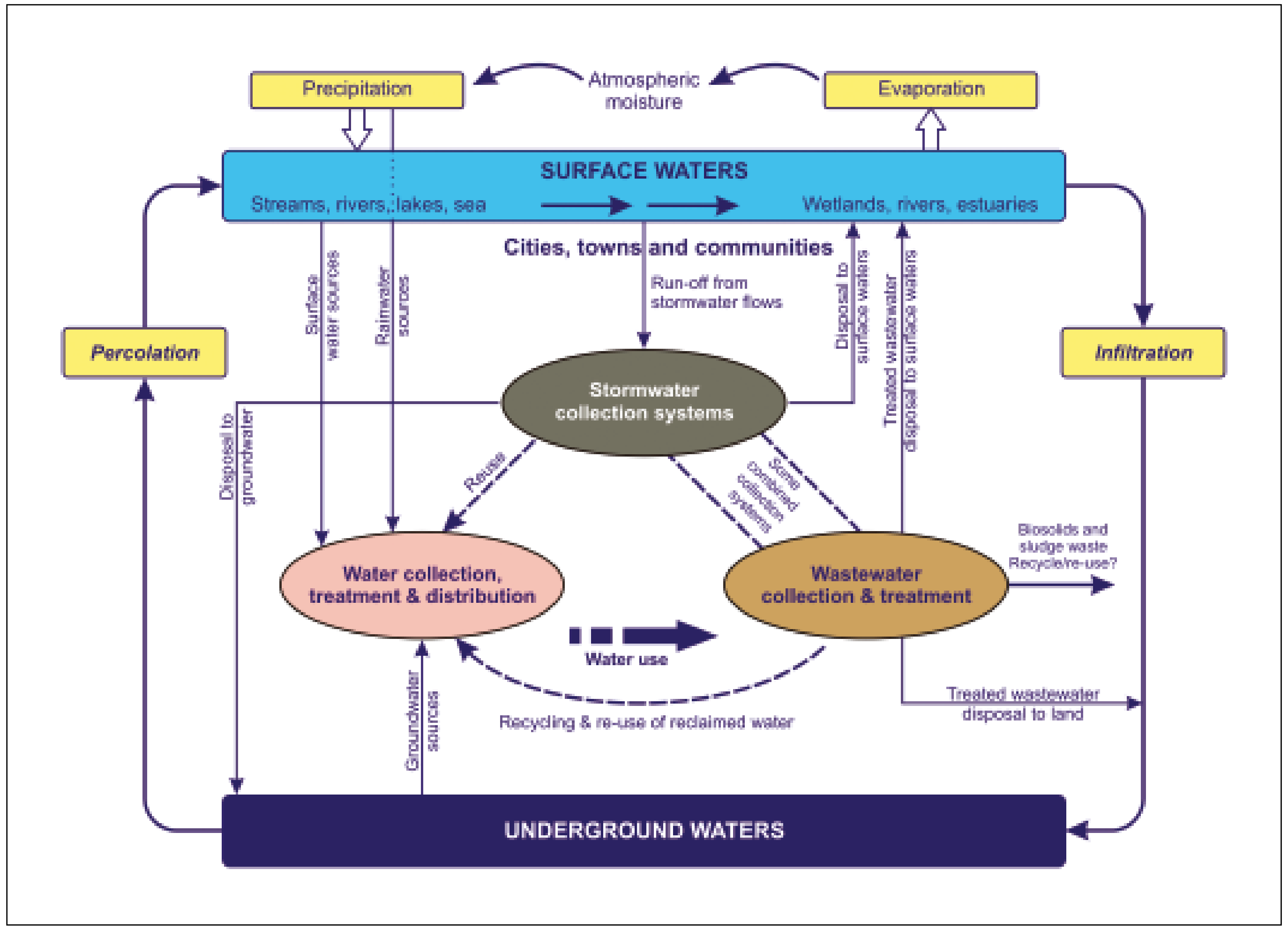


Figure 1.3
A schematic of the urban water cycle (modified after PCE, 2000)

The urban water system is a part of and in constant interaction with its surrounding **natural and social environment**. In coastal areas, this includes:

1. The river basin
2. The coastal zone
3. The broader urban area

The river **basin** (also referred to in literature as "catchment" or "watershed") is 'the area of land from which all surface run-off flows through a sequence of streams, rivers and, possibly, lakes into the sea at a single river mouth, estuary or delta'. This includes "**coastal waters**", i.e. surface brackish or seawater at a distance of one nautical mile from the sea front (CEC, 2000).

The **coastal zone** is the 'part of the land affected by its proximity to the sea, and that part of the sea affected by its proximity to the land, as the extent to which man's land-based activities have a measurable influence on water chemistry and marine ecology' (US CMSER, 1969).

An **urban area** refers to a concentration of people in a comparatively small area, characterised by a great diversity of related activities with a high frequency of interaction and by a physical form showing a concentration of a variety of built-up and un-built spaces (Hengeveld and de Vocht, 1982).

Figure 1.4 graphically illustrates the interrelation between the four systems.

The **urban basin** (elsewhere referred to as "urban catchment") is the hydrological basin of the urban area, including its coastal waters. It is one of sub-basins of the river basin (see Figure 1.4). It provides a functional unit from which to address integrated urban water management in coastal areas.

Furthermore, the urban area and its water system, the river basin and the coast are all subsets and interact with larger regional, national and global social and natural systems. For example, global climatic changes affect the local availability of water. Conversely, energy consumption for the urban water supply contributes to global climate change.

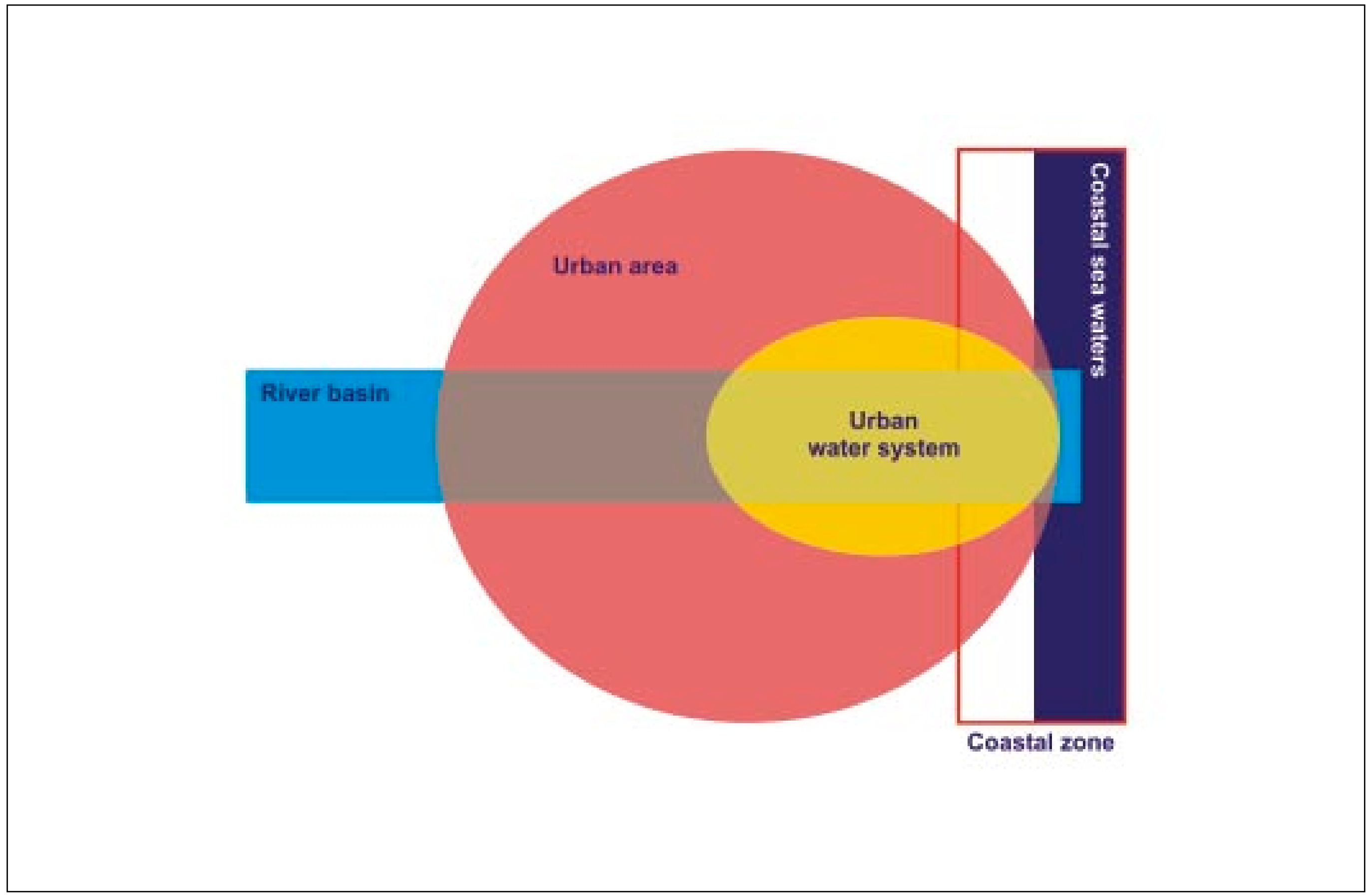


Figure 1.4
The interfaces between the urban water system, the river basin, the city and the coast

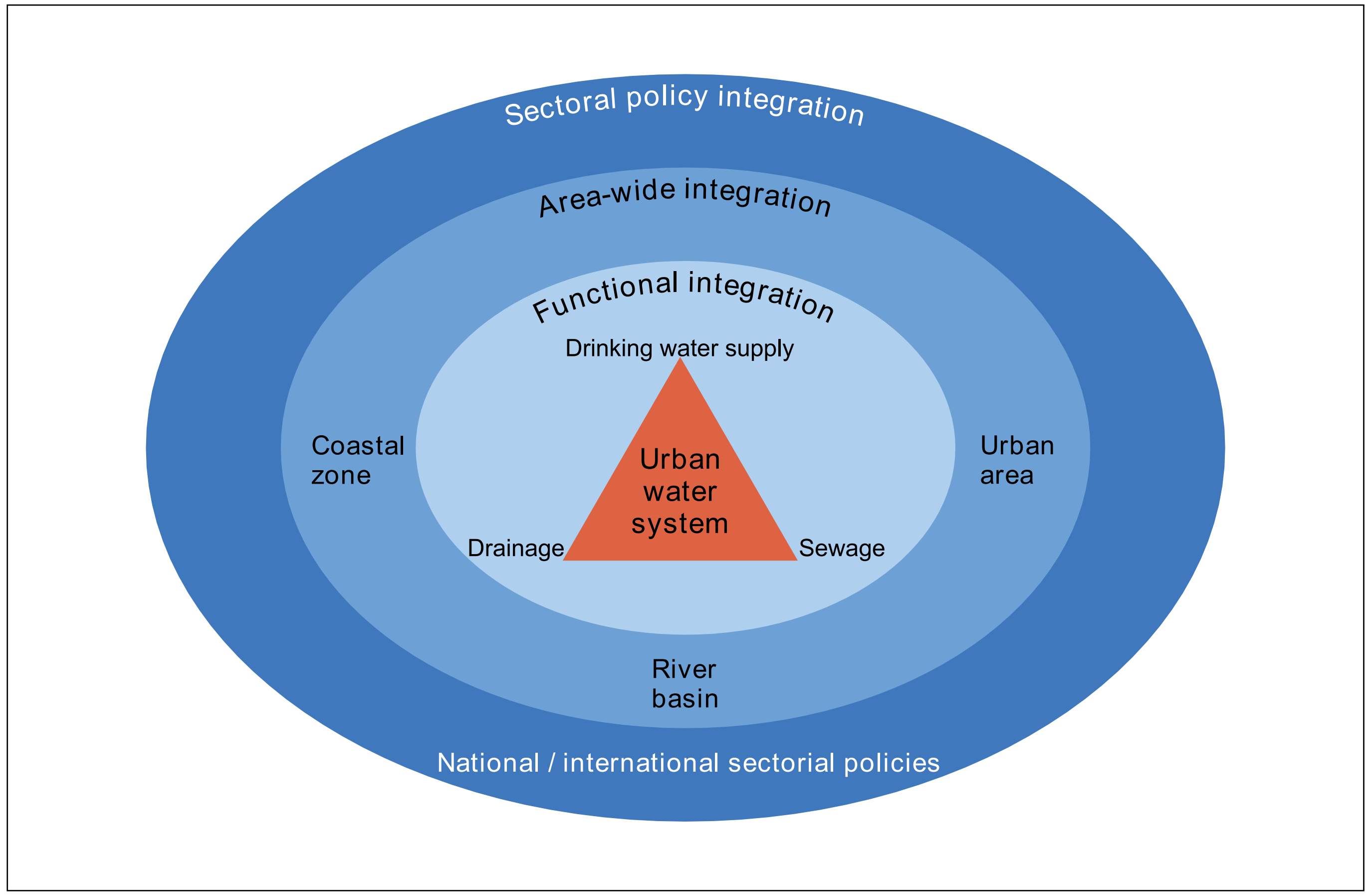


Figure 1.5
Progressive boundaries of integration

1.4 INTEGRATED URBAN WATER SYSTEM MANAGEMENT IN COASTAL AREAS (IUWSMCA)

Integrated Urban Water System Management in a Coastal Area (IWSMCA) is a process which promotes the coordinated planning, development and management of water, land and related physical and human resources in coastal urban areas in order to maximize the resultant social and economic welfare in a fair manner and without compromising the sustainability of vital ecosystems (after GWP, 2000).

Conventional urban water management is solely concerned with the built system and the provision of water services. This is typically the responsibility of one or more, public or private, **water utilities.** Each part of the infrastructure and related service (drinking water supply, sewage collection/treatment/disposal and drainage) is managed separately. Different functional units of one utility or different utilities may operate each service or part of it. Such an approach was acceptable while the pressures were low and the resource capacity high. The present situation, however, is becoming increasingly complex, and requires an integrated approach.

Integration demands a progressive expansion of the "boundaries" of the managed system (Figure 1.5). The core (first tier) of integration refers to the "**functional integration**" of the management of the different water infrastructures and services and the coordinated **management of the urban water system as a whole**.

IUWSMCA, however, goes further than functional (infrastructure and service) integration. It demands an **extension** of the conventional domain of responsibility for utilities to encompass what were previously considered as **"external" factors**. Such factors include the wellbeing of the environment and other communities in the source areas, the contribution to alternative, environmentally-resourceful and sustainable urban development patterns, the protection of sea waters, marine resources and recreational activities and even regional economic development. This is referred to as an **"area-wide" integration** and demands tie-ins with planning and management processes in the three interacting systems of Figure 1.5, i.e. urban land-use planning and development management, river basin planning and management and coastal zone planning management.

Furthermore, urban water management should be coordinated with higher national, international, and global natural and socio-economic systems and mutually support and be supported by broader sectoral policies and goals at the national and international levels. This is referred to as "**sectoral policy integration**". Figure 1.5 indicates these progressive layers of integration.

An urban water utility has a certain outreach and cannot control all factors that affect the urban water system. IUWSMCA does not necessarily demand a new overriding administrative structure with responsibility for the whole system. A "full integration of everything" is neither possible nor desirable. An increasing bureaucratic burden may increase decision-making costs and reduce effectiveness. Integration is desirable **only to the extent that social, economic and environmental benefits from integration exceed costs**. Therefore successful IUWSMCA requires the establishment of effective **links** and **coordination mechanisms** between those authorities (public or private) responsible for urban water services and between these authorities and the authorities responsible for coastal zone management, river basin management and urban management (including land-use and development planning). In addition, it requires the harmonisation of the goals of urban water management with **sectoral** and higher level (**regional, national, international**) **policies** and decisions.

Integration is not confined to administration. It should extend to involve **all relevant stakeholders** in the planning and decision-making process and **actively involve the public** in the making and implementation of decisions.

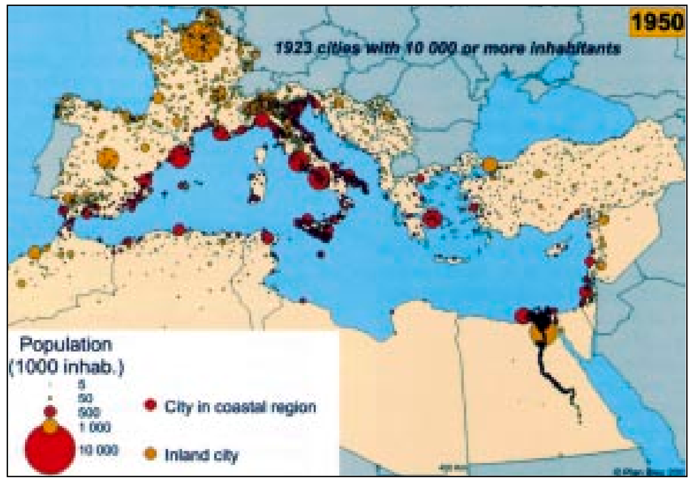
2. URBAN GROWTH AND THE QUEST FOR SUSTAINABLE CITIES

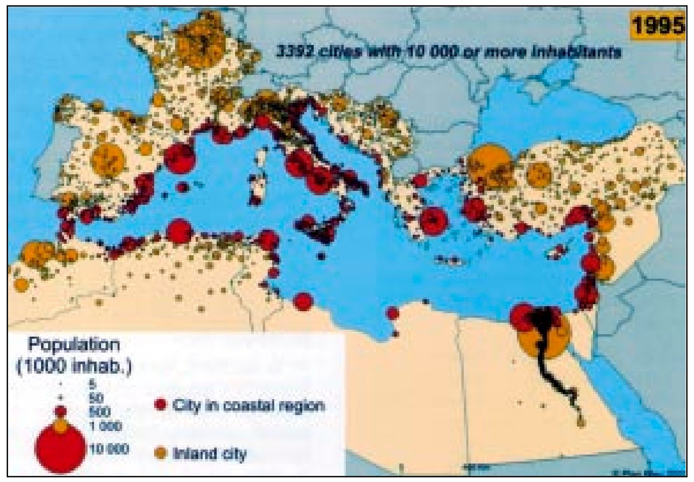
This chapter addresses the urban context of the problem. Firstly, it offers a brief exposition of the main urbanization patterns in the Mediterranean. There follows an identification of the impact of urbanization on coastal water systems. The main principles of sustainable urban development are then presented providing a framework for sustainable urban water system management.

2.1 URBANISATION IN THE MEDITERRANEAN REGION

Around 145 million inhabitants live in the Mediterranean coastal area, 34% of the total population of Mediterranean countries (Attané and Courbage, 2001). Numerous settlements are located along the Mediterranean coastline, ranging from small villages to metropolises. The urban population is increasing both in absolute terms and relative to the overall population growth. In 1995 there were 3,962 urban areas of 10 thousand or more inhabitants in Mediterranean countries, more than double those existing in 1950 (Figure 2.1).

Figure 2.1
Built up areas in Mediterranean countries in 1950 and 1995 (Blue Plan, 2001)





The rate of urbanisation in Mediterranean countries is currently 64.3% and will reach 72.4% by 2025 (Blue Plan, 2001). This rise is mainly due to urban growth in the region's southern and eastern countries. The urban population total for all Mediterranean countries (274.5 million in 2000) will reach 379 million by 2025 but about 98 million of these additional 104.5 million urban dwellers will be in the South and the East. Figure 2.2 depicts urbanisation trends in coastal regions.

There are also some broader changes in demography and urban patterns not reflected in the overall population data. In the North, where urban populations are relatively stabilised, there is a general tendency toward smaller-unit households due both to ageing populations and a trend towards single-person households among the young. The tendency for **suburbanisation** is still significant. In some cities, in recent years a re-urbanisation of inner city areas by wealthy young professionals ("gentrification") has been occurring. Intra-urban social inequalities and segregation according to socio-economic characteristics has become more pronounced. Despite stabilised overall populations, there is a tendency towards urban forms and lifestyles that consume more water per capita and demand higher standards from services (Kallis and Coccossis, 1999).

In the eastern and southern Mediterranean, the rise in urban populations is the outcome of two main factors: continuing **rural-urban migration** and high fertility rates in cities (excluding the North, which has witnessed a rapid drop in fertility). Both are more pronounced in poorer city neighbourhoods. These are often also the areas facing the most problems with drinking water and especially with their sanitation services.

A special feature of Mediterranean coastal cities is the swelling of populations due to **tourists and visitors** in the summer months. Mediterranean countries receive some 200 million visitors per year, mainly during the tourist season. This seasonal peak of population and demand further stresses urban water systems.

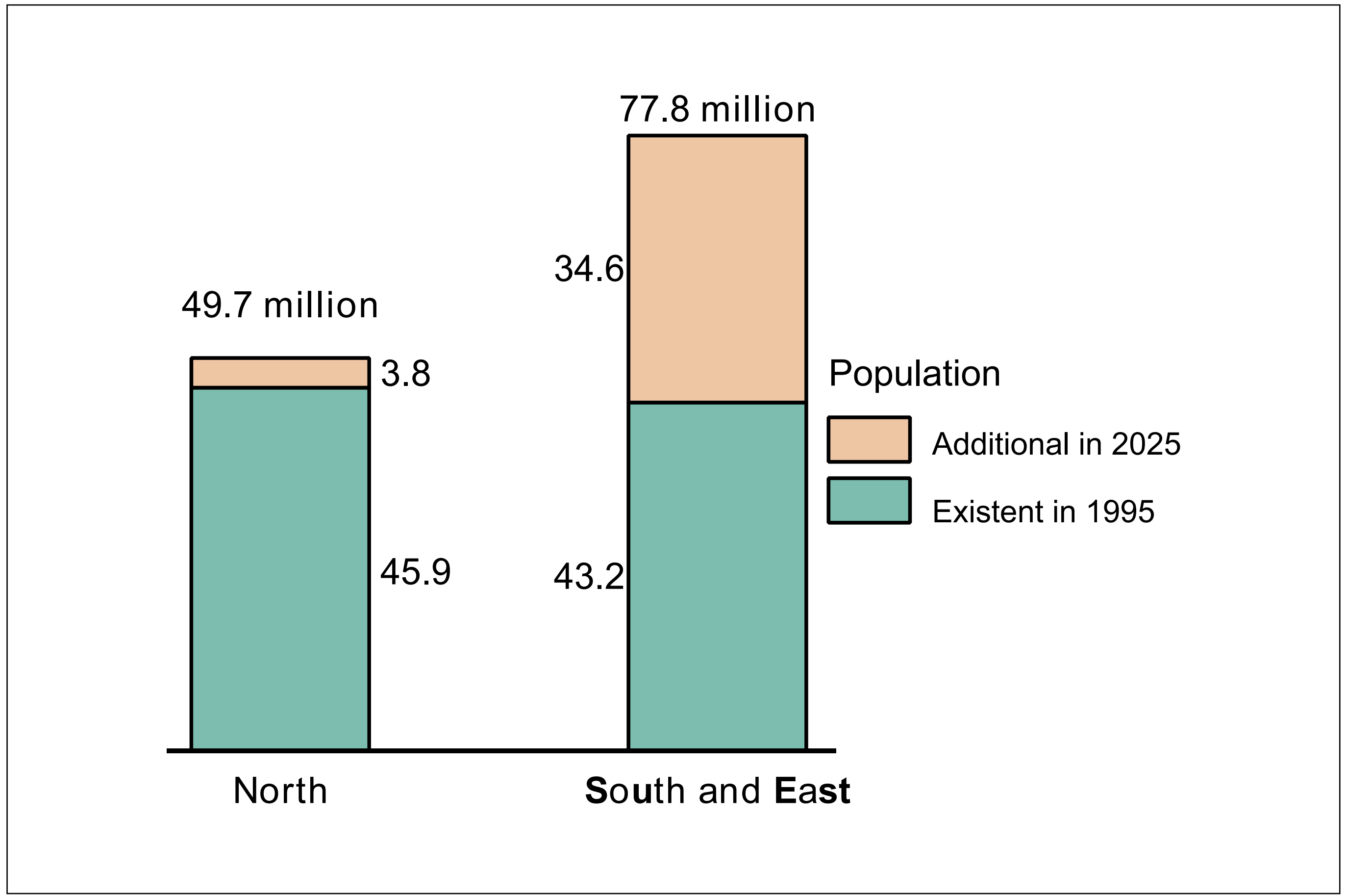


Figure 2.2
Population evolution in cities of more than 10,000 inhabitants in Mediterranean coastal regions between 1995-2025 (Blue Plan, 2001)

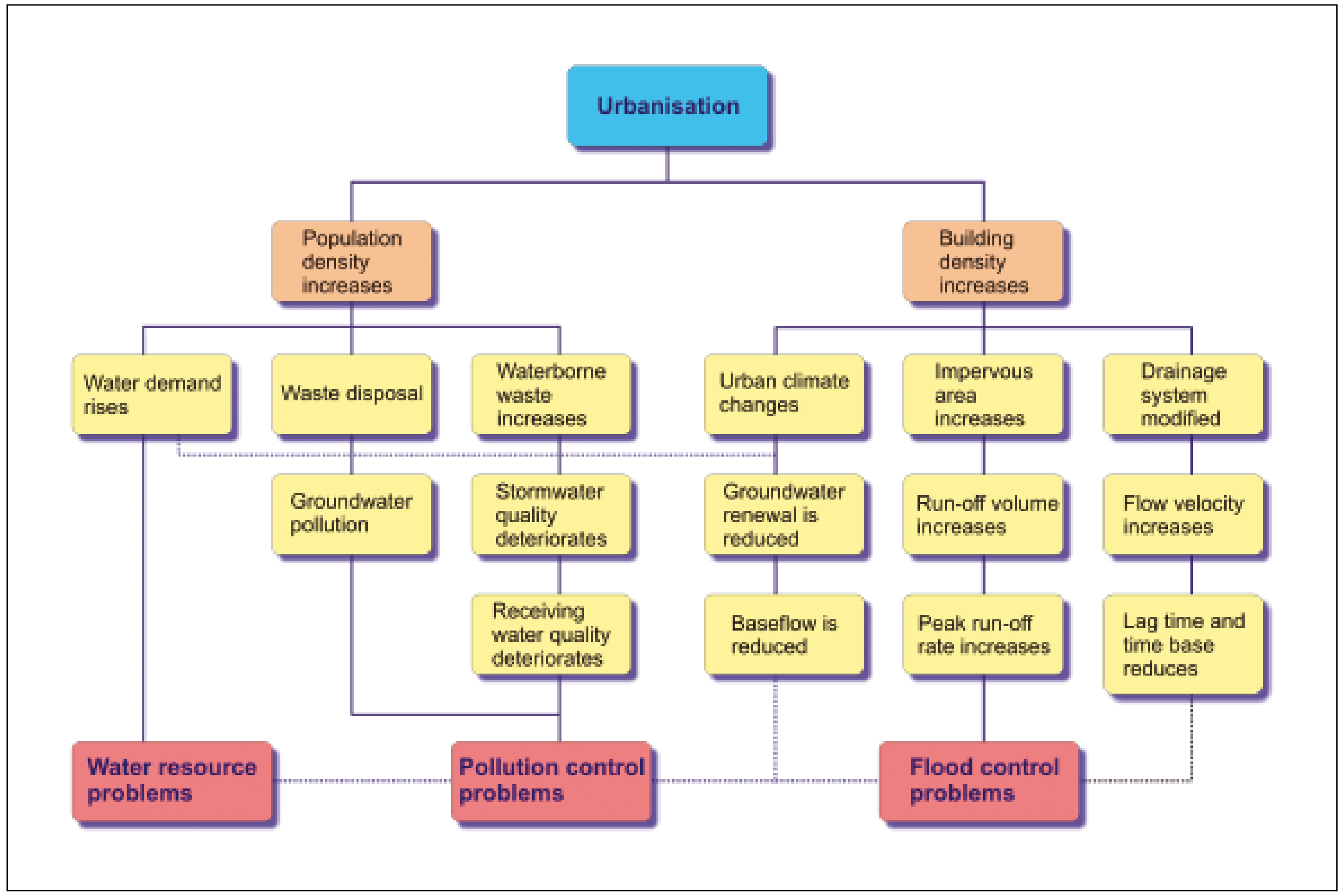


Figure 2.3
Major problems with urban hydrology
(modified after Hengeveld and de Vocht, 1982)

Growth in **peri-urban areas** and **urban sprawl** are important features of Mediterranean coastal settlements. Tourism is an important driver of scattered development in the vicinity of urban hubs. Suburbanisation is an important reason for urban sprawl in the North whereas rural migration contributes to urban sprawl in the South.

2.2 URBANISATION AND WATER PROBLEMS IN THE MEDITERRANEAN REGION

Figure 2.3 illustrates some of the hydrological problems caused by urbanisation. **Water resource problems** arise when an increased demand for water supersedes the capacity of developed and potentially exploitable sources. In the southern and eastern Mediterranean, rising demand is the result of growing urban populations and the rise in the number of visitors to tourist destinations. In the EU-Mediterranean area, rising demand is due rather to resource-sapping lifestyles, urban patterns and tourism.

Increasing demands for water have coincided with the intensified unpredictability of weather patterns and prolonged dry spells. This has caused **drought** crises all over the Mediterranean region. In October 1990, water reserves for the city of Athens (a city of four million people) were enough for just 56 days of typical consumption. In the city of Seville, service during the summer of 1992 was restricted to 16 hours per day; water from the polluted Guadalquivir River then had to be utilised, following its intense treatment (Kallis and Coccossis, 2001). Similar experiences have shared by other Mediterranean cities in the North, South and East.

Increasing urban water consumption and the irregularity of rainfall heighten the need for new waterworks. The **cost** of these is increasing as the most accessible sources have already been exploited. Water has to be transported from further afield (IAURIF, 1997). Works such as dams or transfers also have important **environmental impacts**. These relate both to construction (the impoundment of natural areas) and to the reduction of water flow available for ecosystem needs. The tapping of new water resources or the increased use of existing ones often leads to conflict between coastal cities and hinterland-users that depend on the same sources.

In urban areas and especially areas that have rapidly developed over a short period of time, the water system infrastructure is either obsolete or badly planned, or in some cases, both. **Losses** occurring within the distribution network are high in many cities, especially in the older sectors. These often exceed 30% of the distribution input. Rapid urbanisation surpasses initial pipe designs leading to reduced flows to users, burst pipes and losses within networks.

The **seasonality** of both availability and demand, particular features of Mediterranean coastal areas, intensify water resource problems. Water shortages during the summer months become more frequent. Distribution networks left unused during the winter period face excess stress in the summer. On the other hand, designing the system with excess capacity to satisfy tourism-related summer peak demands (but underused during the rest of the year) raises costs significantly.

In cities where groundwater is utilised, the **overexploitation of groundwater reserves** (i.e. abstraction at a faster rate than natural replenishment) is an important issue. Coastal urban areas are prone to salt water intrusion into the coastal aquifer and the salinisation of groundwater reserves. A total of 58% of the 82 coastal hydrogeological units in Spain and the Balearic Islands show some evidence of seawater intrusion as a direct result of the over-exploitation of freshwater resources. On the island of Sardinia, four aquifers exhibit seawater intrusion, all of them used for human supply purposes (Estrela *et al*, 1996). Groundwater exhaustion has led to the drying out of rivers and marshes and the loss of wetlands (EEA, 1995). Depending also on the local geomorphology, groundwater exploitation may cause **land subsidence** with costly damages to buildings and infrastructure (IAURIF, 1997).

Urbanisation reduces vegetation and increases built-up surfaces leading to lower water retention and infiltration rates and **reduced infiltration** to local groundwater reserves. Nevertheless, the overall impact of urbanisation on the quantity of groundwater reserves may well be positive due to the increased infiltration from urban irrigation, itself due to seepage from water distribution network losses and sewage network ex-filtration.

Pollution from urbanisation increases pressures on existing and potential freshwater sources. The infiltration of chemicals and other pollutants from the surface (e.g. oil residues from cars), seepage from wastewater sewers and diffuse pollution from landfills or household sewage pits contaminate aquifers. Urban aquifers and streams have been irreversibly polluted in many Mediterranean cities. Clean water has to be brought in from farther away. In some cases the rapid growth of settlements and the increased populations in suburbs or peri-urban areas have reached and impacted upon once drinking water sources once considered distant. Agriculture, industry, and upstream cities may also contribute to the pollution of available drinking sources.

Public health risks from undetected pollutants and treatment costs increase. Problems with the safety of drinking water are more intense in smaller and poorer urban settlements where the per capita costs of treatment are higher, monitoring and technical expertise are lacking and the enforcement of standards is weaker. Certain kinds of contamination, bacteriological forms in particular, cause diseases that are especially evident in the deprived parts of poorer cities.

Nearly all the people in the Mediterranean region benefit from access to improved sanitation services (WHO/UNICEF, 2000). Not all, however, are in the form of a central sewage network. Cesspits are still used in many Mediterranean cities, especially in new urban developments in the outskirts. If not well insulated, sewage may leak and pollute the aquifer. Although the coverage of cities with sewage treatment plants in the Mediterranean is increasing, a considerable amount of the wastewater dumped into the Mediterranean remains untreated causing **pollution problems**. A significant level of pollution occurs due to stormwater overflows in combined sewage systems existing in a large percentage of towns, especially in large coastal cities. Considerable amounts of toxic industrial and agricultural waste reach the Mediterranean Sea through its major river systems: the Nile, the Ebro, the Po and the Rhone. The mediocre operation of existing treatment plants, especially in smaller settlements, can also be a problem. In many cities, industrial wastewater is either directly discharged or mixed with common sewage; centralised treatment is insufficient when specific industrial hazards are involved.

The **Pollution of coastal seawater** affects fishing and tourism, activities upon which many coastal urban economies depend. **Eutrophication** (from sewage discharges laden with organic matter, nitrogen and phosphorous) and cyanobacteria blooms (**blue-green algae**), stimulated by excess phosphorous concentrations, are some of the most important sea pollution impacts. Unpleasant odours or eyesores can deter bathers and tourists. Worse still, some pollutants cause immediate or longer-term damaging health impacts on bathers. Hazardous public health impacts through the food chain are also possible if sea waters used for fishing or aquaculture are polluted. Algae growth results in the death of fish and other marine life and leads to the degradation of coastal ecosystems. Negative economic impacts on the coastal zone from sea pollution and environmental degradation can also be significant, and include reduced property values, tourism and visitor flows, etc.

The increase in built-up areas coupled with climatic change and irregularity, have lead to an intensification of **flood control problems.** There have been some notable flash flood events with catastrophic consequences in Mediterranean cities, such as those witnessed in Algiers in 2001, Barcelona in 2000 and in southern France in 2002. Coastal cities are more vulnerable to floods because they are located at the downstream outlet of basins and receive upstream run-off. Urbanisation increases storm run-off in three ways. First, removal of the natural vegetative cover that intercepts rainfall, reduces impact velocity, and shields surfaces. Secondly, the ground surface is reworked, compacted or paved so that it drains well, removing small storage depressions and reducing the amount of rainfall that infiltrates the surface and speeding up rainfall run-off. Thirdly, run-off is channelled in pipes or ditches that are designed for hydraulic efficiency to carry the run-off away as fast as possible. The end result of all these interventions is a tremendous increase in run-off quantity and a decrease in the time it takes for run-off to be discharged. Studies have shown that run-off in urban areas is 1.1 to 4.6 times greater than pre-urban run-off (Guerrieri, 2002).

The development of towns originally occurred predominantly along rivers, on the shores of lakes and in the vicinity of other bodies of water. Those resources represented sources of food and water, and catered for other needs of the population. The rapid and extensive development of towns caused the disappearance of the natural characteristics of those water reserves which became part of the urban water system. Therefore the waters became polluted and their ecosystems were destroyed due both to pollution and to construction along the shoreline.

Many Mediterranean coastal cities lack proper land-use planning; the urbanisation of areas subject to inundation intensifies the impacts of floods. The extension of drainage networks to new urban developments (suburbs or slums) is often very costly because areas that are already urbanised have to be traversed in order to drain off the excess water. These are equipped with drains intended to cope with local needs which can't accommodate additional flows. Additional drainage works are required raising costs substantially (IAURIF, 1997).

Stormwater discharges also cause pollution problems. Rainwater amasses pollutants over its course (surface dirt, litter, solid waste and sediments from streets) forming polluted streams that impact with disastrous consequences on the environments they flow into, if left untreated. Typical stormwater contaminants include petroleum hydrocarbons, metals, and oxygen-demanding substances. In heavily industrialised areas, atmospheric emissions may also impact upon stormwater contaminants as precipitation falls through contaminated air. Sulphates, nitrates and low pH are some of the typical air-induced contaminants. Stormwater run-off can also be contaminated with a wide variety of pathogenic organisms (mainly from pet, bird and rodent wastes). In combined systems, which collect stormwater together with sewage, exceptional storms exceed the flow capacities of treatment plants and disrupt their operations (Metropolis, 1996). If these **overflows** are released untreated, sewage mixed with stormwater ends up unprocessed in recipient waters. The concentration over time and the sheer quantity of the pollution load intensifies impacts and may surpass ecological thresholds.

Cities generate specific climatic conditions, which lead to higher temperatures than in the surrounding open areas ("urban heat island"). Furthermore, high-density urban construction and high-rise buildings modify wind speed and hours of sunshine. In some Mediterranean coastal cities, **Microclimate changes** may affect precipitation and alter the degree of flood protection afforded by engineering works. The urban climate may also influence human health, water quality and the conditions for the development of natural elements in the urban area. Temperature rises may lead to rises in water demand due to increased requirements for irrigation and personal consumption over the summer period.

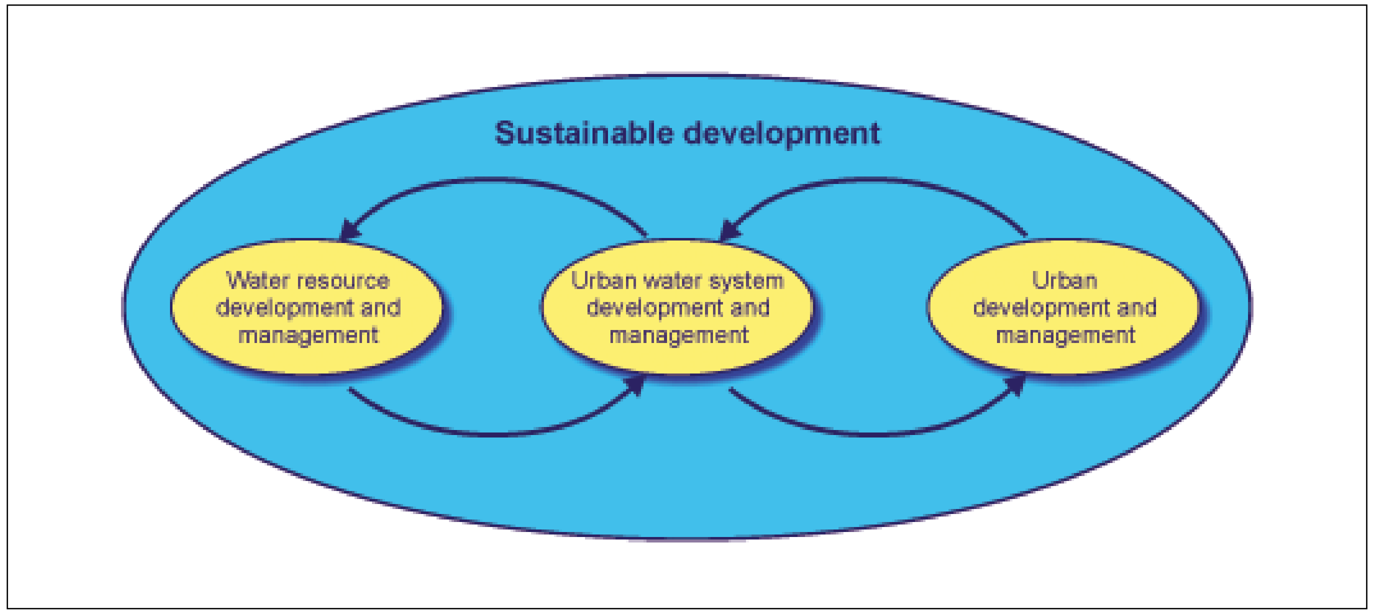
To conclude, urbanisation, urban growth, and changes in urban spatial and socio-economic forms have many negative knock-on effects upon water resources, infrastructure, services and management. To address urban water problems, it is essential to also address patterns of urban development.

2.3 SUSTAINABLE URBAN DEVELOPMENT

The linear, expansionist and reactive modes of urban water management have operated against a backdrop of the sufficient abundance of available water resources, and the fast and uncontrolled urbanisation of the last century. A shift to sustainable urban water management can only be part and parcel of moving towards the **sustainable city**. Water resource management should contribute to the goal of sustainable urban development and equally, urban development should contribute to the goal of sustainable water resource management (Figure 2.4).

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987). Two major principles underpin the process of sustainable development (Haughton and Hunter, 1994).

Figure 2.4
The interrelation of urban, water resource and urban water system management in the pursuit of sustainable development



BOX 2.1
THE PRINCIPLES OF SUSTAINABLE URBAN DEVELOPMENT (COMEC, 1996)

Urban management
Urban policy should be based on the simultaneous use of a range of environmental social and economic tools addressing all sectors of urban life.

Ecosystem-thinking
The city should be thought of and managed as a complex ecosystem comprising of environmental, social and economic features. People, communities, human and environmental artefacts and non-human species are part of an urban ecosystem that metabolises water, energy, food and materials and generates waste and other emissions into the environment. Flows should be regarded as chains of activities that require maintenance, restoration, stimulation and closure in order to contribute to sustainable development.

Policy integration
Coordination and integration should be achieved through the fusing of the subsidiarity principle (decisions taken at the lowest effective level) with the wider concept of shared responsibility. Integration should be achieved both horizontally; to stimulate synergetic effects of social, environmental and economic dimensions of sustainability, and vertically; between all spatial and organisational levels (international, national, regional and local governments) to achieve greater coherence of policy and action and to avoid contradicting policies at different levels.

Cooperation and partnership
Cooperation and partnership between different levels, organisations and interests should be pursued. Sustainable urban development is a learning process based on “learning by doing”, sharing experiences, professional education and training, cross-disciplinary working, partnerships and networks, community consultation and participation, innovative educational mechanisms and awareness-raising.

Respect for ecological limits
Ecological limits are difficult to determine scientifically. Cities, by definition, surpass local and regional limits.
There are however circumstances in which compromising the environment for the sake of potential advantages or benefits to key economic development initiatives, for instance, are not acceptable options. Basic local and global ‘life support’ services vital for human existence, such as water or temperature maintenance, and protection against radiation are some examples. In cases of uncertainty, the avoidance of potentially critical risks to the physical ecosystem must be given very substantial weight in decision-making (precautionary principle).
Demand management
This implies a shift of emphasis from efforts to meet human demands in the urban area to their management and control. In certain cases an optimum trade-off between opposing demands needs to be found.

Environmental efficiency
This refers to the achievement of the maximum benefit for each unit of resources used and wastes produced. Reducing the use of natural resources, increasing durability and closing resource loops are basic strategies to improve environmental efficiency.

Welfare efficiency
This is a social equivalent to the principle of environmental efficiency. It is concerned with obtaining the greatest human benefit from each unit of economic activity.

Equity
The unequal distribution of wealth both causes unsustainable behaviour and makes change more difficult. Social solidarity with respect to the distribution of costs and the benefits of development as well as in the distribution of the burden of environmental protection is necessary.

The principle of “**inter-generational equity**” or “futurity” stresses commitment to the satisfaction of the needs of future generations.

The principle of “**social justice**” concerns the equitable and even distribution of resources and opportunities within the current generation and the tackling of poverty, a major cause and impact of environmental degradation.

The principle of “trans-boundary responsibility” or “**geographical equity**” indicates the need for stewardship with the global environment and the recognition of the impacts of local actions on the global environment and vice versa.

A **sustainable city** is one “in which its people and business continuously endeavour to improve their natural, built and cultural environments

BOX 2.2
GUIDING PRINCIPLES FOR SUSTAINABLE URBAN WATER SYSTEM MANAGEMENT

Systemic approach
The various services and flows of an urban water system should no longer be considered in isolation. They should be seen as a whole, taking into account the complete urban water system. Urban water management should be coordinated with the management of the broader systems that it affects and is affected by: the river basin system, the coastal system and the urban ecosystem.

Ecosystem management
Ecosystem principles emphasise the utilisation of natural processes and ecosystem services, circular metabolism and closure of loops (recycle and reuse of wastewater and stormwater) and prevention over cure.

Ecological limits, environmental efficiency and demand management
Rising demands for water should not be taken for granted. Controlling water demand within resource and environmental limits requires measures that reduce, recycle or optimise water use. Water flows should be used more effectively by reducing losses in storage and transport; by encouraging the multiple use of resources, the use of non-conventional sources, and the control of pollution as well as the recycling of wastewater.

Long term precaution
There is an inherent uncertainty in urban water systems and a related risk in their management. Decisions should be based on a precautionary and preventive approach sensitive to long term risks and contingencies.

Economic efficiency and social equity
Welfare efficiency demands that the cost of water is reflected in decisions and policies. As water is a basic necessity, however, care must be taken to avoid an unfair burden on disadvantaged groups.

Administrative integration
The functional demarcations between, and within, various government agencies responsible for components of the urban water cycle or related systems need to be integrated through appropriate cooperative and collaborative mechanisms. Composite instruments may be needed to achieve multiple objectives.

Participation and Partnership
The involvement and active contribution of stakeholders and the public in urban water decisions is crucial for their quality, fairness and eventual acceptance and successful implementation.

at neighbourhood and regional levels, whilst working in ways which always support the goal of global sustainable development” (Haughton and Hunter, 1994).

Sustainable urban development is therefore a dynamic, participatory and equitable process in which the positive benefits from urban concentration and interaction (economic, social and environmental) surpass the negative impacts, at the local and the global level. Box 2.1 lists the key principles for the sustainable urban development process as set out by the European Commission’s Expert Group on the Urban Environment.

The principles and goals of sustainable urban development provide a guiding framework for sustainable urban water system management. Box 2.2 translates the urban sustainability principles of Box 2.1 into specific principles and goals for urban water management.

The Mediterranean Commission on Sustainable Development, the advisory forum of the Mediterranean Action Plan, has formulated an “**urban management and sustainable development”** group. In its activities it is supported by the research activities of the Blue Plan on “**Urbanisation, urban management, waste management and sustainable development**” and by PAP/RAC. Elements from these initiatives have been incorporated into the present Guidelines. Equally, some of the conclusions of the present study can be relevant to the development of policy guidelines for urbanisation and sustainable development.

3. THE URBAN WATER SYSTEM IN COASTAL AREAS

This chapter describes the main characteristics of the coastal urban water system. Firstly, the concept of a "system" is introduced. Secondly, the urban water system is presented in detail. This includes an exposition of its natural, socio-economic and management subsystems, and a description of inputs, processes and outputs of the system. The three broad systems surrounding and interacting with the urban water system are then presented: the river basin, the urban area and the coastal zone. Interactions between these and the urban water system are then discussed.

3.1 THE CONCEPT OF SYSTEMS

Urban water management involves several processes and artefacts; some are natural, others are modified by humans and some are completely man-made. Analogies should be developed that scientists and managers can use to describe the essential but complex features of these processes. **Systems theory** provides ways and means to develop such analogies.

A **system** is a conceptual model (or *representation*) of a part of the real world. It defines something which is made up of interconnected elements, and has a boundary which differentiates the inside from the environment beyond it. A system is characterised by (Figure 3.1):

- *inputs* (controlled, partially controlled and uncontrolled)
- *outputs* (desirable, undesirable and neutral)
- *system* (boundary, elements, subsystems, processes)
- *environment* (constraints, impacts)

All living and human (socio-economic) systems are **open**; they interact with their environment and receive matter (food), air and energy. They are **hierarchical** and **nested**; that is, they constitute parts of larger systems and they include smaller subsystems, with which they interact. Socio-economic systems are also **dynamic**. They respond to changes in the system environment and to changes within the system itself due to dynamic interactions between the constituent *processes* (abiotic, biotic, chemical and socio-economic processes).

The boundaries of complex systems are blurred; the definition of system, subsystems and processes depends on the purpose and scope of analysis.

One possible conception of a complex system is to view it as consisting of three subsystems and related sub-components (Figure 3.2):

1. A natural subsystem
2. A socio-economic subsystem
3. A management subsystem which modifies the natural subsystem upon modes dictated by the socio-economic subsystem and in order to satisfy demands in it

Figure 3.1
The concept of a system

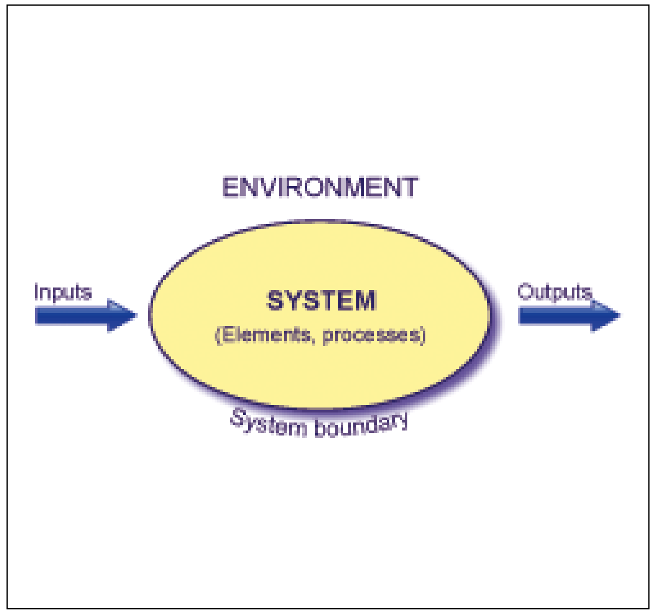
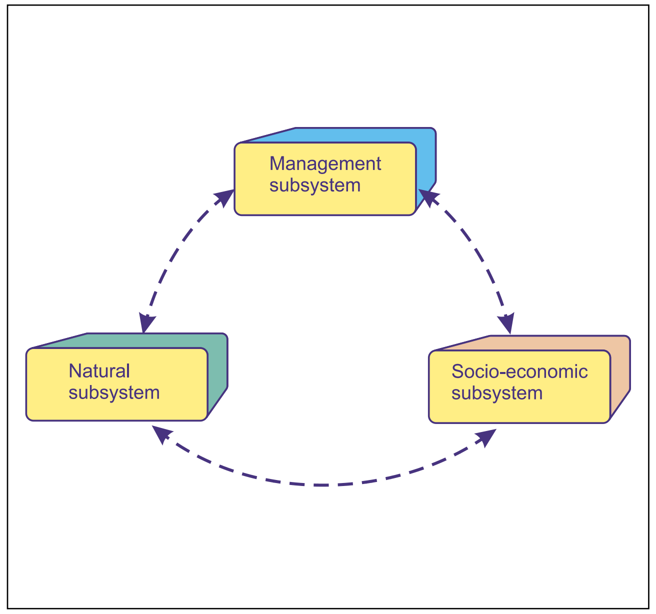


Figure 3.2
The sub-components of a complex socio-natural system



The first step in any analysis of a system is the definition of its **boundaries**. This is followed by the deconstruction of the area within these boundaries into a set of elements and interactions. The identification of inputs, outputs and processes follows. This logic is endorsed in the next section whereby the urban water system is defined, its components described and the inputs, outputs and transforming processes recognised.

3.2 THE URBAN WATER SYSTEM

3.2.1 Boundaries

Urban water management involves several processes and artefacts; some are natural, others are modified by humans and some are completely man-made. Analogies should be developed that scientists and managers can use to describe the

Figure 3.3
Schematic presentation of a "typical" urban water system in a coastal area

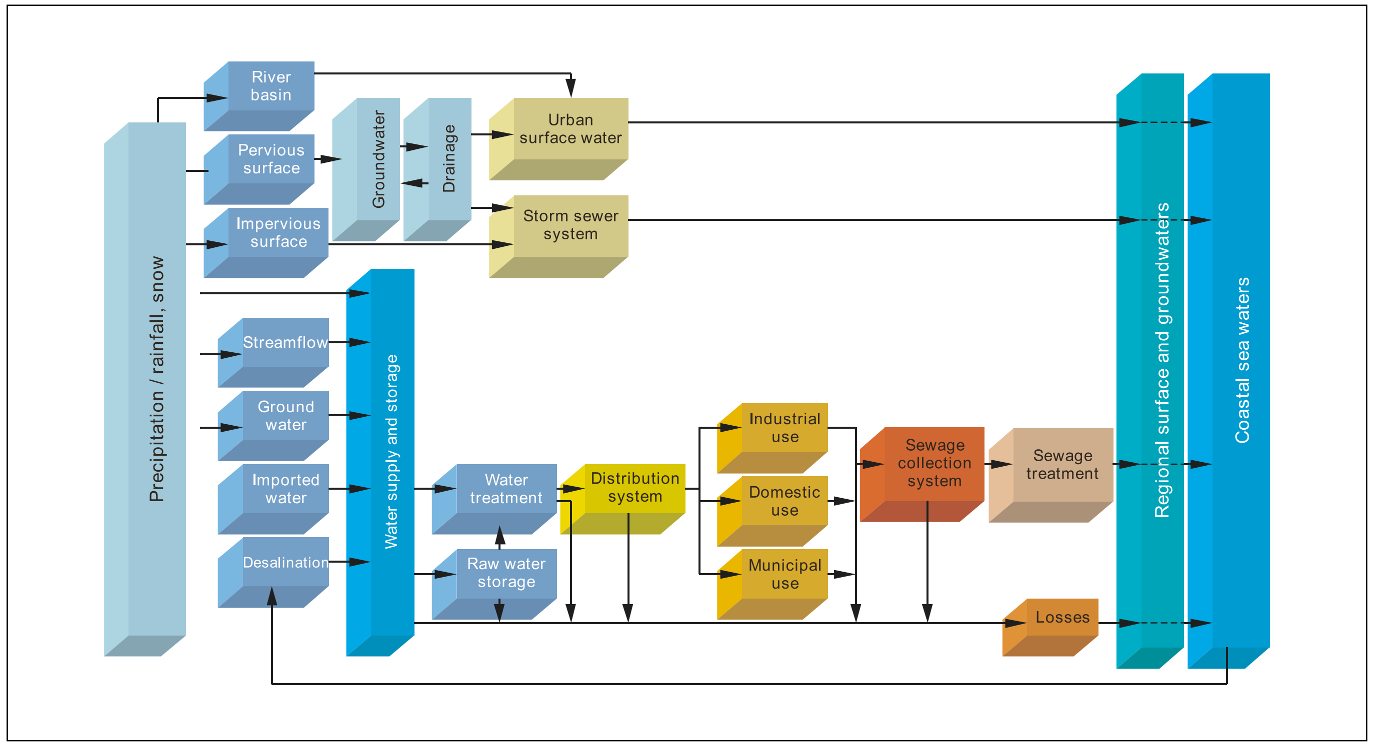
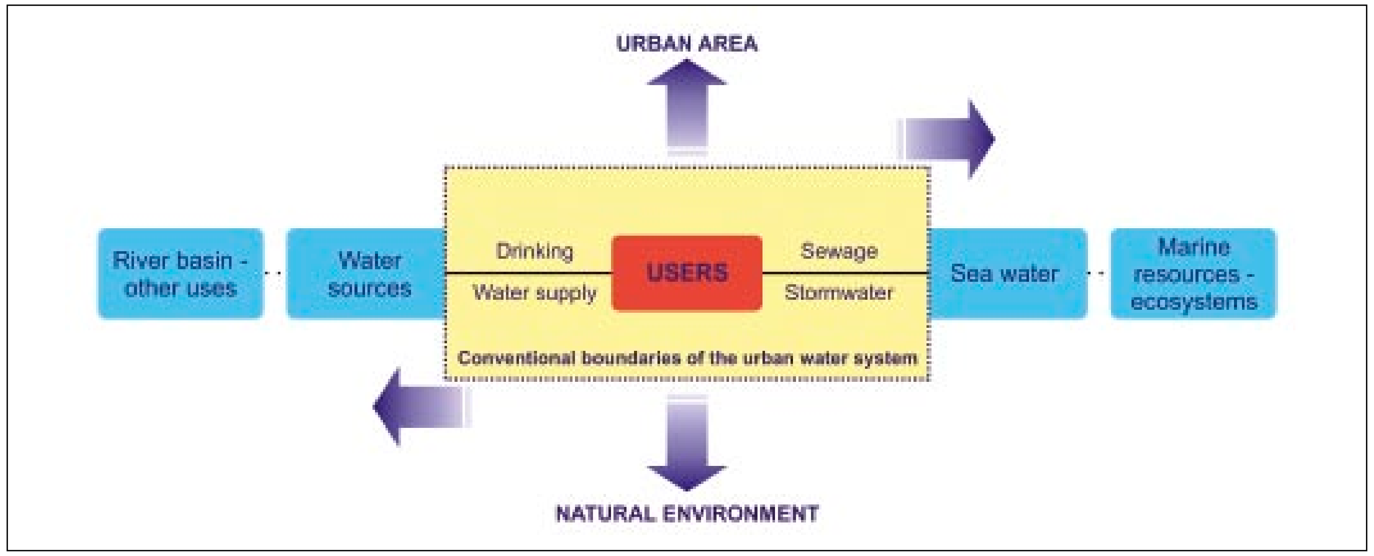


Figure 3.4
Conventional coastal urban water system boundaries and direction of extension (in arrows)



essential but complex features of these processes. **Systems theory** provides ways and means to develop such analogies.

The urban water system includes the natural, modified and human-built artefacts and processes that produce both water services for an urban area and ecological services in the broader basin and coastal zone (Figure 3.3).

The definition of an urban water system typically given in water resources literature constrains it to the infrastructure component in relation to standard utility services (e.g. Grigg, 1996). The extension of system boundaries in these Guidelines reflects their broader scope and the goal of extending analysis and prescription to dimensions previously considered "external". The boundaries of the coastal urban water system should extend to include sea water quality and the status of marine resources and ecosystems, non-urban users sharing the same water sources, activities in the urban area and the river basin that affect the quantity and quality of water resources or stormwater run-off, etc.

Figure 3.4 schematically depicts the desired extension of the boundaries of the urban water system beyond its conventional domain.

The spatial **boundaries** of the extended urban water system are the limits of the basin(s) of the urban area: the **urban basin** (or catchment). If the city brings water from other basins, then these will also have to be considered as part of the urban basin.

3.2.2 The natural water subsystem and its components

The natural water components of the urban water system ensure the health, balance and replenishment of streams, rivers and lakes; provide water for green spaces and woodland; water supplies for human consumption and offer assimilation capacity for waste. Box 3.1 summarises the main natural elements of the urban water system

BOX 3.1
NATURAL WATER ELEMENTS OF THE COASTAL URBAN WATER SYSTEM (Hengeveld and de Vocht, 1982)

Watercourses: These take in open drainage channels including rivers, streams, creeks, swales, sloughs, gullies and other permanent or temporary channels, which drain the basins. They provide drinking water sources, receiving media for pollutant disposal, constitute central features of the urban landscape and the natural passages of stormwater and thus sources of floods.

Lakes and ponds: These are the still water areas, including all lakes and ponds which collect and temporarily retain water. They serve the same functions as watercourses.

Urban channels, lakes and other bodies of water: These are subsets of watercourses and bodies of water found within a city. They are typically heavily modified by human interventions.

Wetlands: These are inundated or saturated areas, at the transition between open water and uplands which support aquatic plants and other organisms. Wetlands are often central to the coastal basin drainage system as they retain and release run-off waters in an acceptable quality, volume and rate of flow. They also support wildlife and aquatic species by providing food and habitats for breeding, feeding and resting.

Floodlands: These include the land adjacent to any of the above units, extending from normal high water level to the highest expected flood levels and include *riverine floodplains and coastal floodplains*.

Groundwaters: These are the bodies of water found below the land surface. In coastal areas they have an open front and discharge to the sea. Groundwater replenishment and flow rates vary. Groundwater bodies with very low flow rates can be likened to non-renewable resources.

Coastal waters: These are the sea waters within the coastal zone and at the sea-end of the urban area. They can serve multiple purposes, of which recreation is important in many Mediterranean urban areas. They receive urban water run-off and pollution discharges. They may host important natural resources and provide a habitat for aquatic species.

3.2.3 The socio-economic subsystem

The urban water system is part of a broader urban, regional and national socio-economic system whose needs it serves. The socio-economic system:

1. Determines the demands from the urban water system in terms of:
   - the quantity of freshwater
   - the quality of freshwater
   - safety with regard to stormwater and flood protection
   - the type and level of services expected, direct (e.g. regularity of supply), and indirect (e.g. contribution to environmental protection)
2. Impacts on the natural and man-made components of the system (e.g. via pollution, land-use changes, watercourse modification, damages to infrastructure, etc.).
3. Characterises the type of management approach followed (e.g. different water management approaches are experienced in different cities, countries, etc.) and determines obstacles to alternative options (e.g. the implementation of advanced technologies will not be possible in a poor city)

Although the simplification of the socio-economic system into a set of key parameters may be desirable from a manager's perspective, this is not possible. Different social sciences hold differing perspectives on the social "system" and emphasise different factors. A provisional yet in no way comprehensive or unique list of some important urban socio-economic features includes:

- culture (traditions, lifestyles, etc.)
- social groups and power relations
- history
- perceptions and ideologies
- political organisation
- urban form
- economic structure and level of economic development
- level of education
- local technological expertise, innovation and the transfer of knowledge from abroad

3.2.4 The management subsystem and artificial urban water system components

The management subsystem modifies natural processes and transforms the natural inputs into valuable services for the socio-economic system. In order to perform this function successfully, it is necessary to provide suitable infrastructure (artificial artefacts) and management organisation. Management subsystems and related artificial artefacts are presented below, while management activities and process such as planning, design, implementation, operation, maintenance, and monitoring are presented in Chapter 4.1.

The artificial elements of the urban water system can be classified according to two major types (Hengeveld and de Vocht, 1982):

1. **location subsystems**, i.e. the physical entities in which water is altered in quantity and quality or consumed (reservoirs, treatment plants)
2. **transfer subsystems** that connect or feed the location systems (pipes, sewers, etc.)

They can also be classified according to function into three general subsystems, according to conventional management tasks:

1. water supply
2. wastewater collection, treatment and disposal
3. drainage and flood protection

Figure 3.5 depicts a typical water supply management process indicating location and transfer elements. Sources may involve surface water such as river intake, reservoir, river abstraction based on upstream releases etc., or groundwater-linked such as, springs, wells and bore-holes, and galleries, or the simultaneous use of both. Unconventional sources such as desalination plants, rainfall harvesting, reclaimed wastewater and others can also be used for urban water supply. Lowland sources are typically located in or nearby the urban area. They are easier to develop but are also more polluted. Upland sources are typically of a better quality as they are far from the city and from agricultural plains, and they are preferable for supply especially if there are no nearby rival uses and if gravity-fed conveyance is possible.

Treatment for high quality groundwater may be limited to a prophylactic disinfection aimed at preventing bacterial growth within the distribution system. For surface waters from a basin with extensive urbanisation impacts, crop cultivation, livestock operation, or industrial facilities, treatment may be more complicated. Typical processes include the dosing of coagulant chemicals, flocculation, sedimentation, filtration and disinfection. In more difficult cases, the treatment process may include oxidation with ozone or other chemicals, activated carbon absorption, ion exchange, or membrane processes.

For transfer, gravity flow is preferred, but where the topography is difficult (as in many areas of the Mediterranean coast) combinations of gravity flow, main pumping and intermediate pumping to establish different pressure zones may be required to secure adequate pressures for all customers. This must be done without increasing pressures to the point at which burst mains and leaks are more frequent. Treated water is stored so as to enable the treatment plant to work at a constant pace as demand fluctuates during the day. The preferred storage is in covered, elevated tanks, water

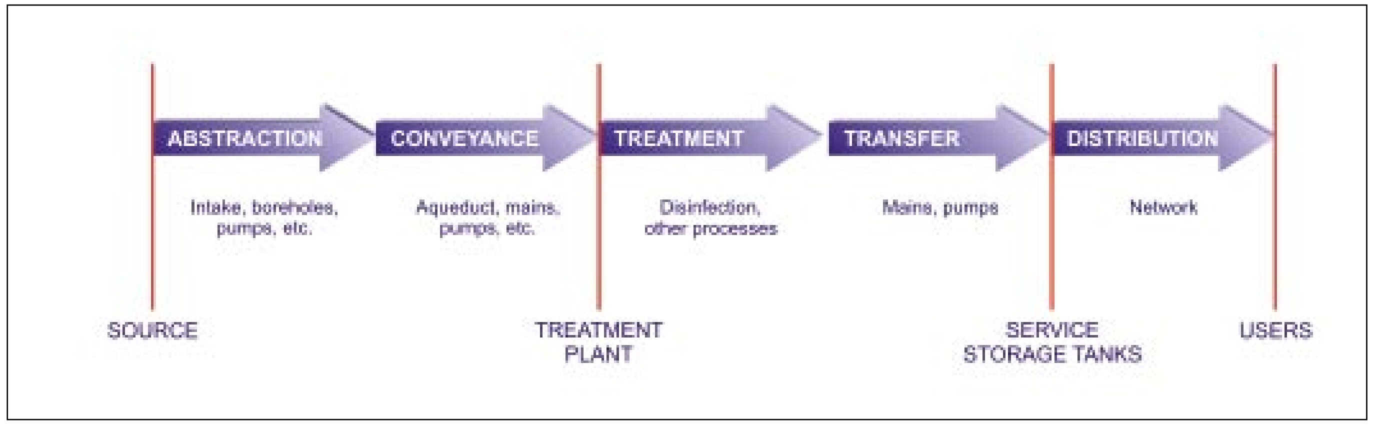


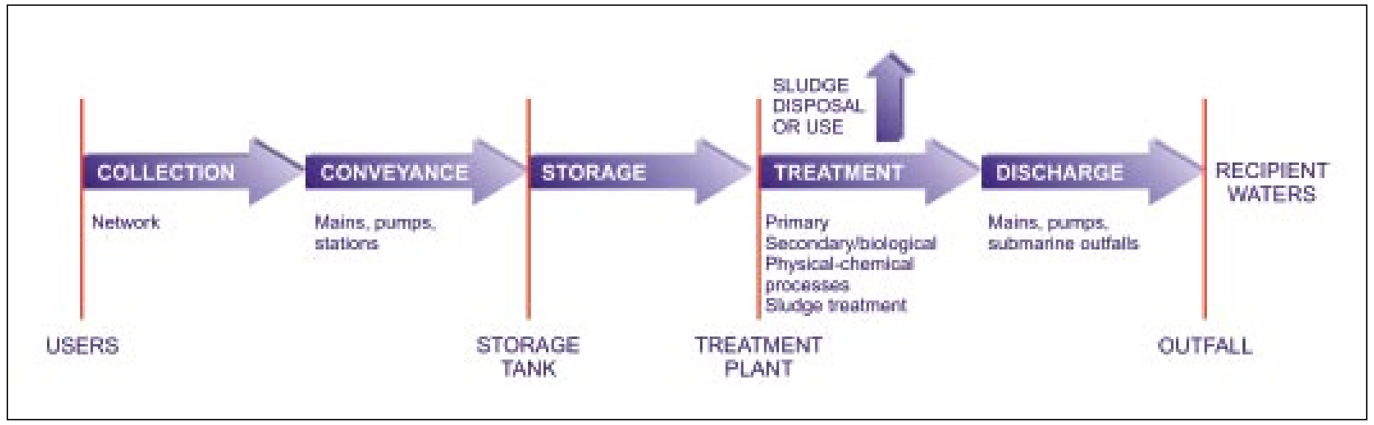
Figure 3.5
The typical elements of the urban water supply management subsystem

flowing by gravity to users. Water is distributed to consumers in closed pipelines that are generally buried underneath city streets. Pipe materials used include asbestos cement (though health concerns may limit its future use), steel, ductile iron, or synthetic materials/plastics (PVC, PEHD).

The water supply management subsystem is followed by the wastewater management subsystem (Figure 3.6). Older sewage collection systems are constructed of brick or stone while more modern systems generally use pipes. Where it is not possible to convey wastewater to a treatment plant by gravity, pump stations and force mains are employed. In low-lying coastal areas, this is frequently the case. Wastewater treatment processes range from the most rudimentary (solids screening) to sophisticated nutrient removal processes. A **primary process** usually includes solids screening and simple settling with grease removal and associated solids handling processes for the settled solids. A **secondary process** usually involves an additional biological step such as trickling filters (attached growth) or activated sludge (suspended growth), followed by another settling process. Secondary processes can result in the removal of 70 to 95% of the remaining biological oxygen demand following primary treatment. In **tertiary processes,** there is an extra treatment step: biological or physical-chemical, supported by chemicals such as those used in drinking water treatment to remove additional suspended solids and organic matter, nutrients and bacteria. Separate, in-situ treatment processes may apply to industries that produce certain waste products. All industrial effluents connected to the urban sewage system must conform to or exceed typical domestic wastewater water quality levels.

Effluent from treatment plants is discharged into the recipient waters, or the coastal sea in the case of coastal urban areas. To discharge the effluent, long submarine outfalls are generally used. In such cases, the effluent is discharged at a distance from the coast (generally more than 500 m) into deep sea areas in order to produce high dispersion of the effluent and so reduce negative impact on coastal waters.

Figure 3.6
The typical elements of the urban wastewater management subsystem (Note: sludge treatment is not depicted)



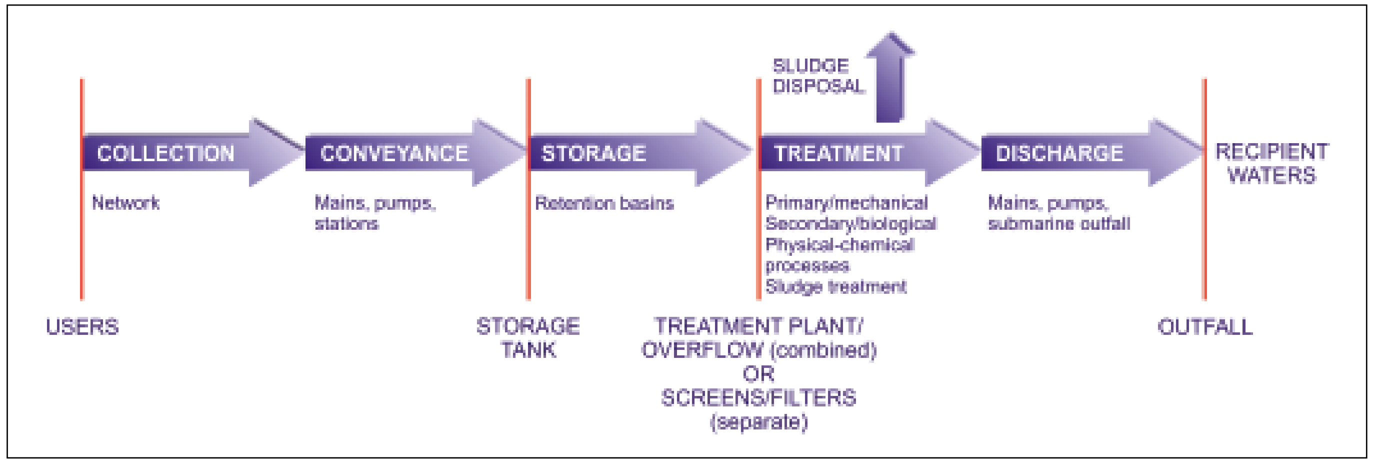


Figure 3.7
Typical elements of the stormwater management subsystem
(Note: sludge treatment is not depicted)

The products of wastewater treatment are sludge and other solid wastes. Sea dumping of the solid waste produced by wastewater treatment processes is no longer an acceptable solution. Treatment processes can be designed to stabilise the sludge and reduce the volume so as to facilitate transportation and disposal to landfills (**sludge treatment**). The first step in the treatment process is typically "gravity thickening", which may double the solids content, reducing the total volume of sludge by half. Aerobic digestion, anaerobic, incineration and composting are some of the other options for sludge treatment.

The drainage subsystem can be divided into three different systems:

- local (urban) stormwater collection, treatment and disposal
- urban flood protection from upstream waters
- urban protection from sea waters and tides

Figure 3.7 depicts the stormwater subsystem. Stormwater collection systems can be combined (carrying sewage and stormwater together) or separate. Most Mediterranean cities have combined systems, but these often cover limited parts of the city, other areas having been left without organised stormwater collection. Separate drainage systems are not common but they are recommended, especially in new urban developments. Stormwater is generally discharged into recipient waters via coastal outlets, or via submarine outfalls, although rarely. Submarine outfalls are used in cases when overflow water from a combined wastewater system is discharged into the coastal sea.

Stormwater treatment processes for separate drainage systems, if applied, are generally limited to simple screening of debris or removal of coarse particles through dynamic settling devices such as cyclone type grit separators. Where space permits, detention basins and sand filters have been used to treat the "first flush" run-off that generally contains higher concentrations of contaminants. Absorption type devices such as activated carbon or compost leaf filters have also been used to remove hydrocarbons or other organic contaminants. For combined systems, a key concern is stormwater overflows when the capacity of treatment plants, mains, or the pump station is exceeded, leading to the pollution of recipient waters with mixed sewage and stormwater.

Sludge resulting from treatment processes is generally disposed of in sanitary landfills. Protection from upstream flood waters includes:

- dams to contain flood water
- channel modification to increase velocities of flood water
- confinement of floods within the channel through levee construction
- diversion schemes (e.g. channels bypassing the city)

In addition, shore protection works protect coastal urban infrastructure and buildings from storm waves and surges and tides. These include embankments and other engineering works (weirs, dams, etc.) but also "softer" technologies which require much less concrete and rock.

The urban water management subsystem includes several important management processes and infrastructural components. These are traditionally managed linearly and separated from each other. The challenge of an integrated approach is how to manage these subsystems together, exploiting synergies and eliminating duplication where possible.

Synergies between the different management sub-components are desirable, and mean, for example, that:

- Treated wastewater and stormwater can provide important sources of water for secondary, or even primary uses

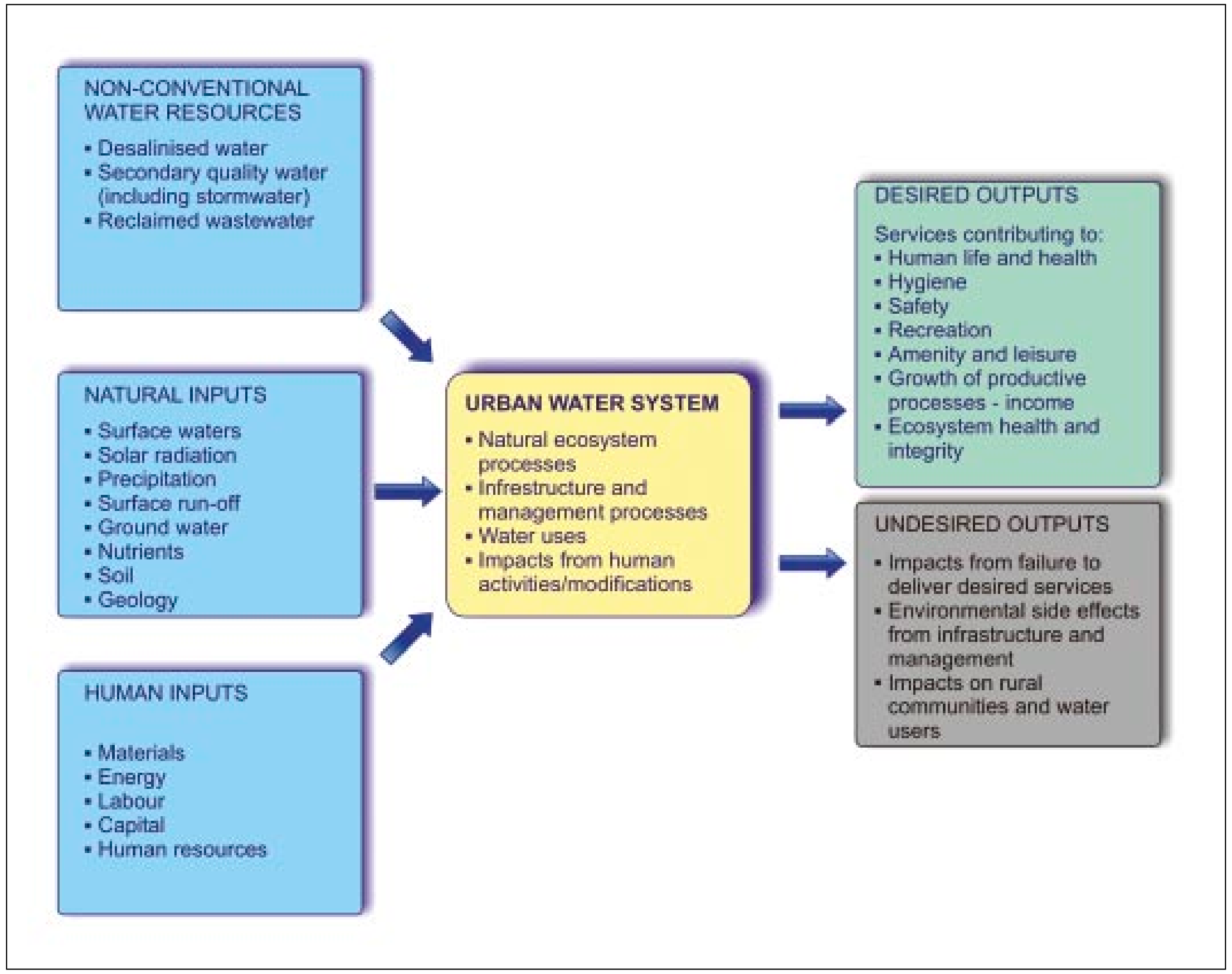


Figure 3.8
Schematic presentation of a "typical" urban water system in a coastal area

- Flood protection, stormwater management and shore protection works should be designed in unison for an optimal effect
- The design of the capacity of wastewater collection and treatment systems should take into account changes in the amount of water used by the water supply system
- Treatment capacity, where possible, should also take into consideration the treatment of the first flush of stormwater
- The drainage system has to be re-naturalised, where possible, in order to reduce management costs and negative impacts on the environment.

3.2.5 Inputs, processes and outputs

Figure 3.8 illustrates the main inputs, processes and outputs of an urban water system. The figure by necessity oversimplifies a complex array of interrelated elements and processes. The main input of the urban water system is water from precipitation or from ground reserves. But the water cycle is not the only input and process of this system. Nutrients and natural substances such as carbon, nitrogen, phosphorous are also introduced into the urban water system (basically as digested food). They are transferred via the sewage network and the wastewater treatment plant or directly by surface run-off to the receiving body of water. Solid sludge is also produced and disposed of on land. Other inputs also enter the system in relation to its management (energy, capital, labour).

The metabolism and transformation of the inputs in the urban area relate to three types of processes. Firstly, there are the natural **ecosystem processes**. These mainly relate to the natural hydrological and nutrient cycles in the area.

These have been (and continue to be) significantly modified by **human (socio-economic) activities** and the urbanisation of areas. For example, the building of surface areas has changed infiltration patterns. Estuary deltas may have been substituted by built infrastructure and the coverage of natural streams may have altered stormwater run-off patterns.

The **management** of water through the specialised infrastructures and regulatory mechanisms tries to account for the new conditions triggered by urban changes and to secure delivery of the desired services to users within the urban area. Natural ecosystem processes alone contribute to many of the desired services such as flow stability, purification, habitat provision and amenity and aesthetic pleasure (PCE, 2000). Replacing the loss of such services with man-made management endeavours may be very costly.

The main system outputs relate to the functions that urban water services satisfy. These concern humans and other living organisms, which also depend on water (quantity and quality).

Hygiene, traditionally referring to the removal of faecal matter from urban areas and thereby the minimisation of the transfer of infectious agents, should be extended to the supply of water for cleaning purposes within households, (e.g. for the washing of clothes and dishes but also for car washing), and within municipalities (for example public space hygiene). In coastal urban areas, the problems of hygiene include the conservation of coastal sea quality, and the quality of sea products (shells, etc.).

Safety relates to stormwater drainage and flood protection. Water has also been an important recreational amenity and scenic element of urban culture. This includes both essential urban public space features such as fountains, ponds, public parks, etc., as well as private leisure uses in houses (e.g. baths, pools, etc.).

The urban water system also has certain undesirable outputs. Failures in managing natural processes and human modifications of these to desirable ends can lead to negative outcomes. These include contaminated drinking water, flood damage to urban infrastructure and pollution-ridden receiving waters and coastal wetlands

Furthermore, even management activities with desirable outcomes, can have undesirable side effects. For example, the consumption of energy in urban water operations contributes to greenhouse gas emissions. Wastewater treatment produces sewage sludge that must be disposed of on land. The construction of reservoirs has environmental and social impacts (e.g. the displacement of populations and habitat alteration by big dams). The use of water for the urban area may impact on rival uses and users of the same sources (e.g. other settlements, agriculture, environmental preservation, etc.). The urban system has to be managed so as to achieve a sustainable environment and provide services for the population, ecosystems and economy.

The integrated approach requires that all relevant aspects of a water system be considered. This includes all aspects of the system itself, the impacts of time on the system in the future, and the interaction with other systems, the environment and issues that will have a likely or definite impact on the coastal urban water system.

An integrated management of an urban water system should pursue three objectives:
1. The minimisation of inputs
2. The maximisation of desired outputs
3. The minimisation of undesirable outputs

3.3 INTERACTING SYSTEMS

The urban water system constitutes the cross section of three broader systems:
1. The river basin system
2. The coastal system
3. The urban system

Figure 1.4 in Chapter 1 graphically depicts the spatial relationship between the four systems.

3.3.1 The river basin system

This comprises the river channel network together with its land-surface area. The river basin forms the logical spatial unit for hydrological studies. A basin is a hydrologically-sealed unit although there can be some groundwater leakage

A river basin is composed of several smaller **sub-basins**. A sub-basin is defined as *"the area of land from which all surface run-off flows through a sequence of streams, rivers and, possibly, lakes in a watercourse (normally a lake or river confluence)"* (CEC, 2000). An urban basin is typically a sub-basin of a larger river basin.

The river basin extends to include **coastal sea waters**, i.e. water at a distance up to one nautical mile from the shore. Accordingly, the urban sub-basin also stretches to this area.

A river basin is made up of different zones with different characteristics (UNEP/MAP/PAP, 1999). Small headwater basins are the **supply zone** for the river system. In these, there is strong interaction between land and water and aquifer and river. Topography, geology, vegetation cover and land-use practices control the export of water, sediment and dissolved load into the stream channel. The inadvertent modification of basin hydrology can

result from changes in forestry, increased building density resulting from urbanisation, mining, agriculture and river regulation.

Further down is the **transfer zone**, where extensive floodplains separate hill slopes from the channel. There is a less direct link between basin and river. The dominant process is the transfer of material through the channel, but there may be significant temporary storage of water and sediment *en route*. Movement of fine-grained sediment (which can include much sewage waste) and dissolved load downstream is less irregular; in-channel biochemical processes may significantly transform the make up the river load, especially through in-stream cycling of nutrients and organic matter.

The **depositional zone**, found in the lower reaches of the river system, is where the main interaction with the coastal sediment system occurs. Fine sediments (often rich in organic matter) can accumulate in salt marshes and other estuarine wetlands, while coarser material can form deltas or become incorporated into beach sediments (UNEP/MAP/PAP, 1999).

There are various uses of river basin water. These can be classified as follows:
- **off-stream uses,** where the abstraction and transfer of water is involved (for domestic, agricultural or industrial use)
- **in-stream uses,** which don't require abstraction (navigation, hydro-electric power generation, aquaculture, waste disposal, recreation, tourism and landscape, nature conservation and wildlife habitat management).

The management of excess water and the protection of life and property from flooding can also be broadly considered a "use".

The relationship between the basin and the urban water system depends on the physical and political geography of the region. Interactions between the river basin and the urban water system include:
- rivalries with competitive non-urban water uses, in-stream and off-stream
- conflict among economic activities regarding land-use in the basin and urban water uses

Coastal urban areas, located at the downstream ends of a river basin, are particularly vulnerable to changes in its upstream areas. Conflicts between urban areas and agricultural producers, especially during droughts, have been common in many Mediterranean urban settlements. The degradation of the quality of upland drinking water sources due to changes in surrounding land-uses (e.g. urbanisation and new settlements and the intensification of agricultural production) is another major issue. Changes in the upstream flood regimes increase downstream flood risks which is another concern. Therefore urban water management can only be part of a broader river basin planning and management scheme.

3.3.2 The coastal system

Figure 3.9 illustrates the coastal system. This is divided into four interacting zones with different characteristics (UNEP/MAP/PAP, 1999). In most Mediterranean states, these are now defined by legislative boundaries.

Coastal waters extend up to a depth of some 20 m, where the effects of waves no longer affect coastal processes (or to a greater depth, if dispersion of pollutants determines definition). Coastal waters accommodate several functions and related infrastructures including maritime transport and navigation, fisheries and aquaculture, fresh water supply through desalinisation, oil and gas exploitation, sand and gravel mining, tourism and recreation, waste disposal and sewage treatment, cooling water, nature conservation and preservation. The flow of nutrients and related biomass production are vital for the marine ecosystems and habitats which are to a large extent responsible for the production of renewable resources such as fish and shrimps. These processes create the conditions for the survival of rare species. Pollution control from urban water systems is vital for the condition of coastal waters.

The **coastal strip** is the narrow transition zone between the land and the sea, where the effects of tides and waves can be felt. It protects the hinterland against waves and acts as a barrier for storm surges. Though less important than the coastal waters, the various beach formations accommodate a variety of ecosystems and habitats, some of which are vital to combating erosion. The intertidal zone is also an important element of the food chain as it accommodates a large number of resident and migrating birds that feed there. Supporting coastal infrastructure in the strip includes *inter alia*: dikes, coastal protection works, residential areas, tourist complexes and recreational beaches.

The area further inland from the strip forms part of the **coastal plain** where all types of human activities and infrastructure can be located. In this study, the part of the coastal plain of interest is its urbanised part, which is shared with the urban system. In comparison to other urban systems, a coastal urban system in the Mediterranean typically has features and infrastructure related to navigation, tourism and fisheries. Surface water flow in the coastal plain produces fresh water but may also cause soil erosion and material transport when the coastal plain is not properly

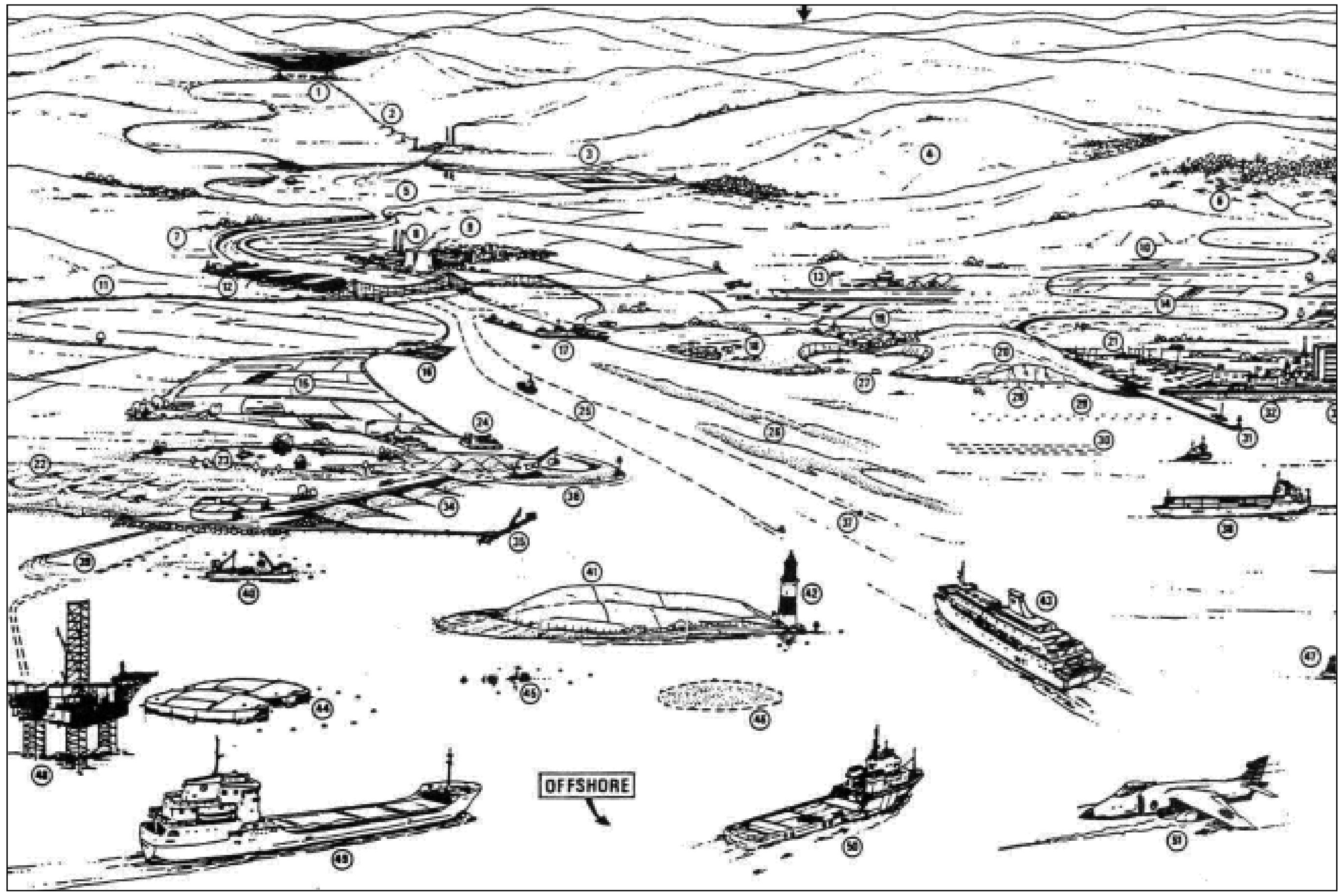


Figure 3.9
An artist's impression of the assorted uses of and infrastructures on the coast (Joliffe and Patman, 1985)

1. Upstream dam or barrage
2. Power line
3. Lacustrine reclamation
4. Natural park or country side conservation
5. Effluent discharge
6. Deforestation
7. Flood prone area
8. Coastal industry or power plant
9. Estuarine urbanisation
10. Drainage and irrigation
11. Transport links
12. Redundant dock
13. Coastal airport
14. Wetland conservation or nature reserve
15. Estuarine reclamation
16. Mariculture
17. Fishing harbour
18. Caravan park
19. Coastal settlement
20. Eroding cliff
21. Marina
22. Dune conservation area
23. Inland water body
24. Hover port
25. Dredged approach channel
26. Sand banks
27. Multiple water space use
28. Scientific interest
29. Buoys, waterskiing
30. Artificial reef fishing
31. Marine breakwater
32. Artificial beach
33. Hotel/apartment development
34. Groins
35. Tanker terminal
36. Beach mining
37. Buoys
38. Coastal trade
39. Sea outfall
40. Aggregate mining
41. Artificial island
42. Lighthouse
43. Ferry
44. Floating or submerged storage tanks
45. Shipwreck
46. Spoil dumping
47. Navigation
48. Offshore oil and gas rigs and pipelines
49. International sea trade
50. Dumping of (toxic) waste
51. Military activities

drained. The high discharge rates of groundwater aquifers may enhance salinity intrusion from the sea and hence a deterioration of groundwater quality. The consolidation of loose alluvial deposits leads to ground subsidence often encouraged by the extraction of groundwater. This has a negative impact on existing urban buildings and infrastructure and in the long term, reduces the ability to accommodate human settlements as it increases the risk of flooding and inundation from both the river and the sea. Inundations due to storm surges and river flows can be catastrophic and in the future, these phenomena may be of paramount importance if scenarios for accelerated sea level rise become reality.

Proper urban water system management is therefore important for securing the sustainability of livelihoods in the coastal plain, and in turn, the proper management of the coastal plain is necessary for maintaining the quantity and quality of coastal freshwaters.

Estuaries are unique complex environments produced by the mixing of fresh and salt water and suspended sediments. Estuaries accommodate a large variety of functions. These include navigation, fisheries and aquaculture, the mining of aggregates, sewage and waste disposal, the production of wood (mangrove) for fuel, ecological habitats and natural conservation (coastal wetlands). The intricate hydrological and ecological structure of esturies is complex and not easily understood. Human interventions may easily disrupt such a delicate environmental equilibrium resulting in changes to the environment with far-reaching and long-lasting consequences. For example, dredging or upstream freshwater abstraction may have significant effects on mixing and sedimentation patterns. Pollution of the silt by heavy metals and other chemicals by wastewater or solid waste disposal inevitably results in high local concentrations of polluted sediments, which in turn will affect the quality of the water.

3.3.3 The urban system

The boundaries of the urban system may vary between states and according to administrative purposes. Cities and their hinterlands are increasingly indistinct from each other, and a small town in or close to a large agglomeration can functionally be part of the city.

Following Haughton and Hunter's (1994) definition, an urban area is a more or less regular and recognisable agglomeration of buildings and thoroughfares, where people live, work and engage in many of their social activities (usually having at least 10,000 residents). Some authors have differentiated between the urban area and the urban system, extending the latter to the broader regional, national and international outreach of the urban area (Hengeveld and de Vocht, 1982).

The overall **urban (eco)system** consists of natural, built and social components. The **natural subsystem** includes air, water, land, climate, flora and fauna. Surface and groundwaters in the urban area, both natural and artificial, provide the intersection between the urban and the urban water systems.

The **built subsystem** encompasses the fabric of buildings, roads, infrastructures and urban open spaces. The built water system is a subset of a city's infrastructure although it may extend beyond its formal administrative borders.

The **socio-economic subsystem** embraces less tangible aspects of urban areas, including aesthetic and amenity quality, architectural styles, heritage and the values, behaviour, laws and traditions of the resident community (Haughton and Hunter, 1994).

The urban water system is part of the broader urban (eco)system. The two are inextricably linked. Changes in urban land-uses transform the features of the basin within the city and thus may affect run-off and infiltration patterns affecting stormwater and drainage as well as local water availability. Water use in urban area and urban pollution change the water quality triggering an intensely negative impact on the urban and broader ecosystem and water resources. Socio-economic changes in the city alter demands from water services. Social changes however may also alter expectations and acceptable standards for flood protection, drainage management or wastewater services.

Reciprocally, the management of the urban water system is a potential instrument of urban development. Policies relating to network expansion and service provision (funding, pricing, authorisations or not) can control or support certain patterns of urban growth. The pricing of water services also has certain social and economic distributive impacts and may be used as a tool to support some and discourage other socio-economic development patterns.

4. INTEGRATED URBAN WATER SYSTEM MANAGEMENT IN COASTAL AREAS

This chapter provides guidance on the integrated management of an urban water system in coastal areas. Firstly, the general elements of urban water management are recalled. A framework of integrated management is then provided and guidance is given for each of its components. The main management tasks necessary to operationalise the sustainability principles identified in Chapter 2 are then presented and guidance is given on how to implement them. Integration between urban water system, river basin, urban and coastal zone management is then examined in more detail. The chapter concludes with proposals for the integration of urban water management objectives into sectoral policies.

4.1 THE MANAGEMENT PROCESS

Management involves a process beginning with planning and continuing through to implementation (i.e. system installation, operation, and maintenance). The process itself must be flexible and proactive to endure any change brought about by a highly dynamic urban environment.

Planning: This involves short, medium and long term analysis concerning the management of water resources in a given urban area leading to the formulation of a global Master Plan. Water resource interventions in urban coastal areas influence various sectors of society; hence the planning process must take into account short as well as long term objectives of the project in a basin-wide, regional, national or international context.

Design: At this stage detailed arrangements (technical, engineering or other programme specifications) are prepared for implementing the recommendations of the plan. Design should include only those projects that are envisaged for implementation in the first phase of plan implementation.

Implementation (including construction): The recommendations of the plan are translated into tasks or projects (of a physical or managerial nature), which need to be executed as a functional system geared to integrating with the whole management structure. System size and project complexity must be compatible with realistically assessed implementation possibilities in monetary terms.

Operation and maintenance: Correct operation and infrastructure maintenance are essential to the cost effective implementation of projects. Inadequate manpower could be a serious limitation to programme implementation.

Monitoring: Key data for the system should be recorded and analysed. New interventions or changes in operation and maintenance should be implemented to correct the identified problems as well as accomodate development needs.

Planning is examined separately in the next chapter. The framework and tasks of implementation are examined in this chapter. More detailed information on a number of tasks can be found in the Volume II of the Guidelines.

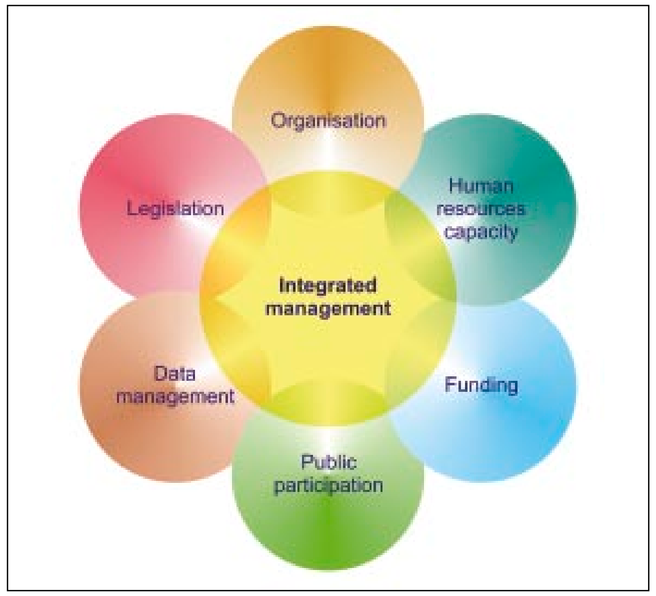
4.2 A FRAMEWORK FOR INTEGRATED MANAGEMENT

4.2.1 The framework

IWSMCA requires that the coastal urban water system be managed as a whole. This includes (see Chapter 1):
- The functional integration of the three urban water infrastructure systems: water supply, sewage and stormwater
- An area-wide integration with river basin, urban and coastal zone management
- An integration with sectoral policy goals

Figure 4.1 illustrates the components needed for the comprehensive management of an urban water system. In the following subsections, guidance is given for each component separately.

Figure 4.1
A framework for integrated management



4.2.2 Organisation

Organisation concerns the effective allocation of tasks and responsibilities:

1. within each water utility (**internal organisation**)
2. between the various utilities and agencies with competency in the coastal urban water system in order to promote functional and area-wide integration (**external organisation**)

Internal organisation demands appropriate communication and the exchange of information between the people involved in the following functions of a utility:

- commercial services
- operations
- planning and design
- administration and support
- finance

Senior management should implement the necessary measures to ensure cooperation between personnel working on the various departments of the utility and especially between technical and administrative personnel.

Furthermore, the internal administrative structure of a utility may have to be changed to meet the goal of external integration. For example, a **new department** with responsibility for integrated planning and management may have to be set up, or an **external relations officer** post created to ensure the maintenance of regular contact with other utilities and agencies involved in the coastal urban water system, and the organisation of joint activities and projects, etc.

External organisation concerns the coordination between water supply, sewage and stormwater utilities or agencies (if these are separated) and coordination with the agencies responsible for water resource and flood management, pollution control, urban land-use planning and control, environmental management and coastal zone planning, as well as other urban utilities (e.g. transport, telecommunications, electricity, etc.).

In certain circumstances, functional integration can be best achieved by **merging water supply, wastewater and stormwater utilities into one common utility** (where this is not already the case). Whether this is desirable however should be decided with due attention to the local context (size of existing utilities, infrastructure characteristics, etc.).

Integration can also be promoted by **merging smaller utilities into larger ones** operating at a metropolitan, regional or **river basin level**. Economies of scale may result from some mergers although in large scale operations, diseconomies of scale may also arise. The optimal operating scale will be strongly dependent upon local circumstances, varying in terms of population density, infrastructure characteristics and condition, etc. (Rees, 1998).

The benefits of integration achieved by merging smaller utilities into bigger ones should be carefully compared to the costs (operational, administrative, etc.). When these are not justified, less formal organisational schemes that promote partnership and cooperation (e.g. **joint committees, task forces**) should be preferred to actual mergers. Chapter 2 of the Volume II discusses the advantages and disadvantages of aggregated and disaggregated utility structures in more detail.

The **private** or **public** character of the urban water utilities does not itself determine the success of integration. Different schemes perform better or worse for different water management goals in different contexts. Chapter 2 of the Volume II compares alternative models of private and public organisation and evaluates their advantages and disadvantages. The **local context** is decisive for what will work best. Solutions should be tailored to local conditions and needs; they should not be driven by international dictates. Mediterranean cities (especially those of the South) face particular conditions (aridity, low levels of economic development, etc.) that may inhibit the implementation of models that have worked well in Western contexts.

A key issue is that the greatest need for improved water services and private funding exists in those countries with the weakest public sectors; yet the greatest risks of failed privatisation also exist where governments are weak (Gleick et al, 2002). Public utilities fail where the public administration is poor; however, privatisation with poor regulation is not a better alternative. A strong and effective regulatory framework is a necessary condition for successful urban water services, private or public.

IUWSMCA cannot be fully implemented by an urban water utility alone. A **broader scheme** of cooperation should be developed with other agencies that have responsibilities in the various aspects of the coastal urban water system (Box 4.1).

A minimum organisational requirement is the **involvement of representatives** in each other's planning activities. For example, representatives from urban water utilities should be mandatory consultants on urban planning committees or coastal zone management councils.

A more advanced option is the development of a **new administrative structure**, designed to foster partnership and cooperation between water, urban and coastal actors. The Master Planning Process **for IUWSMCA** (see following chapter) provides a good opportunity for and an ideal platform upon which to build such a **partnership**. The goal of the partnership would be the preparation of an integrated urban water system plan taking into account not only water service issues but also urban planning, coastal zone management and river basin planning. This shared focus on a practical outcome can energise the partnership.

Forms of partnership for IUWSMCA may include (in reverse order of formality):

- a **lead agency** or other formal entity
- a committee, council or f**orum**
- a **task force**
- a series of informal meetings and gatherings

The entitlements, competencies and procedural rules of the partnership should be clearly defined, if necessary formally (e.g. by legislation). Clear rules should be established on how the outcomes from the work of the partnership (e.g. a Master Plan or a common agreement on principles, etc.) will be integrated into the activities of the parties (e.g. the incorporation of goals into urban or coastal zone management plans).

Alternatively, and if cooperation on a common plan is too ambitious, organisational partnerships can be built around **projects of shared interest**. These might include, for example, the design of a new park in the coastal strip (i.e. where stormwater and water recycling opportunities can be linked to urban design and coastal zone planning) or any other major development intervention in urban coastal areas. Pilot partnerships can increase trust in the value of cooperation and evolve into bigger and more permanent administrative structures.

BOX 4.1
STAKEHOLDERS IN A PARTNERSHIP/FORUM ON COASTAL URBAN WATER SYSTEM MANAGEMENT

- all utilities involved in core urban water services
- public agencies responsible for the regulation of the various urban water-related issues
- river basin authorities
- physical and developmental planning authorities
- municipalities or other urban authorities
- coastal zone management councils (if they exist)
- other urban water utilities
- water service customers
- other river basin water users
- civil society and professional associations
- entities involved in non-core urban water activities

4.2.3 Human resources capacity and management

Management plans are carried out through people. People management represents one of the biggest challenges in ensuring that the objectives of the integrated management process are achieved.

This requires:

- sound personnel policies and practices that guarantee an effective organisational structure
- adequate staffing
- optimal working conditions

Figure 4.2 summarises the main tasks for an integrated human resources management.

The management of human resources involves establishing and sustaining good human relations as well as securing the physical and mental wellbeing of employees so that they make the maximum contribution to achieving efficiently and effectively established corporate goals.

The goal of integrated urban water system management should be built into the above tasks and in particular into recruitment policies and human resources development. Specific tasks and goals include:

1. The hiring of new personnel from diverse disciplinary (or inter-disciplinary) backgrounds (e.g. ecologists, coastal zone experts, etc.).
2. Education and training for the utility's staff on:
   - new management approaches (e.g. water demand management, recycling, etc.)
   - river basin management and planning, urban planning, coastal zone management, etc.

Selected courses or seminars can be held for this purpose. Water utilities can jointly design capacity-building courses with urban authorities, river basin authorities, other utilities, etc., and cross-train their staff in the required competencies. This can foster the development of direct links.

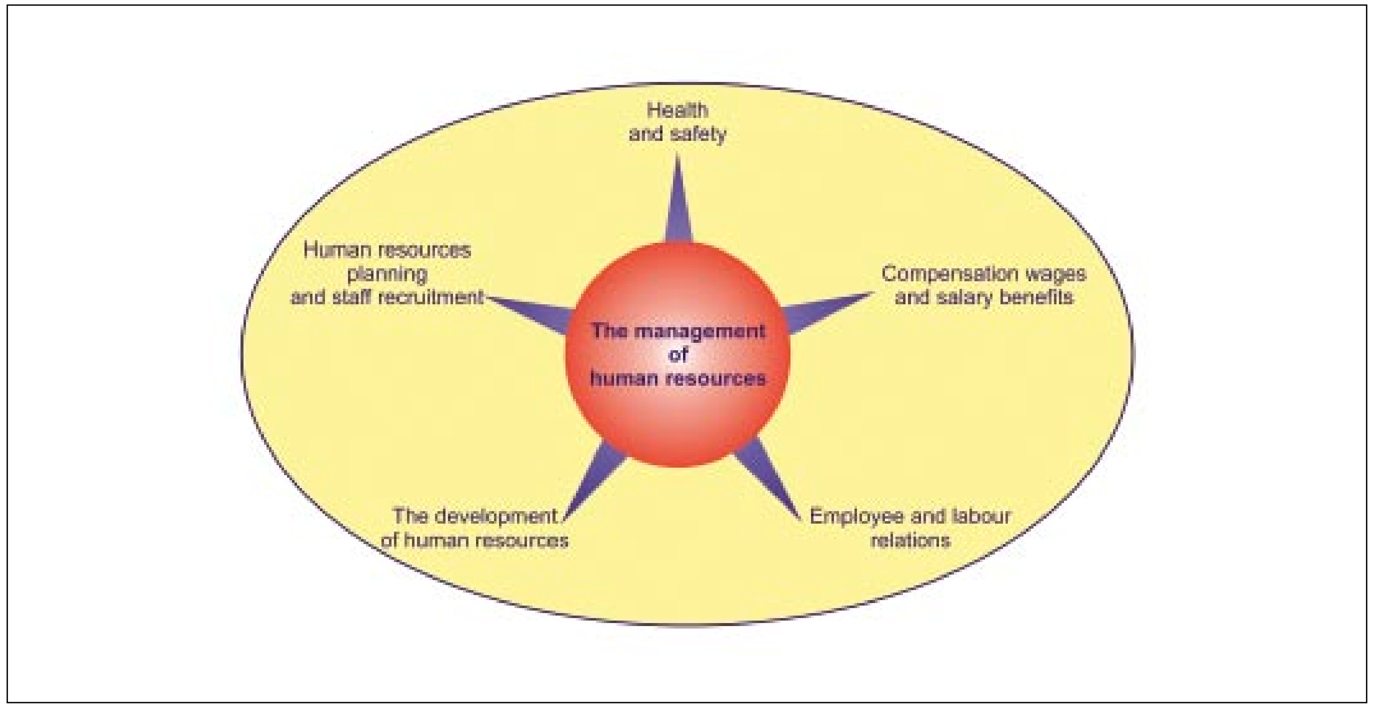


Figure 4.2
Integrated human resource management

4.2.4 Funding

The sourcing of funds is an essential task for coastal urban water system management. Without sufficient funding, the necessary improvements and projects cannot be implemented.

Figure 4.3 shows the different sources of funding for an urban water system and Table 4.1 categorises the different sources.

In principle, public and private utilities have access to the same monetary sources. The one form of funding unavailable to public sector undertakings is **equity finance from private shareholders**. In some cases this might be an attractive option; in others, it might be more expensive than a loan (Hall, 2001).

The "cost" and ability to source funds from external sources will depend on the utility's performance, standing and credibility. Generally, private undertakings are more credible in financial markets and it is easier to secure loans from banks. Successful public undertakings, however, can also secure access to low cost finance from international banks.

A major prerequisite for a funding application is a sound and elaborated **financial or investment plan**. **All utilities in coastal Mediterranean cities should take steps to develop such long term plans** in line with their overall Master Planning Process (see next chapter). The degree of detail of the plan will depend on the scale of the utility and forecasted investments.

The functions and responsibilities of financial management involve:

- converting a business plan into a financial plan
- appraising the suitability of the financial plan to ensure its viability
- ensuring sufficient funds to enable the implementation of the planned activities
- controlling the plan's implementation
- submitting the results of the plan's implementation to all involved parties

The initial step in this process is a carefully designed, realistic, **business plan** which covers such items as capacity and manpower levels**.** An Investment appraisal comes in between the stage where a business plan is translated into its equivalent financial plan and the decision to finance its implementation. Table 4.2 summarises and compares the most common financial investment appraisal methods and their use in decision-making.

The plan must be critically evaluated to ensure its financial feasibility. Sound financial management would establish whether adequate internal financial resources are available to implement the plan and would ensure that suitable arrangements are made to raise supplementary external funding from other sources if these resources are insufficient. The plan is then executed and controlled through such instruments as standard costing, budgeting and variance analysis. The outcome of these activities must be presented to all the interested parties (boards of directors, management, utility bankers and other funding agencies, public authorities and others) in the

SOURCE OF FUNDS	DOMESTIC (INSIDE COUNTRY)	INTERNATIONAL
Internal resources	Surplus of undertaking	-
State	Government, national funds	Aid agencies (for developing countries)
Bank loans	Domestic banks	International banks
Bonds	Domestic bonds	International bonds
Intermediate funds	Municipal development funds	-
International finance institutions	-	Development banks (e.g. World Bank)

Table 4.1
The sources of water service finance (Hall, 2001)

form of various financial reports such as the profit and loss account, balance sheet and cash flow statement. As an example, Box 4.2 shows the balance sheet of the Malta Water Services Corporation for 1997.

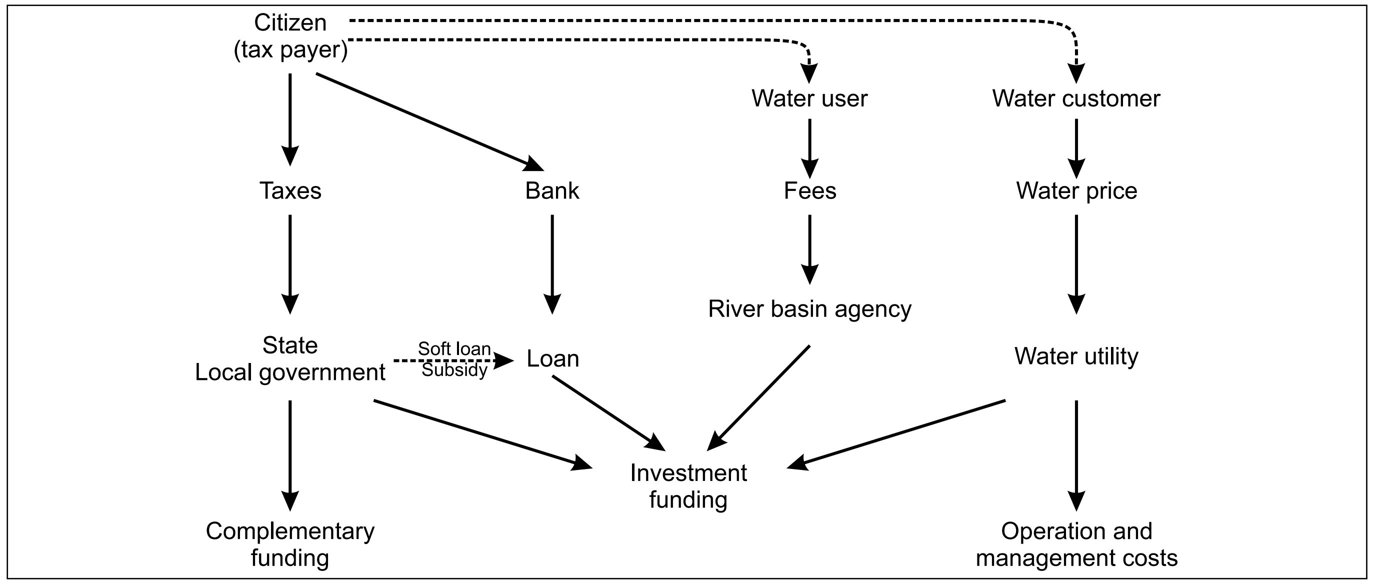
The organisation of the financial management function within the water utility is a necessary condition for the proper conduct of business. The responsibilities and tasks that need to be accomplished by the financial management team are essentially those of:

- establishing the utility's broad financial strategy
- deciding on major capital expenditures and new assets
- interpreting and assessing the implications of external factors including government political, social, economic and environmental polices and regulations on the financial development of the enterprise
- preparing financial reports for all interested groups
- implementing, maintaining and reviewing the management information system
- presenting and controlling the budget
- setting pricing policies
- appraising capital investments
- managing working capital
- instituting and sustaining good communication with stakeholders and relevant financial agencies
- securing adequate finance and credit facilities to meet arising contingencies
- providing cashier and payroll activities
- managing any exposure to foreign exchange risks
- formulating corporate financial planning

Budgeting is one of the most important tools in financial planning. It consolidates and fuses planning and operations, controlling functions within the whole system. Budgeting generally consists of the annual operational budget and the long term budget, both of which are of critical importance to the success of the water utility.

The operational budget is mainly concerned with ongoing expenses such as salaries, expendable materials and operational costs. The lack of sufficient financial provision for operations and maintenance in operational budgets has been a major cause of deteriorating systems and the need for substantial upgrading and rehabilitation.

Figure 4.3
Finance channels (Lee et al, 2001)



METHOD	DECISION RULES: Independent projects	DECISION RULES: Exclusive projects	ADVANTAGES	DISADVANTAGES
Payback Method Establishes the number of years required to cover the initial investment out of the project's future cash flow	Accept projects with payback period below a critical minimum	Accept project with the lowest payback period	• Simple • Emphasis on least risky projects • Avoids pitfalls of dealing with the future	• Difficulties in stipulating investment outlay over time • Ignores cash flow beyond payback • Ignores value of money over time (TVM)
Return on Capital Employed (ROCE) Average profit x 100 Average or total investment	Accept project with a ROCE above a certain minimum return	Accept project with the highest ROCE	• Based on percentage • Based on profit • Focus on performance	• Ambiguous • Ignores scale of investment • Based on accounting notion of profit • Ignores TVM
Net Present Value Computes the NPV of a project's worth in terms of benefits net of costs $NPV = \sum \frac{A_t}{(1+k)^t}$ A_t = net cash flow at time t r = suitable discount rate	Accept project if NPV ≥ 0	Accept project with the highest NPV	• Accounts for TVM • Focus on project's worth • Accounts for investment scale • Determinate solution • Conceptually clear and theoretically superior to IRR • Assumes interim reinvestment of proceeds	• No idea of the safety margin of investment
Internal Rate of Return The discount rate R that equates the present value of the steam of net cash flow with the initial investment outlay $NPV = \sum \frac{A_t}{(1+r)^t}$ where r = IRR	Accept projects if IRR ≥ k, k = opp. cost of capital	Accept projects with the highest IRR	• Accounts for TVM • Investors' preference for rate of return concept • Marks safety margin of investment • Superior to NPV from a practical point of view (no need to know a discount rate)	• No account of investment scale • Assumes interim reinvestment of proceeds at the project's own rate of return • Problems with mutually exclusive projects • Often yields indeterminate answers

Table 4.2
A comparison of appraisal techniques

The capital budget is concerned with long term plant, equipment and the physical water system. In many instances, proper capital budgeting has been non-existent in many water undertakings with disastrous results in terms of overloaded urban water systems, which have not been upgraded to meet current demands. Capital budgets should be planned several years in advance. Capital requirements should be programmed to be in line with an overall integrated plan that caters for all the physical facilities of urban water systems. Capital budgets should be the result of clear, valid, long term integrated plans and should not be subjected to *ad hoc* haphazard planning or management through damage limitation practices.

Budgets are expected to achieve a variegated mix of different aims within the organisation:
- assist in the planning of yearly operations
- coordinate the multiplicity of activities occurring within the various parts of the undertaking
- communicate plans to managers
- motivate managers to achieve enterprise goals
- monitor and control activities
- appraise manager performance

BOX 4.2
THE BALANCE SHEET OF A WATER SERVICES CORPORATION

WATER SERVICES CORPORATION **Balance sheet** **30 September, 1997 (the Maltese currency is Maltese Pound or Malta Liri - Lm)**	1997 (Lm)	1996 (Lm)
Fixed assets		
Tangible assets	**58,453,574**	59,083,856
Investments	**50,000**	-
	58,503,574	59,083,856
Current assets		
Stocks	**3,645,624**	3,291,421
Debtors	**9,391,451**	7,268,072
Cash in the bank and in hand	**154,685**	73,386
	13,191,760	10,632,879
Creditors - Amounts falling due within one year	**(11,526,370)**	(12,823,388)
Net current assets/(liabilities)	**1,665,390**	(2,190,509)
Total assets less current liabilities	**60.168,964**	56,893,347
Creditors - Amounts falling due after one year	**(28,057,100)**	(24,678,975)
	32,111,864	32,214,372
Capital and reserves		
Government interests	**46,343,070**	46,343,070
Accumulated losses	**(14,231,206)**	(14,128,698)
	32,111,864	32,214,372

The preparation of the budget is a 'bottom-up' process whereby budgets originate at the lowest levels of management and move towards the top where they are improved and coordinated by senior management. This allows for management involvement in the preparation of the budget and increases budget acceptability. The process involves:
- communicating details of budgetary policy and guidelines
- preparing the various budgets
- negotiating the budgets
- coordinating and reviewing budgets;
- accepting budgets
- re-examining budgets on an ongoing basis

Water charges are a major source of revenue for utilities. Raising sufficient funds, however, should be balanced with efficiency, equity and environmental goals in the design of prices. These issues are examined in section 4.3.9 and in Chapter 7 of the Volume II of these Guidelines.

4.2.5 Public participation

Public participation is now broadly recognised as a key requirement of water resource planning and management. The **Dublin Statement on Water and Sustainable Development**, a milestone in international water policy[1] recognised as one of its four key principles the need for "a participatory approach involving users, planners and policy-makers at all levels". It called for a heightened awareness of the importance of water among policy-makers and the general public and for taking decisions at the lowest appropriate level, with full public **consultation** and the **involvement** of users in the planning and implementation of water projects.

Public participation in environmental decision-making has recently gained a strong international legal basis with the **Aarhus Convention** on "Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters" (UNECE, 1998). Signing States are

1 The Dublin conference was attended by five hundred participants, including government-designated experts from a hundred countries and representatives of eighty international, intergovernmental and non-governmental organizations. The Dublin Statement was addressed to the world leaders assembled at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in June 1992, and has provided the basis for following international water policies and agreements.

BOX 4.3
THE ORGANISATION OF A PARTICIPATORY PROCESS (adapted from IEMA, 2002)

1. Clarification of the purpose of the participation process and recognition of issues that may arise
2. The identification of the aims, objectives and expectations from the process, both from organisers and participants
3. Consideration of the decision-making process in which participants contribute and determination of the timescale for participation
4. Selection of an appropriate procedural method(s) and the design of a specific application
5. The identification of potential participants
6. The identification of needs in terms of resources and personnel (training of existing staff or the outsourcing of expertise)
7. Planning as to how the results of participation will be analysed and used
8. The determination of evaluation criteria and processes upon which to gauge the success of the process
9. The actual implementation of process and events
10. Reporting and evaluation

committed to incorporating the convention into national environmental legislation. The EU Water Framework Directive endorses the Aarhus principles calling for the "involvement of the general public before final decisions on the necessary measures" (Preamble 46). It asks Member States "to ensure the **participation** of the general public including users of water in the establishment and updating of river basin management plans" and to "encourage the **active involvement** of all interested parties in the implementation of this Directive, in particular in the production, review and updating of the river basin management plans" (Article 14, CEC, 2000).

Public participation in urban water management reduces conflict, improves the quality of decisions and enhances implementation. In the majority of Mediterranean States, there are only a few established mechanisms for public participation in key water management decisions. Where implemented, participation is typically delegated to public information provisions or at best consultation, while true public commitment to the process and the incorporation of its outputs into real decisions and policies are lacking. This is particularly true for urban water management, which has traditionally been considered as a technical task for water utilities with little scope for debate and contribution from the public.

It is highly recommended that urban water utilities and public agencies responsible for urban water management in coastal areas of the Mediterranean develop clear processes facilitating the participation and active involvement of the public in decisions. Chapter 8 of the Volume II provides detailed information on how to design a participatory process.

Information provision and the enhancement of **public awareness** is an important first step in engaging people in decisions. Relevant techniques include (IEMA, 2002):

- leaflets and brochures
- newsletters
- manned or unmanned exhibitions or displays
- advertising or other presentations in public spaces
- the use of newspapers, radio and television
- the dissemination of audio-visual material
- organised site visits
- the provision of information on the Internet and at public meetings

Simply informing the public, however, does not itself achieve public participation. Public apathy can only be overcome if the results of the participatory processes really matter. Real implementation therefore is a prerequisite for public engagement.

The participatory process goes beyond the receipt of information or consultation with the public. It requires that stakeholders including the public be actively involved and **engaged** in actual decisions and their implementation.

Box 4.3 summarises the main steps of a participatory process. There are several tools/methods than can be used to support a participatory process. These include visioning workshops, participatory modelling, social multi-criteria evaluation processes and software, "planning for real", citizens' juries, consensual conferences, referenda and others (consult the Volume II for details).

Several issues may pose barriers to the success of a participatory process, unless carefully and specifically treated:

- the selection of participants and definition of their rights (e.g. voting or veto privileges, etc.)
- the actual implementation of results
- available resources and time constraints
- the framing of issues and independent facilitation

4.2.6 Data management

Data is essential to support management and decision-making for the coastal urban water system. The types of data relevant to urban water systems that should be collected by coastal urban water utilities include:

- hydrologic variables (flows, groundwater levels, etc.)
- infrastructure system characteristics and condition (reservoirs, networks, plants)
- water quantity and quality (source, urban waters, recipient waters)
- climate and environmental data (rainfall, temperature, evapotranspiration, source dependant ecosystems, recipient water ecosystems, etc.)
- data related to water management and operations (performance indexes, inventory of systems, financial database, etc.)

Relevant data should be compiled in a shared **database**. Different types of data, both raw and processed, can then be expressed and utilised, or raw data is honed into more accessible information chunks.

Databases relevant for water management include (Grigg, 1996):

- a geographically-based system inventory database
- a database for locating and itemising the components of urban water systems
- a condition index database
- a system water balance database
- a database for real-time system studies and management
- A data management system for operation treatment plants and generating environmental information analyses
- Assorted analysis and design databases
- financial database

Quality Control and **Quality Assurance** programmes should be a part of any data management programme. In modelling, a statistical level of confidence can be established for the model calibration, and model audits should be performed to validate mathematical representations of processes. Quality assurance should be extended beyond experts-only to include the broader public and stakeholders through an inclusive and participatory process (Funtowisz and Ravetz, 1991).

There are several decision-support systems, which can provide essential assistance to managers wishing to implement an integrated management process. The most important are simulations, forecasts and Geographic Information Systems (see Chapter 4 of the Volume II).

Grigg (1996) identifies three important elements for a DSS management framework:

1. A clear overall management responsibility for development, maintenance and use of the system
2. Adequate model maintenance
3. User support, including communication with users, training, model distribution, and related functions

Important practical issues include:

- a model maintenance office with competent technical staff
- legal instruments to control models and user access
- methods to self-fund model maintenance and improvement
- software transmittal methods
- the collaborative use of models
- An auditing process and continuous model improvement (Grigg, 1996)

An assessment of potential costs and benefits or a feasibility study may need to precede the decision to develop a DSS.

Utilities with fewer financial resources and advanced scientific expertise, especially in the southern Mediterranean coastal regions, may have limited opportunities for integrating decision support systems into their management practices. Local knowledge and accrued experience may be more important in these cases. Nonetheless, efforts should be made to systematically record and categorise this informal knowledge to facilitate access and retrieval. Decision support systems and comprehensive databases may be less applicable to small utilities with simple management requirements.

Water resource / river basin authorities or coastal zone management authorities (where they exist) could play a vital role in the collection and organisation of information for coastal urban water systems.

The integration of the relevant utilities and agencies involved in coastal urban water systems (including urban and land-use planning authorities) can be enhanced by:

1. The creation of common or **shared databases** or other information "clearing houses" (including web-based information sources with data, best-case examples, etc.)
2. **Joint data collection and analyses**
3. The joint use of **decision-support systems of mutual interest**
4. **Collaborative research initiatives**
5. The creation of platforms for the **exchange of knowledge** and expertise between scientific staff (e.g. joint seminars, task forces, etc.)

LAW	WATER SERVICES	WATER RESOURCES	ENVIRONMENTAL	PUBLIC HEALTH	OTHER
Rules / standards					
Level of service / customer services	+	+			
Assets serviceability	+				
Price/Profit control	+				
Utility ownership / structure	+				Public administration Company law
Competition/trading	+				Competition
Investment commitments	+				
"Safety net" / Public goods	+				Social policy
Water use efficiency / Leakage reduction	+	+			
Urban water planning	+	+			
Monitoring and reporting	+	+	+	+	
Access to urban water information	+	+	+	+	
Consultation/participation	+	+	+	+	
Exceptional circumstances	+	+			
Drinking quality	+			+	
Sampling/analysis	+			+	
Source protection Zoning		+	+	+	
Secondary water quality		+	+	+	
Emission limit values / Treatment requirements		+	+		
Pollution permits		+	+		
Integrated pollution control programmes		+	+		
Combined sewer overflow controls/permits		+	+		
Sludge disposal	+		+		
Stormwater permits		+	+		
Environmental Impact Assessment			+		
Strategic Environmental Assessment			+		
Environmental auditing	+		+		
Protected natural areas	+	+	+		
Ecological water standards		+	+		
Minimum environmental water quantity	+	+	+		
Water rights system		+			
Abstraction permits		+			
Water exchanges - markets		+			
River basin planning - councils		+			
Water-sensitive building codes/permits					Physical planning
Equipment design standards	+				Engineering
Appliance design standards			+		Product
Appliance labelling schemes			+		Product

Table 4.3
The legal instruments for urban water system management

4.2.7 Legislation

Table 4.3 summarises the main areas that should be regulated at the national level in order to ensure the effective management of coastal urban water systems. Chapter 3 of the Volume II details what is covered in each area and gives practical examples of relevant legislative measures.

Legislation governing urban water systems is typically fragmented; a plethora of laws address the various aspects of urban water systems. Relevant provisions may spread to several laws and administrative competencies. The rationalisation of the existing fragmented legal provisions into a small number of key laws is recommended. A **Water Services Law** and a **Water Resources Law** should provide the backbones of a comprehensive framework. These should provide a consistent regulatory framework applicable to all utilities, public and private. This revised legal structure may be complemented by specific **licenses/contracts** between the State and utilities.

There might still be reasons, however, for maintaining certain provisions in the forms of acts or administrative competencies. Water pollution control, for instance, may be regulated by an integrated pollution control act (covering all industrial emissions) and administered by a pollution inspectorate. Similarly, public health and safety agencies may be better positioned to monitor and enforce drinking water standards. Some provisions (e.g. competition, taxation, etc.) may be regulated by more general administration and economic laws.

Legislation has to be monitored and enforced to be effective. The common experience of Mediterranean countries is that **enforcement capabilities** are weak. Compliance provisions, penalties and fines, court procedures, etc. are vital. They depend, however, on national judicial systems and are beyond the scope of these Guidelines. In 2004, UNEP/MAP issued a "Reference Handbook on Environmental Compliance and Enforcement in the Mediterranean Region" (MAP Technical Reports Series 150), which can help authorities develop more effective implementation procedures.

Enforcement problems are exacerbated by the nature of water resources and infrastructure which makes surveillance difficult and expensive. A key issue is the hampered ability of public agencies to fulfil an ever-demanding regulatory role in the face of public budget and staff policy restrictions. Economic instruments are often proposed as a cost-effective alternative to other regulatory instruments. Their application in the urban water sector, however, is not spontaneous; it presupposes the establishment of administrative and regulatory structures (e.g. to establish water rights and oversee markets, to regulate private utilities or to license abstractions in order to price them). These have a significant cost that needs to be met by the public sector.

4.3 THE TASKS OF SUSTAINABLE URBAN WATER SYSTEM MANAGEMENT IN COASTAL AREAS

4.3.1 The framework

In Box 2.2, the **guiding principles** for sustainable urban water system management were set out based upon the guiding principles of sustainable urban development. These principles provide the backbone for the main management tasks that should be undertaken by urban water utilities in order to steer urban water management closer towards the goal of sustainability (Figure 4.4). Pricing is given a central position as it is an essential instrument of all management tasks.

Basic guidance on each of these tasks is given below. For those who need it, more detailed information is provided in the Volume II.
Not all tasks will be equally important to all Mediterranean coastal settlements. Water demand management, for example, may be more important in coastal cities experiencing droughts. Source protection will be more important for settlements drawing upon rivers polluted from upstream activities for their potable supply. Nevertheless, these seven management tasks provide the basic components for the *portfolio* of a coastal urban water utility wishing to proceed with sustainable urban water management.

Figure 4.4
Sustainable urban water management tasks

Figure 4.5
The components of risk management
(modified from Ale, 2002)

4.3.2 Risk management

Urban water systems are vulnerable to negative impacts from unforeseen, extraordinary events. The nature of hydrology (climatic variations and extreme events) necessitates a probabilistic approach to both supply and stormwater management planning. Urban water systems are also vulnerable to damage from extreme events and accidents, unintended (e.g. earthquakes or extreme weather events damaging to infrastructure, mechanical failures, upstream pollution or contamination accidents) or even deliberate damage (e.g. vandalism, sabotage and terrorism).

Risk management refers to all the processes and activities that aim to manage an existing risk situation. Its **purpose** is to reduce the likelihood of a crisis (e.g. a drought) by fostering preparedness, and to minimise its impacts. It is a **proactive** approach taken well in advance of a potential crisis so that mitigation can reduce impacts and ensuring that relief and recovery decisions are made in a timely, coordinated, and effective manner (WDCC, 1998). It includes four basic modules/activities (Figure 4.5).

A generic multi-staged process for urban water system risk management is described below (see also Chapter 9 of the Volume II).

Step 1 - Getting the process started
A risk management committee (inter-departmental within the utility, or inter-agency if appropriate, consisting of utility staff plus other institutional actors) should be formed. It is responsible for organising a kick-off **workshop** open to other stakeholders and the public. Risks and hazards should be debated and a set of management priorities defined as an outcome of the workshop.

Step 2 - Getting the public and the other stakeholders involved
The participation of stakeholders and the public should be an integral part of the risk management process from the start (the workshop). The public should be consulted and actively engaged in discussions on acceptable levels of risk, investments, types of selected responses etc. This can be done through regular public meetings (workshops, hearings, forums, etc.).

Step 3 - Identify hazards and impacts
This is the first step of a risk analysis. A detailed **survey** of all facilities should be conducted by studying the plans and drawings or/and by inspecting the ground facilities. This should identify the **vulnerability of** or **weak points of the system**. An outline of how different components of the system can fail, and the type and scale of likely consequences needs to be made available.

Different impacts can be identified according to the severity of a hazard. Impacts should also be differentiated according to their incidence. Some may only be relevant to selected parts of the network or for one segment of the population, others being universal.

Step 4 - Assess and prioritise hazards and impacts
The **quantification** of risks depends on the severity of the consequences and the probability of their occurrence (Ale, 2002). For example, although the risk of a dam failure due to an earthquake might be small in a particular area, its consequences would be so devastating that it would be placed high up on the priority list. Likewise, hazards that have a high frequency in a region, such as droughts in the Mediterranean, should be considered as high-risk priorities. The determination of the **tolerability** of risks is done with the help of the quantification of the risks provided by the risk assessment. The extent to which a risk is acceptable is something that is subject to change over time and society's shifting value systems (Plate, 2002); hence the significance of the input of the public and stakeholders.

Once identified, impacts should be **ranked** from the most to the least important. Ranking should not be based on scientific analysis alone. To be effective, it should take into account concerns such as cost, the extent of the area affected, trends over time, public opinion, fairness, and the ability of the affected system to recover. A good balance of science and public input is crucial at this stage.

Step 5 - Assess vulnerability
Attention should be directed to the underlying causes of vulnerability rather than to the negative impacts that follow a hazard. For example, the direct impact of a drought may be reduced reservoir levels and interruptions to network supply. An underlying cause, however, might be the growth of water demand in recent years due to suburbanisation or increased losses during water delivery due to under-investments in network maintenance. Identifying these other factors is important in order to design appropriate responses. Structural measures, such as water demand management poliies may be better suited than mitigation or response to crises.

Step 6 - Identify mitigation measures
Once hazard and impact priorities have been set and the corresponding underlying causes of vulnerability exposed, then actions that are appropriate for reducing risk can be identified. The emphasis should first be placed on "root causes" and if these cannot be modified, then attention should be focussed "further up" the tree of impacts.

Mitigation measures might include:

- technical measures, such as engineering measures and the construction of hazard-resistant and protective structures and infrastructure, e.g. flood protection works
- non-technical measures, e.g. water demand management, zoning or land-use permits

Risk reduction measures may vary from the most advanced (e.g. the latest wastewater recycling or stormwater management technologies) to the very basic, such as relocating or re-routing pipelines so as to avoid risks to high points like rivers. Silt traps can protect downstream intakes, and pipes made from appropriate material can minimise the chances of breakage. The identification of these relatively easy, low-cost interventions is crucial, especially in smaller, lower-income urban settlements where there are fewer opportunities for adopting advanced measures.

Step 7 - Identify preparation measures
Monitoring of the system is crucial in order to act upon the first indications of a problem. For example, precipitation or reservoir levels should be continuously monitored and analysed with respect to historical data in order to identify a drought early on.

In the case of meteorological hazards such as floods and droughts, it is imperative to have a reliable **early warning system**. Early warning systems include three primary elements: (i) the forecasting of impending events, (ii) the processing and dissemination of warnings to political authorities and populations and (iii) the undertaking of appropriate and timely actions (UN, 2004). The use of **remote sensing technology** and mathematical models of meteorological weather simulations are opening up great possibilities for accurate forecasting (Plate, 2002). The basis of any good monitoring and warning system is obviously an effective **forecasting system**.

There are also some very practical aspects of preparedness that have to be considered. Without proper **access** to storage, treatment and network facilities, no damage can be assessed, evaluated or repaired. Particularly at times of natural disasters, access to the network in its entirety can be obstructed. Roads can become impassable due to swelling streams, destructive earthquakes or lava flows. It is crucial to establish ways of reaching every point of the water system in order to repair damages (Mearns and Overmars, 2000). Furthermore, **spare equipment** and **materials** must be available and in a constant state of readiness.

Step 8 - Identify contingency responses
A degree of residual risk is unavoidable, whatever the mitigation measures. Contingency responses should be envisaged for different events and for different intensities (**response phases**). The roles of specific utility staff and other involved stakeholders must be determined for each response phase. The responsibility for acting during a crisis typically falls on the utility. The planning and

organisation of actions taken however, takes place at a higher level, such as a river basin authority, public authority (ministry, municipality) etc. (Suzenet *et al*, 2001).

Step 9 - Formulate risk management and contingency plans
Having identified potential actions, the next step is to choose which actions will be taken (i.e. form a "to do" action list). When making a decision about protection measures, the available technologies, financial resources and public perception of urgency of protection are taken into account. Other concerns such as feasibility, effectiveness, cost and equity are also very important. Actions should be formulated into a **risk management plan,** including a **contingency response plan** (see next chapter). Additionally, a contingency plan should also define response phases (i.e. immediate, partial/temporary and full service restoration) with staff roles and responsibilities outlined for each phase.

Step 10 - Revise management plans
The preparation of the plan is just the first step. This must be followed by specific scenario exercises with the involvement of a range of stakeholders to ensure that the plan works effectively. It should also be reviewed, at the very least, at two-yearly intervals and following each hazard-related crisis. The plans should be sensitive to changes in social values and perceptions as well as to new knowledge or information about potential risks.

4.3.3 Source protection

Source pollution control can provide a viable alternative to the development of new sources and it should be considered as an option in resource planning. Pollution control has to consider all types of the waste (gas, liquid, solid) and sources of pollution (point and diffuse). A world-wide best-case example of source management is the city of New York in the U.S. Instead of building a new filtration treatment plant, the municipality of New York purchased land parcels around its drinking water sources from individuals and municipalities that owned them. The purchase of land was funded through private restoration bonds with excellent rates of return. New York also applied covenants on the use of fertilisers in the catchment area, and made a one-off investment of around US$ 1 billion to upgrade local sewage plants. Although interventions of such a scale may not be applicable to many Mediterranean coastal settlements, they make a strong case for the possibility of **shifting from developing new sources to investing in the protection of existing ones**. This might even be relevant to smaller/poorer settlements; small-scale quality interventions (e.g. shutting down a plant which pollutes a river or a lake used for drinking water) may be much cheaper than the development of new sources.

Catchment/river basin management programmes provide an important mechanism for protecting or improving the quality of drinking water sources. The EU Water Framework Directive has explicit provisions for the protection of the quality of drinking water sources, which it defines as "protected".

Where possible and feasible, a more **decentralised approach** to water source management is also recommended. Several sources should be used, with different levels of treatment applied to each, according to purpose. The differentiation between sources of water according to the quality requirements of application is central to recycle and reuse strategies. Water from recharged aquifers, stormwater, water reclaimed from wastewater treatment, polluted water from surface or groundwater sources or "grey" water from households can all be useful sources for uses which do not demand drinking quality standards. A polluted river flowing though a city can be used (after basic treatment), for example, for the irrigation of green spaces or for street cleaning. The differentiation of regulatory standards for the various applications is essential and serves to reduce risks and public uncertainty regarding the use of secondary waters. Such a decentralised approach can alleviate pressure and impacts on the developed (or potential) freshwater sources.

Management solutions may vary from the most technologically advanced (such as state-of-the-art aquifer decontamination technologies) to the most simple (e.g. the storage and basic treatment of non-potable river water for irrigation use). Simple solutions can be applicable even to the less-developed contexts of the southern Mediterranean.

4.3.4 Pollution prevention

The reduction of pollutant loads at the source of pollution is recommended, where feasible, over end of pipe treatment. The urban area is one of the biggest sources of all kinds of pollution, including solid waste, air pollution, sewage, stormwater, all of which constantly endanger waters and the environment. Stormwater and sewage pollutants can be significantly reduced by appropriate policies of control at the product level. For example, copper concentrations in stormwater run-off can be reduced by redesigning the linings of care brakes to exclude the use of copper. Eutrophication from sewage can be controlled by **banning phosphorous-based detergents** or **replacing phosphorous with other compounds**.

Benefits relating to wastewater treatment include reductions in the consumption of chemicals and energy, and the amount of sludge produced. The substitution of materials, however, needs careful attention, as the use of substitutes can also trigger undesired and unforeseen consequences. Material substitution at the product level is a demanding policy and requires the building of unconventional, extended partnerships between water agencies or utilities and partners that aren't traditionally involved in urban water management and which may operate at very different geographical levels (e.g. the car and detergent industries). Given the considerable degree of global trade, such policies should primarily be the output of international initiatives (e.g. under the auspices of MAP).

The separation of waste streams at source has the benefit of producing waters of different quality with different treatment requirements. Collecting urine-water separately, for example, relieves centralised treatment plants from nitrogen removal requirements, whereas the collected water can be stored and reused in gardening applications. Related advanced technologies are presented in Chapter 6 of the Volume II.

Wastewater pollution loads from industrial processes can be reduced by **remodelling** the processes to increase efficiency and improve the recovery of materials that would otherwise be wasted. The **Internal recycling** of process water streams to reduce wastewater discharges is another strategy. The **Pre-treatment** of industrial wastewater prior to it entering the sanitary sewer system may also be applied to avoid the transfer of toxic substances that would upset the treatment (and recycling) process or cause problems in the pipes.

A specific form of environmental pollution is the result of inappropriate water resources management (i.e. over-exploitation) and land-use (i.e. urbanisation and change of flow characteristics). In coastal urban areas, the **problem of sea intrusion and groundwater salination** is of particular importance. This is a special type of groundwater pollution, specific to coastal urban areas, which has to be treated integrally with other (traditional) pollution types.

4.3.5 Multiple resource use and recycling

Stormwater and wastewater are not "nuisances" to be disposed of, but **resources** that can be fed back into the system. There are now several opportunities for local scale domestic and industrial wastewater treatment and re-use schemes. These can serve non-potable water demands from gardening, irrigation and cooling. Re-use in the urban system can encompass domestic toilet flushing, the irrigation of public, commercial and private open spaces and industrial needs (PCE, 2000). Wastewater can also be used for agriculture and irrigation beyond the city. After suitable treatment, it can also be used for the replenishment of groundwater (**"aquifer recharge"**). Combined with advanced treatment processes, aquifer recharge can even produce water suitable for potable use.

Similar techniques exist for stormwater management. **Infiltration techniques** can facilitate the percolation of rainfall to replenish groundwater. **Retention basins** and ponds can be used to recharge aquifers or provide urban landscape and ecological features. **Rainwater harvesting** from roofs can ease the load on the drainage system while the collected water can be directed to secondary household applications (toilets, gardening). **"Grey water"** (e.g. water from showers) can also be reclaimed in the household and re-used in secondary applications.

The application of such technologies can take place at varying spatial levels:
- centralised (e.g. dual pipe systems for the whole city, separately distributing drinking and reclaimed/grey water
- municipal/local (e.g. neighbourhood retention ponds)
- decentralised at the household level (rainwater collection roofs or in-house water recycling)

Chapter 6 of the Volume II presents a more detailed inventory of related state-of-the-art technologies for integrated water cycle management, while assessing their advantages and disadvantages.

4.3.6 Ecosystem service management

Natural processes in the urban water system provide important services, which often go unnoticed. Conventionally, the focus is on the services provided by the built infrastructure. **Ecosystem services** maintain biodiversity and the production of ecosystem goods, the harvest and trade of which represent an important part of the economy. Ecosystem services also include life-support functions such as cleansing, recycling, and renewal and they confer much intangible aesthetic and cultural value (PCE, 2000). Important ecosystem goods and services in relation to urban water systems include (PCE, 2000):
- Stabilising processes. Wetlands, for example, act as natural ponds for the retention of stormwater, stabilising excess flows and reducing flood risk. Groundwater acts as a natural reservoir, collecting water in wet periods and releasing it to surface waters in dry periods, thus balancing the impacts of climatic fluctuations.

- The production of goods. Forests, for example, provide a natural mechanism for the cleaning of water, thus contributing to the "production" of drinking water. Aquifers provide a natural water supply reservoir, reducing the need to construct artificial reservoirs.
- Regeneration processes. Wetlands process and filter wastewater and release a much cleaner product, in effect acting as natural wastewater treatment "plants".
- Habitat. Wetlands, estuaries, coastal waters, etc. act as natural fish nurseries and as habitats for migratory species.

Ecosystem processes and services should be utilised to form an integral part of urban water system management and planning ("ecological engineering"). For example, **natural or artificially constructed wetlands** can serve for the collection and retention of stormwater, the treatment of wastewater, or the treatment of polluted water for potable purposes, while contributing to landscaping and aesthetic goals.

Natural drainage systems (e.g. creeks and streams) should be protected from encroachment by leaving buffers, which allow the natural channel to meander without endangering the urban infrastructure and provide sufficient space to preserve the viability of ecosystem functions.

Coastal strips should be protected in their natural state to avoid the hardening of shorelines which obstructs natural water discharge.

Such interventions may be difficult to implement in existing urban areas, but can and should be incorporated into the **design** of new urban developments and their urban water systems.

Mediterranean ecosystems have unique features, distinguishing them from other parts of the world. Ecological features will also differ from one settlement to another within the Mediterranean region. Local strategies for the utilisation of ecological services should be adapted to the local context.

4.3.7 Environmental efficiency and management

In the process of service delivery, an urban water system consumes environmental resources and generates outputs that impact on the natural environment. These include:

- water use and its related impacts on resource-dependant aquatic and terrestrial ecosystems
- energy use for the assorted production, distribution and treatment processes (and hence, indirect contribution to pollutant and greenhouse gas emissions)
- material use and the production of solid waste and process solid sludge (from drinking water and wastewater treatment units)
- wastewater discharges and related impacts on recipient water dependant aquatic and terrestrial ecosystems

A sustainable management of the urban water system should strive to:

- minimise emissions so that they don't exceed the assimilative capacity of recipient bodies
- constrain resource use to within the rates of renewal of renewable sources
- control other environmental impacts
- contribute to the enhancement of the natural environment (e.g. by contributing to river and coastal restoration efforts, etc.)
- improve the environmental efficiency of processes (i.e. reduce resource use and emissions per unit of service product delivered)

It is recommended that Mediterranean coastal water utilities initiate a **programme of internal environmental auditing and improvement**. There are several relevant standard procedural tools and certification schemes in existence. In the **ISO scheme**, industries (e.g. water utilities) report on a list of environmentally-important indicators. **ISO 14001** requires the utility to monitor and measure the environmental performance of its activities and services and **ISO 14031** provides guidance for this purpose. It contains a number of generic environmental performance indicators designed for internal management reporting and monitoring purposes as well as guidance on the process for the selection of indicators.

The **Eco-Management and Audit Scheme** (EMAS) is an alternative scheme, set up at the European level. EMAS integrates into its objectives the establishment and implementation of environmental management systems and the systematic and periodic evaluation of performance and reporting to the public and "other interested parties" (e.g. regulators). EMAS builds on a **public environmental statement** that is produced to report on the environmental performance of the utility. This statement is validated by accredited environmental verifiers. Performance reporting is carried out against a number of **indicators**. The EMAS regulations require that these indicators are based on a comparison with sector, national and regional benchmarks and with regulatory requirements. In comparison to ISO, EMAS places more emphasis on transparency, reporting and the provision of information to the public.

For some small coastal water utilities, especially in the southern Mediterranean basin, it may be too demanding and expensive to undertake a full ISO or EMAS process. Nevertheless, the basic principles of these processes (internal auditing, performance assessment and environmental management improvement) should be adhered to, even if only in a more basic and "sketchy" way. For example, small utilities too should identify (at least roughly) their main impacts on the environment, devise a basic form of data collection that will permit the assessment of change, establish a fundamental monitoring capacity, identify a list of small-scale interventions that can improve environmental performance and produce a regular 1-2 page brief report.

Benefits	Examples
Reduced short term run incremental costs	Lower costs of chemicals, energy, labour and materials
Reduced long term incremental costs	Lower costs of capital facilities for water supply, wastewater disposal facilities
Energy savings	Reduction in the use of heated water
Other economic benefits/ effects	Reduced costs of lawn maintenance (fuel, labour) in efficient irrigation
Environmental quality	Reduced damage to natural water sources
External costs	Reduced pumping costs to farmers due to reduced drawdown of groundwater
Costs	**Examples**
Utility programme costs	Labour, materials, economic incentives; related to implementing conservation programme
Customer programme costs	Materials, installation, operational and maintenance costs, related to implementing a conservation programme
Other economic costs	Increased energy costs for air conditioning due to reduced shading from trees (i.e. from converting from shade trees to xeriscape landscaping)
Reduced aesthetic value	Decreased customer satisfaction due to the replacement of lush green lawns with xeriscaping
Reduced revenues	Without rate adjustments, reduced water use leads to reduced revenues

Table 4.4
The costs and benefits of water demand management
(Dziegelewski et al, 1995)

On most occasions, environmental efficiency improvements will also yield important economic benefits to the utility. For example, unexploited marketable opportunities for energy production from wastewater treatment operations (methane gas) or hydropower production from gravity water flow in the aqueducts.

Some "environmental management solutions" have their own environmental costs. For example, electricity-powered showers or taps consume less water but more energy. Wastewater recycling or sludge treatment also use energy. These realities emphasise the need for a holistic, **life-cycle approach and assessment** to urban water system management, whereby total environmental costs and benefits are evaluated (see next chapter and Chapter 4 of the Volume II for more details on life cycle assessment).

4.3.8 Water demand management

Urban water demand management (UWDM) generally refers to the implementation of policies or measures that serve to control or influence the amount of water used in the urban system with the objective of satisfying urban needs with less "scheme water". In contrast, conventional **supply-side management** is based on the increase of water abstraction or the augmentation of existing water sources through the construction of new waterworks. Table 4.4 indicates the costs and benefits of urban water demand management.

It is highly recommended that in the context of IWSMCA, Mediterranean coastal water utilities develop an **UWDM programme** (alone or preferably in partnership with other urban, river basin and coastal zone agencies and stakeholders). UWDM measures should be considered as a priority over supply alternatives and taken up to the extent that their economic, environmental and social benefits/costs are better than those of supply alternatives. Table 4.5 indicates the range of measures that can be part of an UWDM programme (after the guidelines of the U.S. EPA, 1998). **Basic measures** are simple and should be taken up by all utilities in the Mediterranean region, including small settlements and water utilities with limited financial and human capacities in the Southern Basin. **Intermediate measures** should be considered by medium-sized cities (with populations of circa 10,000-100,000), depending on their administrative and technological capacities. **Advanced measures** should be considered and implemented in big cities (more than 100,000 residents) with strong technological capacities; as such, typically cities in the EU-Med. Other large coastal settlements served by utilities with good administrative and technical capacities in the Eastern and Southern Basins should also consider at least some of the options. Chapter 5 of the Volume II provides a more detailed description of UWDM options available.

Governments have a strong role to play in promoting UWDM in terms of:

- creating a sound base of data and information about alternative UWDM options and their effectiveness
- conducting education programmes that serve to raise public awareness and make the public receptive to water demand management
- setting up appealing regulatory and pricing frameworks that eliminate disincentives against water saving in water utilities and among users

4.3.9 Pricing

Water pricing allocates water between alternative uses and hence provides incentives and disincentives for different patterns of water use. It therefore plays a central role in supporting all aforementioned water management tasks and objectives.

A model water pricing system should:

- provide incentives for the economically efficient use of water
- ensure that the availability of water is equitable; namely that the minimally required quantity and quality of water for use is affordable to all
- provide incentives for water saving (and where applicable, reduce wastewater/stormwater loads)
- secure adequate revenue to ensure the viability of the water utility's operations and for funding the required investments

Most existing water tariffs in Mediterranean cities are **simple**. They generally seek to recover past costs and to ensure stable revenue for the utility. Direct or indirect subsidies are used to maintain low water costs, both for those who need water for their essential needs and for those who use it for non-essential leisure purposes. Tariffs are crudely designed, with limited demand data analysis conducted; seldom do they aim explicitly to provide efficiency or saving incentives. This has lead to the wastage of water and financial resources, inefficient investments and an unfair distribution of costs. There is a need to **reform tariffs** and to shift from simple to **advanced** price systems.

The theory of economic efficiency requires that users pay the **full** (the operational, capital and "external" cost, including the social and environmental costs), and the **marginal cost** (the incremental cost of producing an additional unit) of water and wastewater services. Marginal costs and non-monetary costs (e.g. environmental, social), however, are extremely complex to calculate; their calculation has an important cost in itself (information collection, analysis, etc.). Different methodological assumptions may lead to very different results. A pragmatic approach dictates a shift of emphasis away from ideal, economically efficient tariffs to "**second best**" alternatives (Table 4.5).

Water prices should be determined on the basis of sufficiently **long term, incremental costs** taking into account the cost of the next major work (e.g. dam, expansion of drinking water treatment or wastewater treatment plant capacity, etc.). Care needs to be taken so that charging long term costs before they are incurred does not lead to an unjustifiable accumulation of revenue by water utilities. Water prices may also include an **"environmental tax"**, dedicated to restoring the environmental impacts of water supply and wastewater discharges and providing incentives to users to consume water more consciously. An **abstraction charge** paid by the water utility to the State in proportion to the amount of water used can provide a mechanism for collecting such taxes and managing possible revenue excesses, as well as provide incentives to the utility itself to use water rationally.

There are several possible designs of user tariffs. Three basic types can be identified:

1. **Flat rate tariffs** consist of a connection and a fixed charge, usually determined on the basis of certain customer characteristics (size of household, location, etc.). These are in place in cities where water use is not metered.
2. **Sliding scale tariffs** include connection and fixed charges plus blocks of increasing rates paralleling increasing levels of consumption. A low consumption block can be introduced to ensure affordability of a minimum water quantity, whereas higher categories can be used to foster water saving and/or reflect marginal/incremental costs to provide incentives for efficient use.
3. **Uniform (marginal cost) volumetric tariffs** include connection/fixed charges plus a uniform rate charge directly linked to consumption. This rate can be set so as to reflect marginal/long term incremental costs.

Table 4.6 compares the three different types of tariffs with relation to five different criteria: economic efficiency, social aspects (fairness and affordability), incentives for water saving, utility funding and administrative costs/requirements. Any price system will need to balance the following trade-offs:

- Economic efficiency and water saving goals require volumetric-based pricing. Linking revenue to consumption, however, increases the financial uncertainty of the utility and impacts negatively on its credit rating.

MEASURES	← BASIC MEASURES →	← INTERMEDIATE MEASURES →	← ADVANCED MEASURES →
Universal metering	• Source-water metering • Service-connection metering and reading • Meter public water use	• Fixed-interval meter reading • Meter-accuracy analysis	• Test, calibrate, repair and replace meters
Water accounting and loss control	• Account for lost water • Repair known leaks	• Analyse unaccounted for water • Water system audit • Leak detection and repair strategy • Automated sensors/ telemetry	• Loss-prevention and proactive rehabilitation/ replacement programme
Costing and Pricing	• Cost-of-service accounting • User charges • Metered rates	• Cost analysis • Incentive based tariffs	• Advanced pricing methods • 'Smart' meters
Information and education	• Comprehensible water bill • Information made available to customers about water saving	• Informative water bill • Water bill inserts • School programme • Public-education programme	• Public/stakeholder Workshops on water saving • Advisory committee on water saving
Water-use audits		• Audits of large-volume users • Large-landscape audits	• Selective end-use audits
Retrofits		• Retrofit kits available to users	• Distribution of retrofit kits • Targeted programmes to selected user groups
Pressure management		• System-wide pressure management	• Selective use of pressure-reducing valves
Landscape efficiency		• Promotion of landscape efficiency • Selective irrigation sub-metering	• Landscape planning and renovation • Irrigation management
Replacements and promotions			• Rebates and incentives (non-residential businesses) • Rebates and incentives (residential) • Promotion of new technologies
Reuse and recycling			• Industrial applications • Large-volume irrigation applications • Selective residential applications
Water- use regulation			• Water-use standards and regulations • Requirements for new developments
Enhanced supply management			• Modelling - better timing/ allocation of abstractions • Reduction of losses in reservoirs, aqueducts, etc.

Table 4.5
Water Demand Management Measures
(adapted from EPA, 1998)

	FLAT RATE	SLIDING SCALE	VOLUMETRIC MC
Efficiency	0 Lack of incentives for efficient use	++ Links consumption with cost (higher block(s) can reflect marginal cost) But individual users will face less (if in small households) or more (if in large households) than real marginal cost of their use	+++ Directly linked to marginal cost of supply
Socially-aware /equitable	+++ Charges linked to proxy income criteria	++ Can include social lifeline category But this may not benefit large families	+ Higher costs But can manage by adjusting fixed portion of payment (even making it go 'into the red' to reflect income criteria
Water saving	+ Lack of incentives But may foster voluntary cooperative spirit	++ Higher costs for heavy users But: Incentives distorted for small vs. large households Incentive to conserve is reduced the more one conserves Consumers given the impression that fixed costs can be "spread" by consuming more	++ The more one consumes the more one has to pay. (in proportion)
Funding	+++ Stable and predictable revenue	++ Revenue uncertainty; can be managed by fixed charge/ support measures Possibility of revenue excess; can be managed by setting some blocks lower than fixed costs and some higher ("break even")	++ Revenue uncertainty; can be managed by fixed charge/ support measures Possibility of revenue excess; can be managed by adjusting fixed charge to "break even"
Administrative	+++ Easy to administer No need for meters/ metering costs	+ Relatively more complex to administer	++ Easy to administer once established But: administrative burden of calculating marginal costs

Table 4.6
Comparing different tariff designs
(based on Chapter 7 of the Volume II)

+++ = performs very well according to the criterion
0 = fails according to this criterion

- Long term, incremental (marginal) cost pricing improves efficiency but may create unjustifiable revenue surpluses.
- The more complex the pricing system is, the higher its administrative cost.
- Recovering a higher proportion of the water costs through charges improves efficiency and provides stronger incentives to save water. Unless mitigated however, the cost of water for the poor may increase and water use may become unaffordable.

Support tools can be used to mitigate some of these problems:

- The revenue instability of volumetric tariffs is partly addressed by adding the fixed charge. Utilities can also develop coping mechanisms, such as contingency funds, revenue tracking accounts, or rate adjustment mechanisms, that can reduce risk and increase flexibility in the management of a variable stream of revenues (Dziegelewski et al, 1995).
- Revenue surpluses should be accurately and objectively tracked and determined. Their use could then be limited to special funds (e.g. a conservation fund, a social fund to support low income users or an environmental protection/ restoration fund). This is often difficult, however. A solution through the tariff system is to lower the fixed charge below the level required to recover fixed costs so as to break even with potential surpluses (note, however, that this may increase revenue uncertainty and risk).
- Administrative costs will be reduced if proper expertise is utilised and as experience with managing the tariff accumulates. Rising administrative costs can also be recovered by the charges.
- Affordability concerns can be addressed via income support measures and tariff-based measures (so called "social tariffs") (OECD, 2002) (Box 4.4).

BOX 4.4
INSTRUMENTS FOR ADDRESSING AFFORDABILITY CONCERNS
(based on OECD, 2002)

Income support
- Welfare assistance and housing-related allowances covering water bills (or offering partial-assistance)
- Municipal "hardship funds"
- Water service vouchers and concession cards for vulnerable groups
- Tariff rebates and discounts for bills of predetermined amount or for specific groups
- Payment assistance in the form of easier payment plans, special loans and the cancellation of arrears

Social tariffs
- Sliding scale tariff with a socially-aware, "lifeline block"
- Different tariffs for special social groups, areas of the city, etc.
- Lower fixed charges (even loss-making) for disadvantaged social groups, areas of the city, etc.
- Cross-subsidies: taxes or charges added to heavier consumers or identified affluent user groups of users, and then re-directed for investments that benefit low income consumers

Other
- Targeted subsidies to high cost areas or vulnerable groups
- Disconnection moratoria
- Special service contracts for vulnerable customers with favourable payment procedures

Seasonal or **dry year tariffs** are especially recommended for Mediterranean settlements, given the pronounced seasonality of both rainfall and water demand. Different tariffs (higher prices, different designs, etc.) could apply in the summer period (or in dry years, as defined), and fund the higher cost of supply in peak periods as well as the need to intensify water saving incentives.

Wastewater and stormwater costs are usually collected through local taxes or as an add-on to the fixed or volumetric portion of the water tariff. The administrative cost of designing tailored household wastewater tariffs that would provide incentives to reduce pollutant loads are not justified by the benefits incurred. Specific effluent charges and tariffs are applicable to industries, however, especially those producing waste that needs advanced treatment

4.4 INTEGRATING WITH OTHER MANAGEMENT PROCESSES

4.4.1 The framework

The urban water system has important interfaces and reciprocal relationships with the wider context of the river basin, urban area and coastal zone (Chapters 1 and 3). IUWSMCA requires an "area-wide" integration between urban water management (supply, drainage and wastewater) and river basin management, urban management (land-use and infrastructure) and coastal zone management. Figure 4.6 graphically illustrates the overlap of the domains of the different management competencies (see Figure 3.4). Integration requires that duplication is minimised and complementarities and mutual support fully exploited.

4.4.2 Integration with river basin management

River basin management refers to the integrated management of water resources at the river basin level. It is concerned both with the allocation of water resources to various water uses in the basin and the "allocation" of pollution controls for the protection of water quality for different uses. It is also concerned with drought and flood problems. Organising water management at the river basin level enables the management of the interdependency of water quantity and quality; water and adjacent land-based resources and ecosystems, and upstream and downstream effects. Tools for river basin management include planning and programmes containing measures, permits (abstraction and pollution), economic instruments (taxes, permit charges, etc.), standards and controls.

Why integrate urban water management and river basin management?

1. River basin management is now an **international policy priority**. All EU Mediterranean countries should have operational river basin authorities and planning processes by 2009, meeting the requirements of the EU Water Framework Directive (CEC, 2000). Urban water utilities will increasingly have to cooperate and coordinate efforts with river basin authorities.
2. River basin management establishes a rational system for the **allocation of water** to the urban area and for rival, in-stream and off-stream, uses. This is particularly important for Mediterranean settlements where conflicts between urban areas and agricultural water users are common and often intense. The coordination of water resource management at the river basin level allows for security, flexibility and economies of scale in

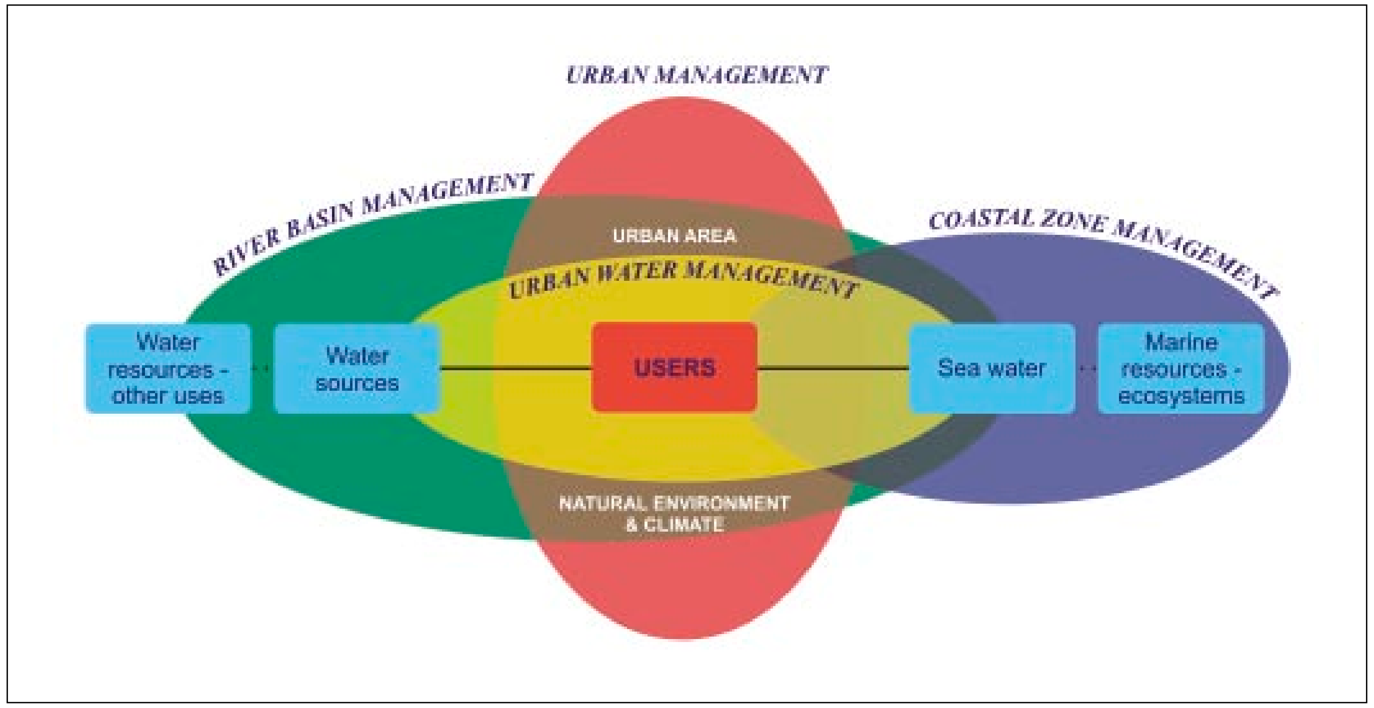


Figure 4.6
IWSMCA as the integration of urban water, river basin, urban and coastal zone management

investments (e.g. multiple-purpose reservoirs). The multi-purpose share of water resources can avoid the need for the construction of large and costly infrastructure. For example, urban water utilities may opt to invest in water conservation in irrigation and increase their own share of resources, or they can transfer water from agriculture in drought periods and compensate producers for lost production.

3. River basin management provides for upstream-downstream (urban) cooperation on **flood control**. The management of upstream water uses (e.g. releases from power production plants) for example can be managed to reduce risks of flooding in downstream coastal urban areas.
4. River basin management can contribute to **protecting the quality** of urban drinking water sources and hence reduce the need for costly treatment or for the development of new sources.
5. River basin management establishes a rational and cost-effective system for the allocation of responsibilities **for pollution control**. For instance, the degradation of a coastal area may be the compound result of several activities and sources of pollution. These might include discharges from the urban area but also pollution from other upstream sources (e.g. industries, diffuse pollution from agriculture, etc.). Applying control measures in the urban area alone will only have a limited effect. The allocation of control measures pertaining to all the different sources of pollution in order to attain given qualitative standards can be more effective and cheaper.
6. River basin management provides a good basis upon which to coordinate regional **land-use** policies with water management (flood, quality, quantity) goals.
7. River basin management provides a framework for protecting the **ecological condition** of waters. The EU WFD asks for the classification of all water bodies according to ecological standards, including hydromorphologic conditions. The goal is the attainment of, at the very least, a "good status" (as defined) for all waters, unless this is prohibitively expensive (Kallis and Butler, 2001). Such standards can provide boundary conditions for the management of urban water resources. For example, ecological standards can be "translated" into minimum river flows that would define ecological constraints on the future development of water sources by the urban area.

How can integration be strengthened?

1. Urban water management decisions should explicitly **respect the goals** set at the river basin level. River basin management should likewise take into account the special features and needs of the urban water system, as well as the pressure brought to bear on the river basin by the urban water system.
2. **Representatives** from urban water utilities should participate in **decision forums** at the river basin level. By the same token, representatives from river basin agencies should participate in decision forums for urban water management.

3. Cooperation may be sought in **shared tasks** of common interest, such as data collection, database management, etc.
4. **Projects** of common interest should be pursued, e.g. the implementation of a pollution control programme to protect the quality and restore the ecological health of an aquatic ecosystem which serves the city's drinking water supply.

4.4.3 Integration with urban (land-use and infrastructure) management

Urban land-use management determines the scale, arrangement and allocation of urban activities in space. Land-use controls (consents, permits, etc.) are used to limit or permit certain activities in specific areas or to set minimum standards and requirements for new developments. The rules upon which such controls operate are defined in urban and regional land-use (or "spatial development") plans (see next chapter). Urban land-use management is typically the responsibility of a delegated public agency (or ministry department).

Urban infrastructure management refers to the management of the systems and networks of other utilities operating in the urban area, such as electricity, gas, telecommunications, transport, etc.

Why integrate urban water and urban management?

1. **Urbanisation** is the main driver of man-made pressure on water resources and urban water systems. The conventional urban water management approach ("***big pipes in - big pipes out***") sees water infrastructure services as mechanisms that serve the urban development and redevelopment process. This approach has outlived its usefullness and the sustainability of water resources and systems is under threat.
2. The provision of centralised water and wastewater infrastructures (together with other urban utilities) may in some cases be a driving factor rather than a consequence of **urban sprawl**. Water system management can provide an effective tool for controlling urban development and for steering it towards desirable paths.
3. The spatial distribution and the types of built-up areas and urban developments affect bodies of water, stormwater run-off flows and quality (and hence flooding risks and the pollution of coastal waters), water infiltration to the **groundwater** (and hence groundwater quantity and quality), requirements for **network** expansion, etc. Managing urban land-uses can contribute to the achievement of water system goals.
4. Urban **landscape features** can provide water services. For example, retention ponds can be used for stormwater management and provide landscape features in parks. Economies of scale can be the result of such **multiple uses**.
5. **More compact urban forms** demand less water and can be easily served and at lower cost by water networks.
6. There are many **tasks that are shared** by water and other urban utilities presenting numerous opportunities for reduced operational costs.

How can integration be strengthened?

Urban water system goals and requirements should be incorporated into urban land-use planning and decisions. The concept of **Water Sensitive Urban Design (WSUD)** emphasises that the processes of urban development and redevelopment need to adequately address the sustainability of the water environment. WSUD aims to find ways of incorporating consideration for the water environment and infrastructure service design and management opportunities into the decision-making process associated with urban planning and design at an earlier stage (VSC, 1999, Mouritz *et al*, 2003). WSUD aims to integrate the following opportunities into the built-up areas of cities:

- the retention of stormwater
- the utilisation of stormwater as a secondary source
- the use of vegetation for filtering purposes
- the protection of water-related environmental, recreational and cultural values
- localised water harvesting for various uses and localised wastewater treatment plants
- water-efficient landscaping
- a reduction of household water demand
- the protection of water-related ecosystems
- the protection of the quality of urban water bodies and coastal sea waters

WSUD incorporates the goals of an integrated urban water system management into urban land-use planning and development. Box 4.5 presents some important management tools for WSUD, especially in relation to stormwater management. Box 4.6 summarises the main economic, environmental and social opportunities and constraints for WSUD.

The tools in Box 4.5 are more applicable to **new urban developments**. Nevertheless, several opportunities also exist for previously urbanised areas. WSUD principles could be incorporated into **redevelopment initiatives**, such as new squares, parks and riverfront or seafront reconstruction. For instance, the design of a new "metropolitan park" or a new waterfront "promenade" could incorporate provisions for stormwater retention into its spatial design and landscaping.

WSUD is particularly relevant to many Mediterranean urban coastal areas where urbanisation is still an ongoing process. The urban landscape features that will be utilised will greatly depend on the local context (natural environment, vegetation, urban form, etc.).

BOX 4.5
TOOLS FOR WATER SENSITIVE URBAN DESIGN
(VSC, 1999, Mouritz et al, 2003)

Public Open Space Networks
Description:
Multi-purpose drainage corridors in residential developments which integrate public open space with conservation corridors, stormwater management systems and recreation facilities.
Advantages:
- integration of public open space, habitat and stormwater corridors
- protection of natural water features with vegetated buffer strips
- improvement of visual amenity, public access and passive recreational activities
- incorporation of water features in public open space
- creation of landscaped links between public and private areas
- incorporation of pathways between community activity nodes
- treatment of pollution and encouragement of detention and filtration of stormwater
- possible use of stored stormwater for irrigation purposes
- enhanced property values

Limitations:
- networked area may be physically unsuitable for recreational activities
- networked open space may be unevenly distributed and remote from some areas of development
- development of active recreation areas next to drainage facilities needs to be carefully planned and managed.

Housing Layout
Description:
Development of a more compact form that integrates residential blocks with the surrounding drainage function of public open space.
Advantages:
- incorporates a mixed density and use, a pedestrian focus, quality design and a distinct local identity and character
- reduces capital and maintenance costs
- provides greater areas of public open space
- allows for use of water features in public open spaces for run-off drainage

Limitations:
- possible unattractiveness of compact form of development to developers and community

Road Layout
Description:
It incorporates natural features and topography of site, enhancing visual amenity, temporary storage, infiltration and water quality.
Advantages:
- road drainage system can be incorporated within open space network or adjacent to private landscaped areas
- reduced cost
- aesthetic benefits

Limitations:
- existing layout or irregular terrain may conflict with drainage function
- requirement of suitable area to locate infiltration system
- soil permeability and road gradient
- potential conflict with standard public utility alignments
- public acceptability
- difficulty of incorporation of crossovers

Streetscape
Description:
Integrates road layout with stormwater management needs.
Advantages:
- incorporates water into streetscape
- more aesthetically pleasing
- local detention or infiltration, encouraged by the use of agricultural type drains and gravel filter beds
- incorporates indigenous vegetation
- enhances public open space
- enhances landscape possibilities and streetscape amenity

Limitations:
- local site conditions
- possible limited application in established areas
- potential conflict with standard utility alignments
- difficult to implement in areas embracing a range of subdivisions or developments

BOX 4.5 / CONTINUED

Parking area storage
Description:
Incorporated specifically designed or modified inlet structures that permit the temporary storage of stormwater.
Advantages:
- integration with car park landscaping proposals and steep slope stabilisation
- improved aesthetics
- incorporation of indigenous vegetation

Limitations:
- parking lot sizes, topography and soil condition and proximity to structures and traffic routes
- acceptable depth of water
- regular maintenance and periodic inspection of discharge control structures

On-site detention for large sites
Description:
On site stormwater detention in underground tanks, driveways or landscaped depressions.
Advantages:
- reduced flooding risk and peak discharges downstream
- integration with site landscaping and steep site stabilisation
- improved site aesthetics
- incorporation of indigenous vegetation
- use of run-off for local irrigation or commercial/industrial purposes

Limitations:
- parking lot sizes, topography and soil condition and proximity to structures and traffic
- acceptable depth of water
- regular maintenance and inspection

Compared to Western countries (such as Australia, where the WSUD concept was first developed), land-use planning processes and the related administrative competencies are weak in many Mediterranean states. Processes such as sub-urbanisation, urban sprawl, illegal settling by the poor or the development of tourism and recreation facilities, are spontaneous and difficult to control. Official land-use planning goals and control mechanisms are often breached. The

BOX 4.6
OPPORTUNITIES AND CONSTRAINTS RELATING TO WATER SENSITIVE URBAN DESIGN
(VSC, 1999)

Economic opportunities
- Capital cost savings: reduces capital costs (pipework and drains).
- Construction cost savings: reduces construction costs (e.g. grading, tree clearing).
- Water quality cost savings: potentially reduces the costs of water quality improvement, by retaining existing waterways.
- Developer cost savings: reduces developer contributions for downstream drainage capacities.
- Improved market value: the incorporation of water features, water frontages, and networked public open space - preserving and enhancing an ecological system - tends to make developments more desirable and marketable.
- Improved recourse utilisation: offers cost benefits where areas are unsuitable for residential development, but are suitable for passive recreation and contribute to required public open space allocation.

Economic constraints/limitations
- Market limitations: the market may be sensitive to new urban forms.
- Maintenance/operation costs: can potentially increase maintenance and operation costs.
- Limited lots for development: potential loss of profits through the reduction in the number of lots for development.
- Storm events and steep terrain: there may be a possible need to supplement water- sensitive treatments (such as swales) with pipes to accommodate minor storm events and steep terrain.
- Land acquisition difficulties: fragmented land ownership may limit opportunities to implement water-sensitive initiatives.
- Open space requirements: the benefits may be reduced where potentially attractive residential areas are earmarked as open space.

BOX 4.5 / CONTINUED

Environmental and social opportunities	Environmental and social constraints/limitations
• Hydrological balance: maintains hydrological balance by using natural processes of storage, infiltration and evaporation. • Sensitive area protection: protects environmentally sensitive areas from urban development. • Waterways restoration: restores and enhances urban waterways. • Impact reduction: minimises the impact of urban development on the environment. • Natural habitat enhancement: can increase the diversity of natural habitats and suburban landscapes. • Groundwater recharge • Amenable urban and residential landscapes. • High scenic value. • Linking: opportunities to link community nodes through public open space.	• Water table depth: opportunities are limited in areas with high water tables. • Topography and erosion: opportunities are limited in areas of deeply dissected terrain and high slope. • Ground conditions: opportunities are limited in areas of poor soil (high slaking or highly dispersive) and shallow depth to bedrock. • Safety perceptions: perceived safety risks. • Acceptance: possible public resistance to new forms of urban landscape.

solution to urban water problems requires first and foremost that these broader problems relating to urbanisation and planning be addressed.

In some cases, there might be scope for an inverse integration, i.e. an "**urban-sensitive water design**", i.e. using water management as a tool to control undesirable urban sprawl. Water infrastructure "**moratoria**" for example, may be used for developments in areas which are not part of the formal land-use plan (e.g. sprawling tourist settlements). Such policies will be effective only if they are part of broader land-use control initiatives.

There are several potential mutual benefits that can be derived from closer cooperation between water and other urban utilities. Box 4.7 summarises a number of these opportunities.

4.4.4 Integration with coastal zone management

Integrated Coastal Zone Management (ICZM) focuses on multiple resource and multiple use management of the coastal zone based on physical planning and resource management with a strong emphasis on **land-use regulation** and **physical interventions**. It originates from two management activities: **fisheries management** (in the broadest sense, and extending to land-based activities and waste that affect habitats) and **physical planning on the coast**, focussing on the rational allocation of land-use (including sea use) to human activities (tourism, industry, urban development, etc.) (UNEP/MAP/PAP, 1999).

Why integrate urban water and coastal zone management?

1. Stormwater and wastewater discharges are critical factors affecting the quality of the coastal environment and the sustainability of coastal (terrestrial and marine) ecosystems as well as related economic activities (recreation, tourism, fisheries). A proper design of the urban water system is necessary in order to take into account the special features of the coastal zone and the activities within it. Blueprints of treatment plants and outfalls of wastewater to the sea require special designs or modelling so as to ensure the effective dispersal of pollutants - one which doesn't affecting bathing or shellfish production areas.
2. Upstream interventions in the water cycle can affect downstream coastal processes. Quantity and seasonal cycles of water flowing to the sea should be maintained because they are crucial to sustaining coastal ecosystems. Many fisheries including salmon, shrimp and oysters strongly depend upon river flows that enter the sea. Rivers transport beneficial nutrients to coastal ecosystems and sand to beaches. They also establish beneficial brackish conditions in estuaries which provide habitats for juvenile fish as well as nesting for colonial water birds. Dams and water diversions can cause serious imbalances to such ecosystems and reduce their productivity and species diversity by diverting water and nutrients away from the coast or by changing the beneficial hydro-period through the use of store-and-release tactics created for irrigation, flood control and water supply (FAO, 1992). The design and management of upstream

BOX 4.7
OPPORTUNITIES FOR COOPERATION IN WATER AND OTHER URBAN INFRASTRUCTURE ACTIVITIES

Underground and excavation works
These can be shared minimising nuisance to the public and costs. For example, the laying down of new gas pipes in a city can be an opportunity for an urban water utility to replace old distribution pipes.

Works design that is sensitive to other infrastructures
Utilities should strive to minimise negative impacts on each other's infrastructures. Damage from road works often triggers bursts in water distribution pipes and by the same token, excavations for distribution pipe interventions can damage road infrastructure. Simple measures such as sharing layouts and maps or ensuring that various utilities exchange representatives could avoid such costly damages.

Joint customer services
Tasks such as meter reading, billing, fee collection, etc., can be shared between water and other utilities such as telecommunications, electricity or gas providers. Several operations can also be shared, such as data and information management, modelling, planning, etc. The advent of multi-utilities serves as testament to the considerable economies of scale to be derived from linking these types of tasks.

waterworks (e.g. release flow from dams) must take such downstream impacts into account.
3. The development of coastal infrastructure (e.g. port facilities) can impact on the quantity and quality of freshwater resources.
4. Flood protection needs to take into account coastal tidal and wave patterns.
5. Integrated Coastal Zone Management is a priority in the Mediterranean region and a key goal of the Mediterranean Action Plan. PAP/RAC in particular has developed a number of innovative ICZM demonstration projects. A number of Coastal Zone Forums exist in Mediterranean settlements and their number is expected to grow in the future. These initiatives provide an opportunity for solving water management problems and achieving water system goals.

How can integration be strengthened?

1. Representatives from urban water utilities should participate in ICZM committees, forums, etc. Equally, representatives from ICSM bodies, agencies, etc. should participate in decision forums for urban water management. **Consultation** between the two bodies should be encouraged during the making of key decisions (e.g. the construction of a new dam, a spatial plan of the shoreline, etc.).
2. Cooperation may be sought in **shared tasks** of common interest such as data collection, database management, research, etc.
3. **Projects** of common interest should be pursued. For example, urban water utilities, ICZM authorities or partnerships and river basin authorities may co-operate in a programme dedicated to the cleaning up of a polluted bay.

4.5 INTEGRATING URBAN WATER MANAGEMENT INTO SECTORAL POLICIES

If the goals of IUWSMCA are to be achieved "**Sectoral Policy Integration**" with other important policies (economic, social, environmental) is necessary. Why?

1. Social and economic policies cause changes that impact on the urban water system and are major drivers of **pressure** on water resources. A policy of industrialisation or tourism development of a region, for example, will have important repercussions in terms of water resource and service demands.
2. There are important **complementarities**. The goals of IUWSMCA can be supported (or shared) via interventions in other policies. For example, social support measures can address affordability problems arising from the burden of water tariffs. Education policies can heighten environmental awareness and make the public more supportive of water demand management efforts.

Policy integration and harmonisation of the different policies should take place at **different levels** (organisational, spatial, etc.). International policies should also be harmonised, as should national, regional and local policies.

Suggested guidelines for sectoral policy integration follow:

Urban policy

- Urban growth, land-use planning and new developments and urban regeneration projects in particular should incorporate the principles and tools of Water Sensitive Urban Design.

Regional Development policy

- The development of tourism on the coast should be integrated with policies for urban water system management and environmental protection. The seasonal character of water system use by tourism should be manageable and justified.

- Public funding of infrastructure projects should not discriminate in favour of supply-side expansion and against water demand management. Hydraulic projects such as dams and transfers should no longer be funded as "development projects" per se. They should be pursued only when absolutely justified and only if better (economically, environmentally and socially) than water demand management.

Economic policy

- "Green taxes" (e.g. a groundwater abstraction tax) should be introduced to discourage increased water use and freshwater abstractions. Special, tailored subsidies can support the diffusion and adoption of water-saving and water cycle technologies.
- Environmentally-aware models of economic growth and consumption should be encouraged, detaching economic development from consumption increases. These will also yield benefits in terms of reduced water use and wastewater production.

Public health policy

- Standards should be set for the use of unconventional water sources.
- Rules formalising deviations from normal standards may need to be drafted for contingency situations (e.g. permitting a rota of cuts to water supply or the temporary use of lower quality water). The responsibilities of public authorities in protecting the public in such situations need to be clearly defined.

Environmental policy

- Performance standards (voluntary or if necessary, legally-binding) must be set for urban water utilities in terms of their consumption of energy and materials and the production of wastes.
- Environmental policies on forestry, urban areas, land-use, etc. need to contribute to the goals of river basin and urban water management.

Social policy

- Special urban water services standards and support mechanisms for lower income population segments (as properly defined) must be in place.

Public administration

- Administrative reforms and funding mechanisms to support them must be implemented in order to enhance cooperation between the different actors involved in the urban water cycle.

Research policy

- Public research programmes should support research on innovative urban water management technologies, planning processes and policy instruments in line with the tasks of IUWSMCA (cycle management, water saving, utilisation of ecosystem services, etc.). These should be given priority over conventional hydrological engineering and research.

5. PLANNING FOR INTEGRATED URBAN WATER SYSTEM MANAGEMENT IN COASTAL AREAS

This chapter offers guidance on the preparation and implementation of plans aiming at the integrated management of urban water systems in coastal areas. Firstly, the stages of a generic Planning Process for urban water system management are outlined. An organizational framework for planning is then briefly presented. Next, the features of several other thematic plans relevant to urban water system management are presented. The chapter is completed with a discussion of the opportunities for integration of urban water system planning with urban land-use, river basin and coastal zone planning.

5.1 THE MASTER PLANNING PROCESS

Long term planning is essential for sustainability and for integrated urban water system management in coastal areas. The subject of this chapter is **Master Planning**. Master Plans are integrating, large-scale and long term guidance documents for the management subject at hand, wherein all the various infrastructure, technological and policy components are combined to achieve the desired goals. Figure 5.1 relates Master Planning to other types of plans. A Master Plan falls midway between a **strategic plan** which deals with the overall strategies and basic guiding principles for the development of the Master Plan (with some indications on capital and operating components) and an **action plan**, which details the implementation and allocation of resources for specific works.

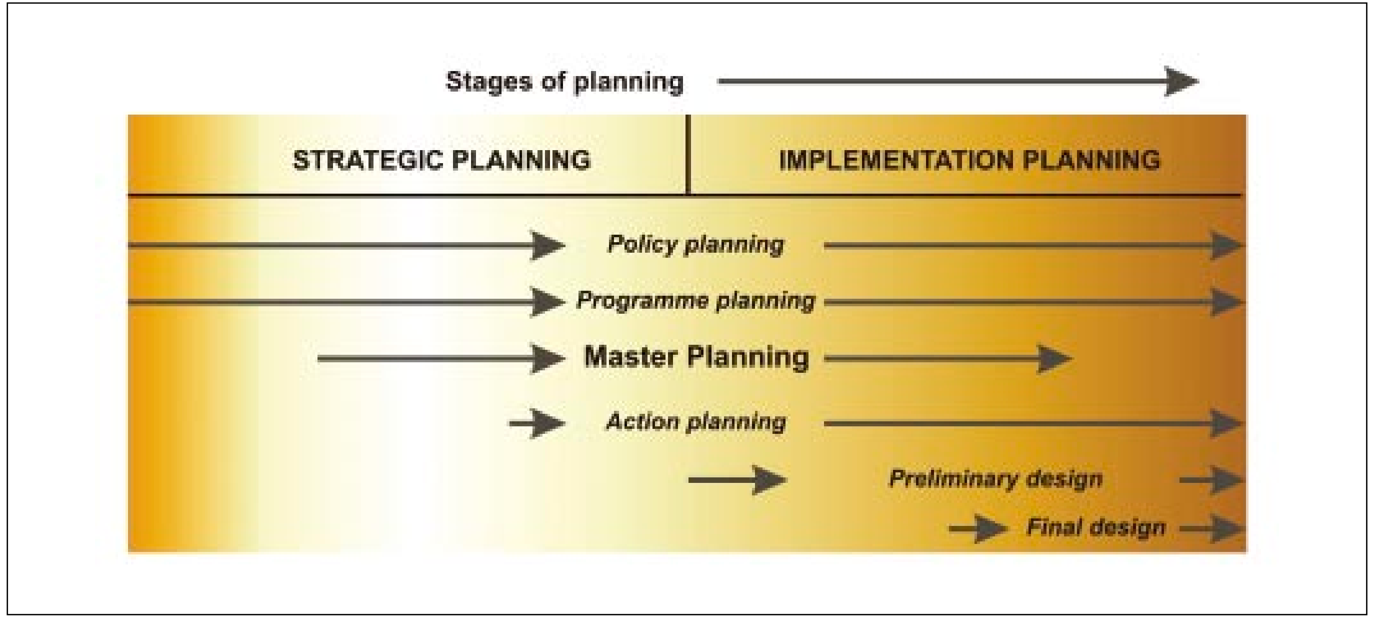
The appropriate spatial remit for an urban water system Master Plan is the **urban basin** (catchment area). The timescale of the Plan should be in the order of ten to twenty years. A mechanism for intermediate plan amendments can lend greater flexibility in response to shorter-term changes in the urban area or the water system. Planning is a cyclic process that follows a sequence of basic steps from analysis to synthesis and action. It is possible to identify a number of steps comprising Master Planning for an urban water system (Figure 5.2). These are indicative and outline a typical process that has to be adjusted according to specific situations.

Step 1 - Initiation

Planning process and goals will vary depending on who initiates and who has the overall responsibility for the process. The initiation of a planning process for urban water systems (or part of them) may be either "top-down" (e.g. from the government) or from the "grass roots" (e.g. following public demand). Factors that can trigger the initiation of the process include:

- pressing problems (e.g. a drought)
- contentious decisions, conflicts, pressure group initiatives
- broader/external initiatives promoting integrated management (i.e. international agreements, national development plans, river basin plans)
- regulatory requirements

Figure 5.1
Types of plan (Grigg, 1996)



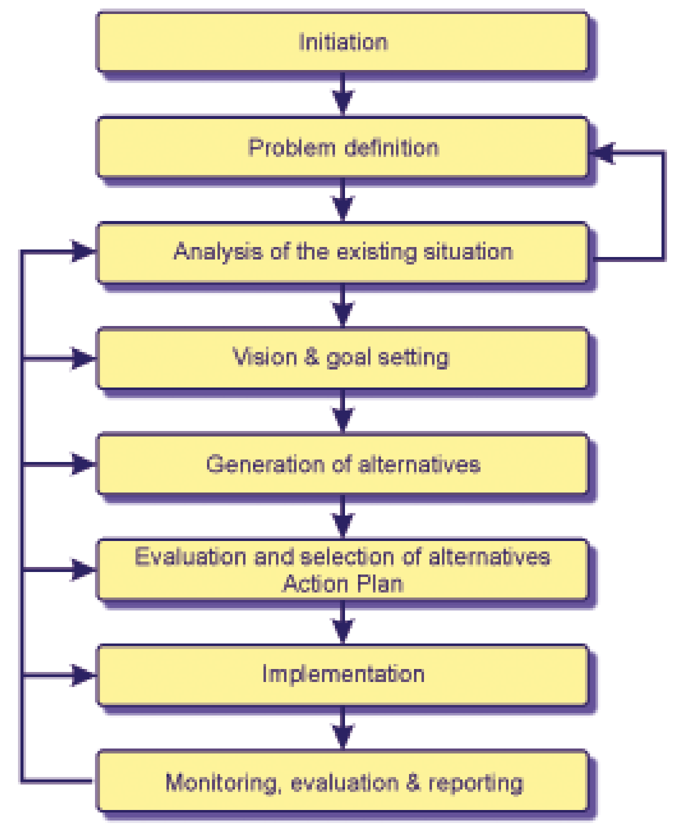


Figure 5.2
The stages of a Master Planning Process

Once a decision has been reached to begin an integrated planning process, a **proposal** should be written giving a breakdown of all the activities in the preparatory phase. The proposal could contain:

- the prerequisites for the integrated planning process (such as political will, scientifically-based knowledge, the existence of a national framework for integrated urban water system management, financial aid, etc.)
- the general goals (to be specified in detail during the subsequent phases)
- the geographic area under consideration, actors and institutions
- organisations expected to participate and the partnership scheme executing the process
- financial particulars
- a timeline for the plan with the division of tasks into sub-phases
- a work plan for the corresponding timetable

Due consideration of staff and resources is important at this stage. Staff training or the allocation of some tasks to external consultants may be necessary.

Step 2 - Problem definition
The first and most important element of this stage is the identification of **project needs** (supply, sanitation, protection). Other elements are:

- setting boundaries
- making assumptions about context
- identifying target groups
- selecting the initial approach that the analysis will take

An **open and participatory process** at this stage is essential, as varying perspectives on the nature of problems and the goals of the whole planning exercise may exist. The initial problem formulation is often restructured, modified and re-framed as information, and understanding increases. In complex cases, problem definition is a goal in itself. The planning process may serve as a coordinating platform for dialogue between conflicting interests, itself facilitating agreement on shared notion of problems faced.

Step 3 - Analysis of the existing situation
This step essentially involves a **reconnaissance survey** of basic characteristics in terms of the structure and dynamics of the natural and human elements of the urban water system. It deals with the critical processes and factors, their extent and spatial distribution. Tasks include:

- data collection and processing
- The appraisal of existing system characteristics and performance
- stakeholder analysis (the involvement of other agencies, organisations, etc.)
- the review and analysis of existing plans

There are various standard tools for the identification of issues at this stage including profiling, environmental assessment and SWOT (Strengths-Weaknesses-Opportunities-Threats) analysis.

A data inventory may have to be formulated by planning participants prior to the collection of data. Chapter 4 of the Volume II presents the main data necessary for urban water system planning and related data management and analysis techniques. The initial collection of data may lead to reformulations of some of the aspects of problem definition. By the same token, changes in problem definition may demand new data.

Step 4 - Vision and goal setting
Goals can be of three types:

- global (goals which are general and do not result from area-specific particularities)
- area-specific
- sectoral

Goals need to be as clear as possible to provide guidance and may be conflicting but not contradictory. For example, goals can be expressed in statements such as “to provide adequate and affordable water services”, “to secure safe drinking water quality”, “to minimise flood risks” or “to protect valuable species and coastal habitats”. They will provide the criteria for selection of alternative courses of action and may be further specified into a set of **objectives**. The objectives are operational statements of purpose (policy statements) and can be short or medium-term. Where possible, they should be expressed in a quantitative form. Objectives may range from the more general to the very specific, such as the achievement of exact standards (e.g. 100% population connection rates to supply and sewage networks, faecal coliforms less than 200 MPN/100 ml in shellfish harvesting areas throughout the year).

Visioning is a tool increasingly used in the goal-setting phase of planning processes (Walzer, 1996, Okubo, 1997, Kallis *et al*, 2004). It can also precede problem identification and data collection and be used as an opportunity to highlight problems and identify data demands. Working in groups, managers, or broader teams of stakeholders, and the public articulate and try to express their ideal vision for the future. Scenarios about the future can be used as platforms upon which to articulate ideas about desired and undesired futures. The goal of a visioning exercise is the agreement of participants in a common vision-statement (goal) and its specification into subsequent operational goals (or objectives). In Chapter 8 of the Volume II, the participatory method of multi-stakeholder **visioning workshops** is presented in more detail.

Step 5 - The generation of alternatives
Having defined goals, alternative courses of action should then be identified. This is the most creative planning stage. Alternatives might include:

- Technical solutions (e.g. a new waterworks, a dual pipe system)
- Non-technical solutions, such as:
- organisational arrangements (e.g. an urban basin committee, abstraction permits)
- management programmes (a demand management programme, an education and awareness programme)
- economic instruments (e.g. reform of tariffs, subsidies, taxes)

The identification of alternatives can constitute the second part of a visioning exercise/ workshop, where participants (decision-makers on their own or together with stakeholders and the public) are asked to identify and assess in more detail, plausible measures that need to be taken in order to realise their shared vision. Participants can also deliberate and suggest criteria and constraints for the evaluation.

Individual alternatives will need to be grouped into more integrated pacts of alternative **strategies**. One strategy, for example, may include a combination of dual piping and demand management measures, coupled with rebate schemes, price reform and an awareness campaign. Strategies should be internally coherent and not mere collections (“wish lists”) of separate measures.

Step 6 - The evaluation of alternatives, and selection and development of the action plan
Once developed, alternative strategies and measures have to be evaluated against the set of goals and objectives (criteria and constraints) developed in the planning process. Assessment might include cost-benefit analysis, environmental impact analysis, risk analysis, etc. Scientific tools may contribute to such assessments (simulation, optimisations). Ideally, several tools and sources of data should be used together in a multi-disciplinary fashion. **Multi-criteria** techniques in particular are suitable for comparing alternatives quantitatively and qualitatively with reference to a range of different criteria. These assessment techniques are presented in more detail in Chapter 4 of the Volume II.

Once alternatives have been compared and ranked with different evaluation techniques, selection must take place. The ultimate responsibility belongs to the agency, utility or partnership that has the responsibility of implementing the plan, and it will be a **political decision**. It is important, however, that there is prior **consultation** and participation (and ideally **“deliberation”**) with a

BOX 5.1
THE CONTENTS OF A TYPICAL COASTAL URBAN WATER SYSTEM MASTER PLAN

1. **Executive Summary**
- The institutional framework for the process
- Legal authority for planning
- Limits of jurisdiction
- Planning timescale
- Participants

2. **Need, Scope and Plan Objectives**
- Plan vision
- Strategy for planning
- Goals of planning process
- Specific objectives

3. **General Background**
- Location, physical features
- Demographics, social development
- Economic conditions, employment, industry, tourism, transport, public finance
- Land-use/land cover
- Historical supply and demand
- Water pollution control
- Flood control
- Navigation, fisheries, recreation, etc.
- Ecology and special protected areas
- Legislation
- Institutional framework

4. **Water Resource Assessment**
- Surface water quantity and quality
- Groundwater quantity and quality
- Estuary, coastal brackish and seawater resources
- Reservoirs (location, characteristics)
- Non-conventional resources (reused wastewater, desalination, rainwater harvesting)

5. **Related Resources Assessment**
- Geography
- Climate and meteorology
- Geology and hydrogelogy
- Soil characteristics
- Fisheries

6. **Development Needs**
- Social and economic scenarios
- Domestic and industrial water supply
- Navigation/ports
- Flood management
- Pollution control
- Fisheries
- Tourism, sport and recreation
- Environment and special protected areas
- Existing and planned development

7. **Water Demand Assessment**
- Drinking water
- Domestic use
- Waste disposal
- Recreation
- Aesthetic enjoyment
- Fish, wildlife and ecosystem maintenance
- Cooling water
- Industrial processing

8. **Statement of Conditions**
- Water delivery system description
- Wastewater infrastructure
- Other water infrastructure
- Rate structure
- Quantity issues
- Quality issues
- Anticipated infrastructure needs

9. **Description and pre-screening of alternatives to meet development needs**
- Water exploitation
- Storage
- Flood protection
- Sewage systems
- Protection of water resources
- Synthesis of technical, economical, environmental, and other characteristics of the proposed projects

10. **Potential Projects**
- Water studies
- Engineering, geology and cost estimation, coordination and functions of the urban basin plan
- Economic evaluation
- Environmental Impact Assessment
- Risk assessment

11. **Formulation of the water Master Plan**
- Establishing long term objectives and development targets (social and economic scenario, constraints, industrial growth, public health improvement, protection of the environment, employment, etc.)
- Criteria for plan formulation

12. **Evaluation of Alternatives**
- Analysis of alternatives
- Selection of alternatives for the plan
- Impact analysis of selected alternatives (environmental, economic, risk, social and cultural, regulatory)
- Organisation and management of urban water system
- Legislation and other administrative measures
- Water conservation programme
- Monitoring proposal
- Future study proposal
- Future projects proposal
- Coordination and consistency

13. **Implementation**
- Planned implementation
- Administration and funding
- Public participation
- Complementary programme and efforts

broader range of stakeholders and the public over the selection of measures (see Chapter 8 of the Volume II). Input from this process should then inform the final decision.

The final output of this stage is the selection of a **strategy**. This strategy will consist of several sub-measures, which, when combined, will facilitate the stated goals. The elaboration and specification of the implementation of the strategy and its measures leads on to the action programme of the Master Plan (**action plan**).

Step 7 - Implementation
This is the actual realisation of the strategy and the action plan. Two important issues pertain to this phase. The first concerns the proper **allocation** of financial and human resources to the tasks undertaken. The second concerns the **timescale** of the implementation. Most plans are long term and therefore subject to the vagaries of changing economic and political conditions. Plans that tend to generate their own resources and that do not rely on short term grants have the greatest chance of maintaining their viability over a long period. The long term character of plans should also be clearly communicated to the public and politicians, as disappointment may quickly follow on from a lack of immediate observable progress.

Step 8 - Monitoring, evaluation and reporting
After implementation, ongoing monitoring and evaluation is required to determine success in achieving the goals set out in the design phase. Planning is an **evolutionary and adaptive process**, where planners and communities reassess their initial values, goals or even problem perception in the light of evidence and knowledge gained during the initial design and implementation phase. The **rational** phase of planning is complemented by an **iterative** one of trial and error (Mouritz *et al*, 2003). Criteria and goals set may either be relaxed or tightened depending on the achievement of initial goals and costs.

Evaluation is not, as monitoring is, a continuous process. It is performed at selected time periods. *Interim (ongoing) evaluations* are carried out during the implementation phase and are designed to review progress and to anticipate likely effects. *Terminal evaluations* are carried out at the end of the implementation phase and they are programme and process-related. *Impact evaluations (ex-post)* are normally undertaken several years after the final disbursement by independent authorities and aim at measuring direct and indirect impacts. In all cases, evaluation needs to be characterised by its objectivity, credibility and representation (participation) ensuring that key local and national actors (or stakeholders) are involved in the monitoring and evaluation process.

Monitoring, data collection and analysis are essential to evaluation. Establishing operational monitoring systems for previously unrecorded parameters may entail high costs that need to be built into the planning process and the assessment of strategies. Decision-support systems and assessment techniques can be used in the evaluation phase to equal effect. **Indicators** and **benchmark assessment frameworks** are essential tools for monitoring progress and the achievement of predetermined goals.

Regular **reporting** is an important task and can also contribute to transparency, awareness and cultivate interest in the planning process. Different types of reports for different audiences may need to be devised. A report would typically include a review of measures undertaken, progress with respect to goals set (with the use of indicators and quantifiable information), and justifications for any deviations as well as costs and other financial details.

Box 5.1 presents the contents of a typical Master Plan for a coastal urban water system. The specificities of the plan may vary according to the case, the local context and the scope and goals of the planning exercise.

5.2 THE ORGANISATIONAL FRAMEWORK

An urban water system Master Plan may be undertaken:
- By an urban water utility (alone or with the help of a consultant), the plan serving rather as a technical document to help organise and better implement its internal activities and to plan for investments and funding. Such processes tend to be closed to external stakeholders and may not take into account all the dimensions of the coastal urban water system, but remain restricted to those of operational relevance to the utility.
- By an urban water utility under a regulatory demand with a responsibility to submit the plan to a higher governmental authority. In the case of privatised water utilities, the submission of the plan might be an instrument by which utilities and public authorities agree on investments, funding and prices or even a benchmark framework upon which the performance of private utilities is assessed by public authorities.
- By a governmental agency as guidance for the more obviously operational plans and decisions to be taken by the water utilities. In this case, the plan can be part of a broader river basin plan.

Planning might be undertaken on a **voluntary** basis, it can be demanded by **legislation** or it can

	Initiation	Analysis	Problem identification	Goals	Assessment/ Action Plan	Implementation	Monitoring & Evaluation	Chapter in Volume II
Information								
Data management	+	+				O	+	4
Database		+					+	"
Decision Support Systems		+	+	O	+		+	"
Simulations		+	O	O	+		+	"
Scenario Analysis		+	+	+				"
Forecasts		+		+	O			"
Assessment								
Environmental Impact Assessment					+	+	+	4
Strategic Environmental Assessment		+	+				+	"
Cost-Benefit Analysis		+	+		+		+	"
Scenario Analysis	+		+	+	O			"
Risk analysis	O	+			+		+	9
Conflict resolution	+		O	+	+	+	O	8
Life Cycle Assessment		+	O		+			"
Assessment and Reporting								
Sustainability Indicators	O		O				+	4
Benchmarking	O		O				+	4
Implementation								
Technologies (water demand)						+		5
Technologies (water cycle)						+		6
Standards					+	+	O	3
Zoning / Protected Areas					+	+	O	3
Economic Instruments					+	+	O	7
Awareness	O				+	+	O	8
Participation	O		+	+	+	+	O	8

Table 5.1
IUWSMCA tools

\+ most useful
O useful

be set as a **prerequisite for funding or permit** schemes. Political willingness and commitment by all interested parties and the dedicated support of the public authorities responsible is fundamental to the success and credibility of the venture.

The above plans, however, will have restricted scope and will tend to be focussed on the **limited domain** of the utility or agency that undertakes them. IWSMCA requires a **broader partnership and cooperation** between utilities and agencies involved in urban water management (water supply, wastewater and drainage), together with an extended range of stakeholders as well as agencies responsible for urban planning, river basin planning and coastal zone planning.

It is therefore recommended that the task of preparation, implementation and monitoring of an urban water system plan is not undertaken by a utility alone, but by a broader formal partnership (**task force, committee, forum**, or other; see section 4.2.2). The plan and the planning process will then play a **coordinative** role and act as a platform upon which the different actors will harmonise their management activities. The preparation of the plan will provide an opportunity for the different authorities and stakeholders to exchange ideas and information and agree on a common course of action.

5.3 PLANNING TOOLS

A variety of instruments and methods can be employed in the preparation, implementation and monitoring of the plan, depending on the local context and the scope and scale of integrated urban water system management. These are indicated in Table 5.1 and positioned with respect to phases of the planning process. The **participation** of stakeholders and the public should continue throughout the planning process. Public input is relevant to problem framing, vision-making and the identification and assessment of alternatives as well as to the actual implementation and the evaluation of results.

The Volume II of the Guidelines provides more information on each tool (see Table 5.1). Some basic information on planning support tools is also provided below.

Environmental Impact Assessment (EIA) is a method of identifying the impacts of human activities on natural environments, and options to reduce or mitigate negative impacts.

Box 5.2 presents the basic steps of an EIA. An EIA can be useful in comparing the environmental impacts of water management alternatives. Environmental assessment will be much more effective if it is implemented earlier in the decision-making process, however, when various alternatives are compared. **Strategic Environmental Assessment** (SEA) refers to just such an early environmental impact assessment at the policy or planning level. The basic steps of an SEA are similar to those of an EIA. The degree of data and detail in the assessment might be lower, since options and projects are less concretely specified at the planning level than at the project level of the EIA. An Urban Water System Plan

BOX 5.2
THE PHASES OF AN ENVIRONMENTAL IMPACT ASSESSMENT

- Description of the proposed project and the existing environment
- Assessment of the impacts of the proposed project on the environment (with special reference to regulated environmental standards)
- Design of mitigation measures and future management
- Draft impact statement designed for public consultation/dissemination
- Finalisation of the impact assessment and judgement of its development application
- The monitoring of actual impacts

BOX 5.3
THE PHASES OF A COST-BENEFIT ANALYSIS

- Statement of the objective
- Estimate of the duration of the project
- Identification of costs and benefits
- Quantification of costs and benefits in monetary terms for each year of the project
- Choice of an appropriate rate to discount future costs and benefits in order to obtain an aggregate present value of the project and then sum them up
- Evaluation of options on the basis of the results

CRITERIA	UNITS	ALTERNATIVES			
		α_1	α_2	α_3	α_4
K_1		$K_1(\alpha_1)$	$K_1(\alpha_2)$	$K_1(\alpha_3)$	$K_1(\alpha_4)$
K_2		.	.	.	.
K_3		.	.	.	.
K_4		.	.	.	.
K_5		.	.	.	.
K_6		$K_6(\alpha_1)$	$K_6(\alpha_2)$	$K_6(\alpha_3)$	$K_6(\alpha_4)$

Table 5.2
An example of a MCDA matrix

BOX 5.4
THE PHASES OF A SCENARIO ANALYSIS

- The identification of critical factors influencing development opportunities
- The setting up of hypotheses about changes in critical factors
- The development of coherent sets of hypotheses on the evolution of changes as alternative pathways
- Analysis of impacts and cross impacts on environmental factors and conditions, with consideration for feedback effects on development opportunities.

BOX 5.5
THE PHASES OF A LIFE CYCLE ASSESSMENT

- Definition of system boundaries, both temporal and spatial (e.g. for urban water systems these start from the withdrawal of raw water to the discharge of the treated effluents and sludge).
- Compilation of an inventory of material and energy streams crossing the system's boundaries, either as inputs or outputs, and linking it with processes.
- Impact assessment of the mass and energy streams of the previous phase, including:
- classification of impacts. Impact categories include: resource depletion, green house effect (direct and indirect), ozone layer depletion, acidification, eutrophication, photochemical oxidant, formation, human toxicity, aquatic toxicity and landfill volume. Impacts can be classified on the basis of the geographical scale of their contribution, from global (climate change) to local (noise, occupational health).
- specification and quantification of impacts, where possible.
- equivalency of the different impacts (using established normalisation factors, such as those available from SETAC). The results can also be normalised and expressed as fractions of the total anthropogenic contribution to the various impact categories in a given year in a particular area.

could be accompanied by a SEA, identifying and analysing its main environmental impacts and proposing mitigation measures or management alternatives that would lessen impacts.

Social Impact Assessment (SIA) is an extended form of impact assessment (Becker and Vnclay, 2003). EIA can be thought of as a subset of SIA. The term "social" emphasises that the focus is not merely on environmental impacts but rather on broader impacts on the community affected by the development project. The assessment process and procedure is similar to that of EIA, but with a broader consideration of impacts and mitigation measures. A SIA may need to complement an EIA in cases where an urban water project or plan has important social effects that need to be taken into account (e.g. a dam that displaces people or a programme significantly increasing water prices).

Cost-benefit analysis (CBA) compares all costs and benefits resulting from a project or public policy in monetary terms. Box 5.3 shows the basic stages of a CBA. CBA can be used to compare the economic merit of various urban water management alternatives. **Ecosystem valuation** and the incorporation of ecosystem-related costs and benefits into CBA is a very important task. Many proxy techniques exist which can assign monetary values to ecosystem services. However, strong criticism has been levelled against the methodological foundations and the practice of these techniques. In some cases, socially unacceptable environmental impacts may be justified according to economic reasoning. The monetary valuation of ecosystems, therefore, should be complemented by other environmental appraisal techniques (EIA, multi-criteria, conflict resolution, participatory approaches, etc.).

BOX 5.6
URBAN WATER SYSTEM SUSTAINABILITY INDICATORS (Water U.K., 1999)

Categories	Indicators
Water services	
Water demand and availability	Population with sufficient water (%) Population growth possible with current resources (%)
Household water demand	Per capita water consumption (Lt/capita/day)
Non-household water use	Water efficiency (Lt/$ GDP)
Leakage	Total leakage from the network (Ml/day)
Drinking water quality	Tests complying with standards (%)
Foul flooding	Properties flooded (%)
Combined sewer overflows	Overflows in satisfactory condition (%)
Wastewater treatment works	Population served by works meeting numerical standards (%)
Good environmental management	
Environmental engagement	Sectoral ranking in a Business in the Environment or other similar national survey (%)
Convictions for public health and environmental offences	Number of legal convictions
Biodiversity and the environment	
Species	Priority species with action plans in service area (%)
Habitats	Priority habitats with action plans in service area (%)
River water quality	Quality of rivers in service area
Bathing water quality	Designated waters achieving mandatory standards (%) and guideline value (%) as advocated in the EC Bathing Water Directive
Energy and materials	
Energy used at fixed sites	Energy used per Ml water supplied (kWh) Energy used per Ml wastewater treated (kWh)
Renewable energy at fixed sites	Renewable energy as a percentage of total energy used
CO_2 emissions at fixed sites	Emissions per head population (tonnes/year)
CO_2 emissions from road transport	Emissions per head population (tonnes/year)
Sludge management	Sludge recycled/reused (%)

Cost-effectiveness analysis (CEA) can take into account overriding social or environmental goals which cannot be reduced to their monetary value alone. Instead of comparing gross costs and benefits, CEA aims to find the least cost alternative of achieving specified objectives (environmental, social or other). Cost-effectiveness analysis may be preferable to CBA in urban water decisions where critical resources or services are at stake.

Multi-Criteria Decision Aid (MCDA) can compare urban water management alternatives according to a number of criteria (economic, social and environmental), taking into account the multiple stakeholders involved (Table 5.2). In comparison to CBA, an MCDA can compare alternatives evaluated in different "metrics" (i.e. not just monetary values). The output of a MCDA can be the ranking of alternatives; there are several different aggregation techniques and several MCDA software types on the market that render them operative. Note that for the aggregation and formal ranking of alternatives, there must be a convention for the assignment of weights to different criteria (and the importance of each criterion to the various stakeholders) and for harmonising scores expressed in different metrics. Alternatively, an MCDA can be used as a platform upon which stakeholders deliberate, frame the decision issue and seek compromise alternatives (Munda, 1995).

A **scenario** is a long term description of the future (time limit up to 30 years). Box 5.4 presents the basic steps of a **scenario analysis** exercise. A scenario analysis is very useful in planning as it facilitates deliberations about the future and the definition of planning goals as well as assessing alternative courses of action with a long term perspective. For example, three alternative scenarios (possible, feasible and/or desirable) can be prepared for the state of a coastal urban water system after 20 years. In a meeting or workshop, stakeholders can then discuss in a meeting or a workshop which scenario (or which mix of elements from different scenarios) they would like

BOX 5.7
BENCHMARKING INDICATORS IN THE DUTCH DRINKING WATER INDUSTRY (VEWIN, 2000)

Water quality
The quality of drinking water is expressed in an index derived by taking the base of 100 points for perfect quality and deducting points for the various parameters that fall short of the given standard required by national legislation. The closer the average measured value lies to the standard, or even falls short of the standard, the larger the deduction. Incidental under-achieving values also lead to deductions, by which the average duration, impact and average surplus value are decisive.

Service
The quality of service is defined as the level by which the expectations of the customer have been satisfied expressed as a reported figure that indicates the level of service. For this, the interests of the customer on the various dimensions of service together with performance as experienced by the customer are studied. The quality of service is determined using a telephone inquiry session engaging almost 6,000 small users who have had recent contact with their water company. In addition to the question of a figure for a total level of service, a number of detailed questions are asked concerning various aspects of service.

Environment
The environmental impact caused by water companies during the production and distribution of drinking water is studied using environmentally oriented life-cycle analysis (m-LCA) according to the Eco-indicator method as specified for the water industry. Factors taken into account in compiling the final index include energy use, dehydrated natural area with the area of influence of an extraction site, consumption and use of auxiliary substances, chemicals and filter materials, production of useful waste materials, residues and emissions, impacts due to central softening and contribution to global environmental effects (greenhouse effect and acidification).

Finance and Efficiency
Total cost per connection is the main indicator. For cost comparisons, a division is made into four cost categories: taxes, costs of capital, depreciation and operational costs. Tariffs are also compared in five standard user situations.

to see realised, and identify actions they need to take in order to achieve this.

Life Cycle Assessment (LCA) is a tool that evaluates the impacts of the production, use and disposal of a product, process or activity. It is a 'cradle to grave' approach that provides an overall view of the complex interactions between different phases in the life of a product. LCA can be extended from the assessment of "products" to the assessment of whole systems, such as the coastal urban water system. The basic steps of an LCA are shown in Box 5.5. LCA can be used to compare the overall environmental performance of alternative management interventions or to assess the environmental performance of a coastal urban water system (and compare it with other systems, or assess its change over time).

Conflict resolution techniques will be useful where there are pronounced differences of opinion between agencies, stakeholders, etc., on the merits and evaluations of different alternatives, inhibiting agreement on a common Action Plan. Conflict resolution processes usually include a group of representatives of the conflicting interests (in the form of a group, forum, panel, etc.) coordinated by an experienced **facilitator**. The process follows a sequence of identifying the problem and relevant data, identifying alternative, innovative solutions that reduce conflict and then planning for implementation. Group facilitation techniques are crucial to revealing the deeper causes of conflicts and to searching for common ground to overcome them.

Risk analysis is a process of identifying and understanding the relevant components of a risk (hazards, impacts and vulnerable/affected systems) in order to evaluate alternative strategies to manage that risk. Risk analysis is based on **risk assessment,** a process where the probability or frequency of harm for a given inherent hazard (an event or agent that has the potential to cause harm, e.g. a pollution accident or a drought) is estimated either quantitatively or qualitatively. The assessment and determination of a risk proceeds through the following stages (Harrop & Nixon, 1999, WDCC, 1998):

- the identification of sources and components of a hazard

- a frequency and probability analysis of the hazard occurring
- the identification, assessment and ranking (prioritisation) of impacts from the hazard
- a vulnerability assessment of the exposed areas, groups of people or ecosystems

Risk analysis rests on the definition of an **acceptable** (or **tolerable**) **level of risk**, i.e. a level of vulnerability that is considered to be "acceptable", balancing factors such as probability of hazard and intensity of impact, cost, equity, etc. Public input is essential as perceptions of risk differ and change over time, and experts alone cannot decide on behalf of the people on the acceptable levels of risk.

An **indicator** aims to provide a clue to a matter of larger significance or to make perceptible a trend or phenomenon that is not immediately detectable (WRI, 1997). Indicators imply a metric against which goals can be assessed. **Sustainability Indicators** are generally expected to link different aspects of public goals (environmental, economic, social, and cultural) or relate to a "sustainability policy" target (Lundin, 1999). Box 5.6 provides an indicative list of sustainability indicators for urban water systems developed in the U.K. Similar lists of indicators tailored to the local context could be devised in Mediterranean countries and used to assess progress towards the sustainability of coastal urban water systems or to compare the water-sustainability performance of different cities. Sustainability indicators can provide the basis for a regular (annual) sustainability report, where the basic trends in terms of water sustainability performance can be documented and explained.

Benchmarking refers to the comparative assessment of several cities-systems upon a shared set of indicators or upon predefined target values for each indicator (**yardstick** comparison). Benchmarking can be used by national authorities as an incentive to urban water utilities to improve their performance. For example, utilities may be asked to report each year upon a predefined set of data and indicators (see Box 5.6 or a Box 5.7, an example of a more detailed process) and then the national authority can compile a report in which it compares their relative performance and ranks them. Comprehensive benchmark service assessment frameworks are provided by the Dutch Association of drinking water companies (www.vewin.nl), the Office for Water Services (OFWAT) in England and Wales (www.ofwat.gov.uk) and the International Water Association (IWA, 1999). Elements from these frameworks should be adapted where relevant to the Mediterranean context and implemented.

5.4 OTHER PLANS

5.4.1 Types of plan

A Master Plan should be large in scale and cover the **entire urban water system (basin)**.

The Master Plan is positioned in the middle of an administrative/organisational **hierarchy** of plans (Figure 5.3). The Master Plan should incorporate the principles of **national**, **regional** or other authoritative **strategic** water management, urban, coastal or other plans. A Master Plan for the coastal urban water system may be subdivided into water management plans for smaller spatial units, such as municipalities, heavily urbanized/industrial pressure zones, sub-drainage basins, etc.

In certain cases, it might be necessary that the overall urban water system plan be broken down into (or conversely, composed of) separate, more specific plans, for each of the basic services: water resources and supply; wastewater management and stormwater/drainage (Figure 5.4). Integration with the Master Plan can be two-way. Either the Master Plan provides a more strategic document providing guidance for the preparation of the subsequent plans, or the sectoral plans are amalgamated into a broader Master Plan. This integration is particularly important where service responsibilities in the urban area are shared between more than one utility or public agencies.

Additionally, in certain cases, the need may exist for specific thematic plans addressing specific management tasks (e.g. risk management, demand management, quality control, etc.).

Figure 5.3
A hierarchy of plans

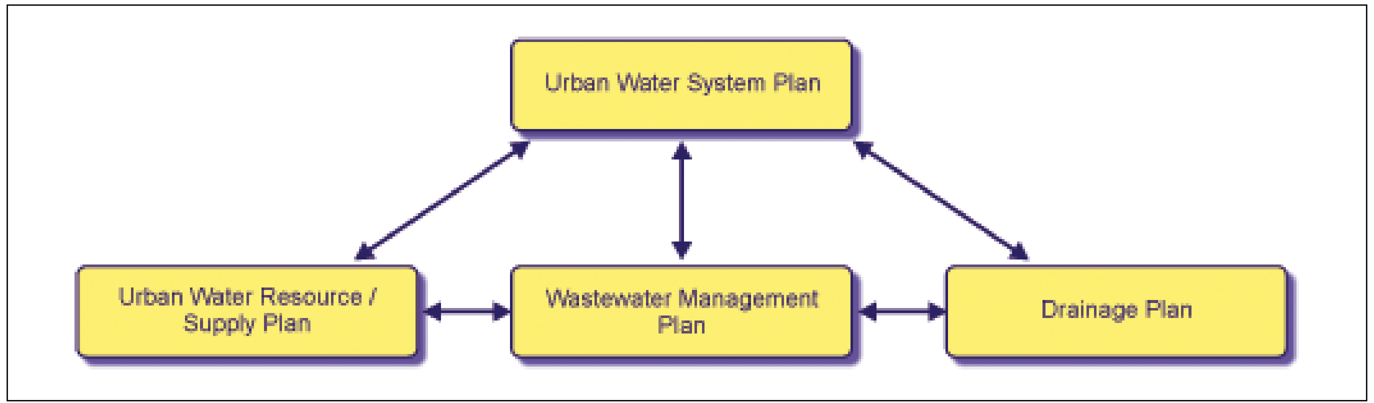


Figure 5.4
Sectoral urban water plans

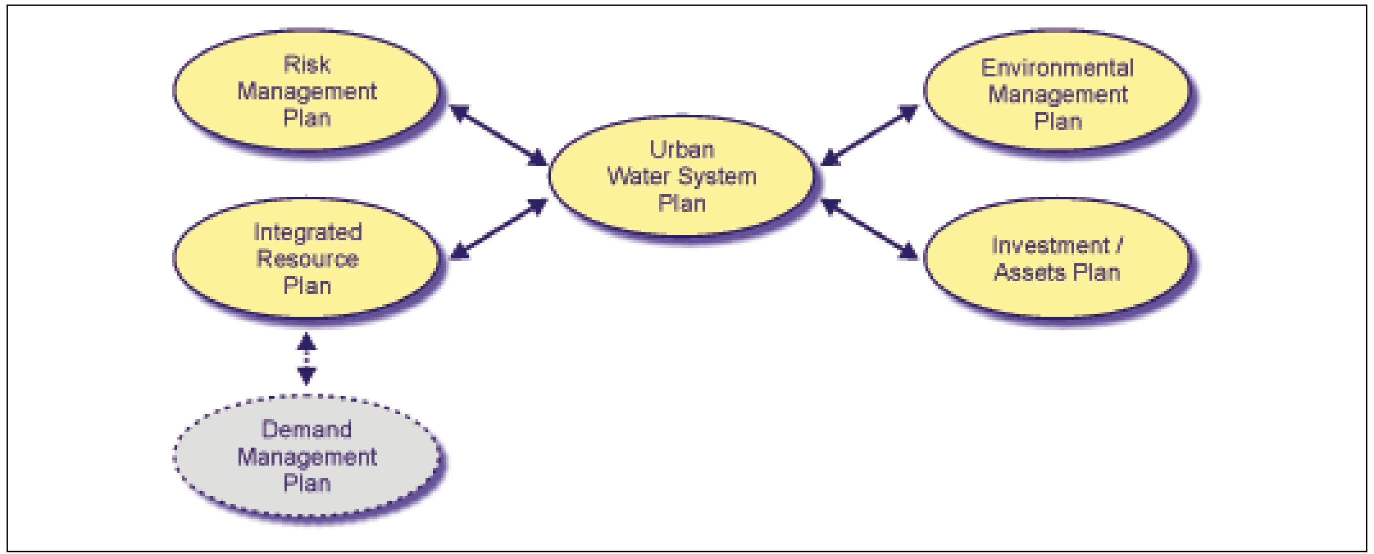


Figure 5.5
Thematic urban water plans

Figure 5.5 illustrates a non-exhaustive list of possible thematic plans. The relationship between the master and the thematic plans should be reciprocal (i.e. the Master Plan based on input from thematic plans or conversely, the Master Plan providing strategic guidance for the formulation of the thematic plans). A brief outline of the main features of each of these plans follows below.

5.4.2 The Integrated Resource Plan (IRP) and the Demand Management Plan

The IRP concept and process was developed by energy utilities in the U.S. in the 1970s as a response to the energy crisis and the quest for energy conservation. IRP is a process that comprises of a least-cost analysis of different **water supply and demand options**, open and **participatory decision-making**, the explicit consideration of **risks** and **uncertainty**, and recognition of the **multiple institutions** concerned with water resources and the competing goals among them (Beecher, 1998).

Figure 5.6 presents the principal steps of an IRP process. These follow the basic logic of a planning process, as described above. Demand management options include those presented in Table 4.5. Conventional supply options might include new water supply works, an increase of abstraction from existing works and new technologies such as desalination. Reclaimed water from wastewater or stormwater collection and treatment is another supply option, thus linking IRP with wastewater/stormwater management and planning. Links can also be made to water quality management by considering the protection and improvement of water quality as a potential resource option.

Data requirements are similar to those of the general Master Planning Process. The assessment of supply and demand requires hydrological and socio-economic/demographic data. The evaluation of costs and benefits requires financial and environmental data. A central task of IRP is the comparison of the economic costs of the various measures or combinations of options, and the identification and quantification of external costs and benefits (including environmental ones). Since the monetary values of environmental benefits or costs may be difficult to quantify, environmental impacts can also be assessed in more qualitative terms and evaluated according to alternative evaluation criteria in screening and ranking options. IRP should also address risks and uncertainties associated with each of the options. Public participation and scrutiny is essential.

IRP considers supply and demand options on an equal footing. Alternatively, a utility might decide to commit to the development of a **water demand management strategy and plan**. Box 5.8 shows the potential components of such a comprehensive water demand management plan.

5.4.3 The Environmental Management Plan

An **Environmental Management Plan (EMP)** defines the goals and measures that should be implemented for the improvement of the environmental performance of the urban water system. Box 5.9 presents the basic stages of an environmental planning process. Alternatively, one of the standard environmental appraisal and reporting schemes, such as ISO, EMAS (see section 4.3.7) or Life Cycle Assessment may be used as the platform for environmental planning and management. An EMP should be integrated with the overall urban water system Master Plan. Environmental measures could form part of the overall Master Plan. Environmental constraints or goals from the EMP could also be used to evaluate the alternative water management measures in the Master Plan.

Environmental management options include:
- measures to reduce water abstractions and improve water efficiency (see also water demand management)
- measures to reduce impact from abstraction on water source aquatic ecosystems (e.g. release flows from dam, recharge of aquifers, restoration of the damaged ecosystems of waterworks etc.)
- measures to preserve the ecological quality of water sources and surrounding terrestrial areas
- measures to reduce energy use (in processes, facilities, etc.) or to produce/recover energy from operations
- measures to improve the disposal of solid waste (sludge) from drinking water and wastewater treatment plants
- measures to improve the treatment and disposal of liquid wastewater and for the restoration of damaged recipient ecosystems (terrestrial and aquatic)

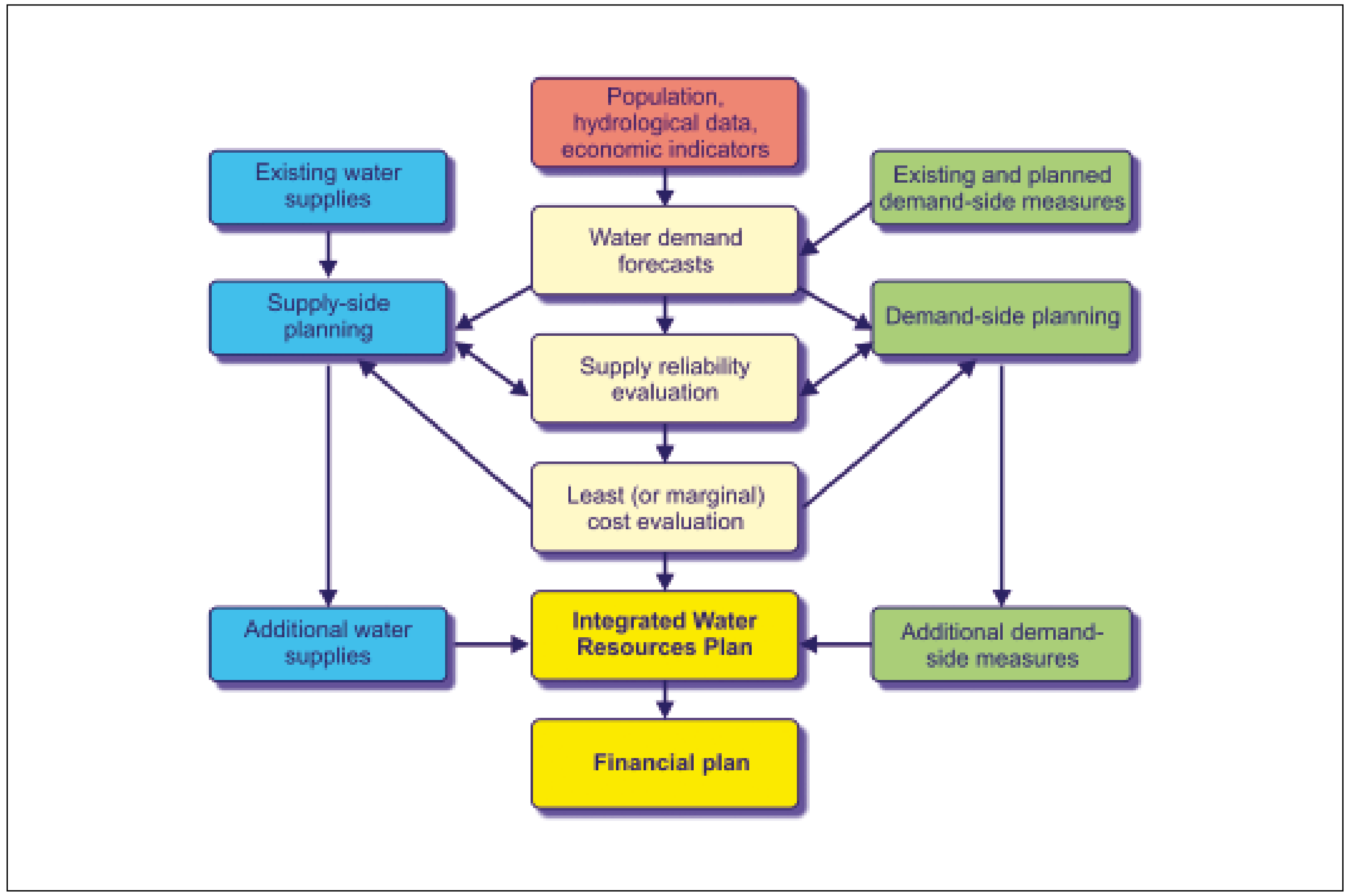


Figure 5.6
The Integrated Resource Planning Process (after Beecher, 1998)

BOX 5.8
THE COMPONENTS OF A COMPREHENSIVE WATER DEMAND MANAGEMENT PLAN
(after EPA, 1998)

1. **Specify water-saving planning goals**
- List of water saving planning goals and their relationship to supply-side planning
- Description of community involvement in the goals-development process

2. **Develop a water system profile**
- Inventory of existing facilities, production characteristics and water use
- Overview of conditions that might affect the water system and demand management planning

3. **Prepare a demand forecast**
- Forecast of anticipated water demand for future time periods
- Adjustments to demand based on known and measurable factors
- Discussion of uncertainties and "what if" (sensitivity) analysis

4. **Identify water demand management measures**
- Review of water demand management measures that have been implemented or that are planned for implementation
- Discussion of legal or other barriers to implementing recommended measures
- Identification of measures for further analysis

5. **Analyse benefits and costs**
- Estimate of total implementation costs and anticipated water savings
- Cost effectiveness assessment for recommended water demand management measures
- Comparison of implementation costs to avoided supply-side costs

6. **Select measures**
- Selection criteria for choosing water demand management measures
- Identification of selected measures
- Explanation as to why recommended measures will not be implemented
- Strategy and timetable for implementing water demand management measures

7. **Integrate resources and modify forecasts**
- Modification of water demand and supply capacity forecasts to reflect anticipated effects of water saving
- Discussion of the effects of saving on planned water purchases, improvement and additions
- Discussion of the effects of planned water demand management measures on water utility revenues

8. **Present implementation and evaluation strategy**
- Approaches for implementing and evaluating the water demand management plan
- Certification of the water demand management plan by the system's governing body

5.4.4 The Risk Management Plan

A risk management plan identifies the main risk factors and develops a plan of measures to reduce risks and to respond to contingencies if they occur. Box 5.10 presents the basic stages of a risk planning process. The identification of potential risks can feed directly into the urban water system Master Planning Process and influence the establishment of goals and the comparative evaluation of alternative measures (in terms of their comparative risks). Risk reduction and mitigation measures could also be considered as part of the overall Master Plan.

5.4.5 The Investment (Assets) Plan

The basic features of financial planning and management were described in section 4.2.4. An **Assets Plan** is a variant of a financial plan. It is "*an objective, auditable, defensible assessment of the expenditure likely to be required to achieve future asset performance defined by the policies, objectives, and obligations of a water utility*" (WS Atkins). The main assets of a water utility consist of the network infrastructure (pipes, pumps, reservoirs) and the production units (reservoirs, treatment plants). An Assets Plan assesses the long term needs for such assets in relation to service standards. It also estimates the costs and drafts a plan for the renewal, extension and funding of these works. Sound financial management would establish whether adequate internal financial resources are available to implement the plan and would make suitable arrangements for raising supplementary external finance from other sources if these resources are insufficient.

BOX 5.9
THE STAGES OF AN ENVIRONMENTAL MANAGEMENT PLAN

1. **Develop an environmental audit**
- Inventory of existing facilities and production processes and their direct environmental impacts
- Future projects and programmes and their potential environmental impacts
- Documentation of the consumption of energy and materials and production of liquid and solid waste; sources used and disposal practices

2. **Specify environmental goals**
- List of environmental goals
- Development of a list of data/indicators to assess progress in the achievement of goals
- Description of community involvement in the goals-development process

3. **Identify environmental management measures**
- Review of environmental management measures that have been implemented or that are planned for implementation
- Discussion of legal or other barriers to implementing recommended measures
- Identification of measures for further analysis

4. **Evaluate measures**
- Estimate total implementation costs and anticipated environmental benefits, in monetary and non-monetary terms
- Cost effectiveness assessment for recommended environmental measures
- Comparison of implementation costs with savings made by avoiding damage control costs

5. **Select measures**
- Selection criteria for choosing environmental management measures
- The identification of selected measures
- Explanation of why recommended measures will not be implemented
- Strategy and timetable for implementing environmental management measures

6. **Present implementation and evaluation strategy**
- Approaches for implementing and evaluating the environmental management plan; definition of evaluation criteria, indicators and goals
- Certification of the environmental management plan by the system's governing body

BOX 5.10
THE STAGES OF A RISK MANAGEMENT PLAN

1. **Analysis**
- Inventory of existing facilities, production processes and their "weak points"
- Identification of potential hazards, impacts and their probability
- Analysis of vulnerability and underlying causes
- Prioritisation of risks
- Identification of stakeholders involved in risks
- Description of community involvement in the risk identification and prioritisation process

2. **Identify mitigation and preparation measures**
- Review of risk management measures that have been implemented or that are planned for implementation
- Discussion of legal or other barriers to implementing recommended measures
- Identification of measures for further analysis:
- Mitigation (technical and non-technical)
- Preparatory (monitoring, early warning, access routes, etc.)

3. **Evaluate measures**
- Estimate total implementation costs and potential benefits (deferred damages, etc.)
- Evaluate which actions are deemed feasible and appropriate by the general public

4. **Select measures**
- Selection criteria for choosing measures
- Identification of selected measures
- Explanation of why certain recommended measures will not be implemented
- Strategy and timetable for implementing preparatory and mitigation measures

5. **Set up a contingency response system**
- Define risk parameters to be monitored
- Based on parameter values, define increasing levels of "alert"
- Define contingency responses for each level ("emergency" measures for higher alert levels)
- Define arrangements between different agencies and stakeholders for each level

6. **Evaluate and revise plan**
- Run hypothetical risk and emergency scenarios and test applicability of plan and responses;
- Review process after hazardous events

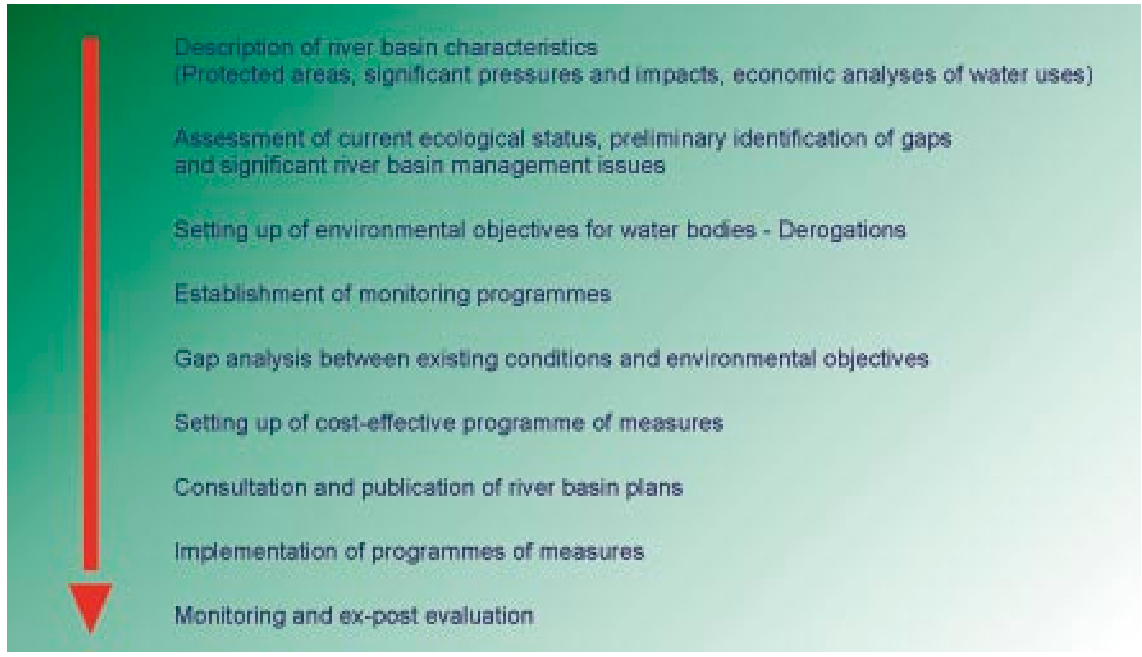


Figure 5.7
River basin planning for the EU Water Framework Directive

5.5 INTEGRATION WITH OTHER PLANNING PROCESSES

Urban water system planning has many inter-dependencies and complementarities with other planning processes, and most importantly with river basin, urban land-use and coastal zone planning. The goals of the urban water system Master Plan should be coordinated with those of the other planning processes and opportunities for joint/complementary measures and shared planning tasks should be fully exploited.

5.5.1 Types of plan

River basin planning is concerned with the allocation of water (and related works) to the different users of the basin and with the design, implementation and allocation of measures to control pollution within acceptable qualitative standards (for human and ecological purposes).

The EU Water Framework Directive makes a structured process of river basin planning process mandatory in all EU Mediterranean Member States. Proposals for "exporting" the model to other countries exist through the EU Water initiative. Figure 5.7 shows the basic steps of river basin planning as defined in the Directive. Note that the WFD primarily accounts for the accomplishment of quality and ecosystem goals and does not explicitly address quantitative (resource or flood) issues (e.g. the allocation of water resources or the planning of waterworks). Member States, however, are expected in practice to combine quantitative with qualitative water planning into one administrative structure and planning process.

The urban water system is one of several users in the basin and one of several sources of pollution. The urban basin is a sub-component of the whole river basin.

Figure 5.8 graphically depicts the relationship between river basin and urban water system plans. River basin planning through the WFD for example, will set out quality standards and programmes of measures to protect the quality of drinking water sources of the urban area. On the other hand it will establish constraints for urban areas in terms of standards for effluent discharges (with respect to environmental objectives of recipient freshwater or coastal waters). New urban waterworks or water abstractions will also require approval by the river basin authority on condition that they do not impact negatively on the ecological status of source waters.

Pathways to better integration between the two planning processes depend on the specific configuration of the river basin authority and the urban water utility in any given case. Typically, a river basin authority will be responsible for a river basin consisting of several smaller sub-basins, one of which will be the basin of the urban area

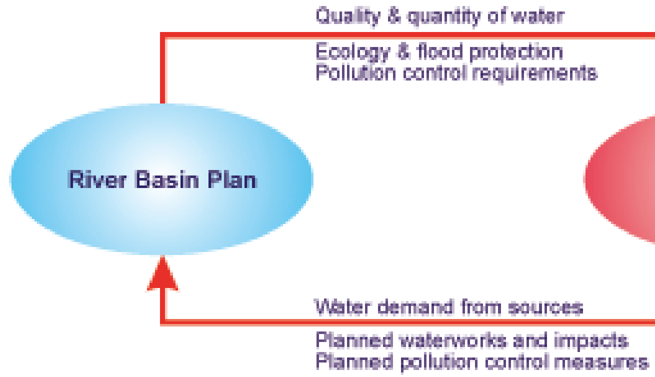


Figure 5.8
The relationships between river basin and urban water system planning

(urban basin). The urban water utility will have responsibility for certain services, but not for the whole water system in the urban basin. In such cases, there are different options for integrating the two planning processes:

1. The river basin authority can prepare **sub-basin plans**, operationalising the basic strategies defined in the river basin plan. One such plan can be for the urban basin, providing the overall conditions and constraints for the development of the Master Plan of the water utility (allocated water quantity, pollution standards for freshwater and coastal waters, flood control requirements, etc.). The urban basin plan might define specific obligations for the urban water utility that will have to be incorporated as service objectives/standards in its Master Plan.
2. A less "top-down" approach may be appropriate if there is a higher degree of cooperation between river basin agencies and urban water utilities or if the urban area is a very significant user of water in the basin (e.g. a metropolitan area). The latter can participate directly in the creation of the river basin plan and serve to harmonise goals at the basin level with goals for urban water infrastructure and services.

In certain cases, the urban water utility may transfer water sources from more than one river basin (possibly from those beyond the location of the urban basin). River basin plans can provide overall conditions and constraints but there is a need for more careful arrangements for cooperation to avoid the greater potential for inter-regional antagonisms.

Well-defined **representation** of the urban water utility on river basin boards, councils or other decision-making bodies is important.

5.5.2 Integration with urban land-use planning

Land-use plans determine the scale and forms of development. A **site analysis** (identification of the natural features of the area that need to be taken into account) and a **land capability assessment** are necessary inputs to the preparation of a land-use plan. Land-use physical planning decisions relevant to water system management include (Kallis and Coccossis, 1999):

- the allocation of new housing (whether approved or not, and location plans with respect to the availability of water and impact on run-off and pollution patterns)
- codes for new buildings and domestic appliances
- urban landscape and irrigation codes
- assignment of protected lands
- incentives/disincentives for the location of particular types of commercial enterprise and industries

Figure 5.9 shows the relationship between the two planning processes.

Water-sensitive land-use planning should determine where development can occur within the site, in order to incur the least impact on the ecosystem. Multiple use measures that combine the retention of stormwater and/or wastewater treatment with public amenity and aesthetic (landscaping) features (see section 4.4.3) should be part of a water-sensitive land-use plan.

Land-use planning can also play an important role in controlling the level of water consumption. Per capita water consumption in low-occupancy and in suburban households is much higher than in higher occupancy and central district houses, especially in areas with considerable outdoor

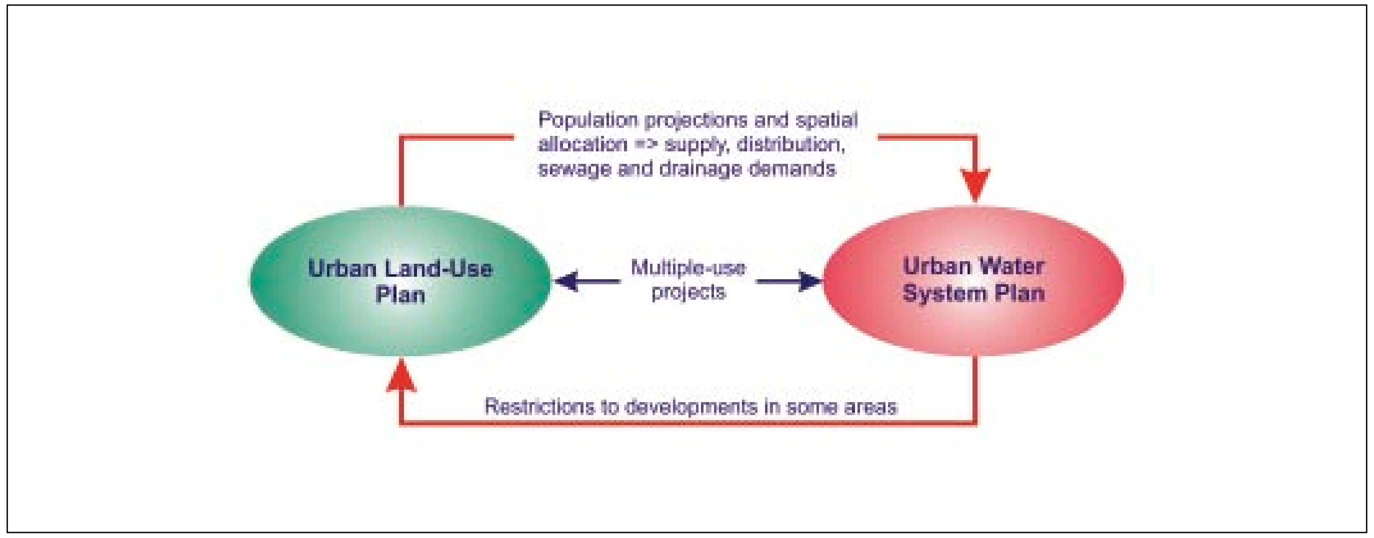


Figure 5.9
The relationships between urban land-use and water system planning

water use (Spiller, 1993, Sakrison, 1997). Land-use policies, which promote more **resourceful types of urban form**, can be important tools for water demand management. Several options for the use of water conservation measures (e.g. the use of secondary sources; landscaping that demands less water) can be identified at the design level for road layout, housing layout and streetscape (including regulated self supply options).

Practical measures that use physical planning instruments for water management include for example:

- regulations that require provision of adequate water and sewage systems before development can occur
- the curtailment of new urban developments in areas of severe overexploitation unless a long term assured water supply can be demonstrated
- standards for efficient water appliances in new buildings
- the exclusion of areas around drinking water resources from the urban plan
- restrictions to building in flood prone areas or in natural drainage channels
- water-sensitive urban landscaping

New urban developments and urban public space **landscaping** provide several opportunities to improve the management of water.

The **goals and objectives** of the water Master Plan should be incorporated into the urban land-use plan of its equivalent level (policy, strategic, operational). An urban land-use plan will follow along the lines of the basic Master Planning Process described above. Goals and objectives relating to the water system and its management may provide performance targets or assessment criteria for the allocation of land-uses. For example, the protection of groundwater aquifers (a goal) or the limitation of aquifer pollution from heavy metals below drinking water standards (an objective/performance standard) can be introduced as elements of an urban plan and in turn be taken into account when judging new developments (e.g. on street and streetscape planning or the licensing of cesspits). Box 5.11 shows some goals and objectives of sensitive urban design that can be part of an urban land-use plan. These can be quantified into standards.

A clear presentation of the Urban Water System Plans, ideally in short and concise forms (**"model plans"**) can facilitate their incorporation into other plans. Enlisting Best Planning or Management Practices is another way of fostering easy integration with land-use plans. Specific practices relating to Water Sensitive Urban Design TU SAM NEŠTO OBRISAO can then be taken into account when devising the strategies and measures of the urban land-use plan. Box 5.12 gives a (non-Mediterranean) example of how water system objectives can be incorporated into land-use planning in practice.

The overall lesson from this example is that an active stance is required on the part of water utilities or agencies to see their management goals incorporated into urban land-use plans. In comparison to countries like England, however, urban growth processes in a number of Mediterranean countries are less controllable and planning processes much less explicit. Water utilities themselves may also not be aware of the importance of engaging with colleagues in urban planning. **Information and mutual awareness by water and urban professionals** on the need for cooperation is an important first task.

BOX 5.11
WATER SENSITIVE URBAN DESIGN GOALS AND OBJECTIVES (after Mouritz et al, 2003)

To manage water regimes:

- maintain appropriate aquifer levels, recharge and streamflow characteristics in accordance with assigned beneficial uses
- prevent flood damage in developed areas
- prevent excessive corrosion of waterways, slopes and banks

To maintain and, where possible, enhance water quality:

- minimise waterborne sediment loading
- protect existing riparian or fringing vegetation
- minimise the export of pollutants to surface or groundwater
- minimise the export and impact of pollution from sewage

To encourage water conservation:

- minimise the import and use of scheme water
- promote the use of rainwater
- promote the re-use and recycling of wastewater
- reduce irrigation requirements
- promote opportunities for localised supply
- promote resourceful urban patterns of water use and the benefits to be derived from water-saving opportunities

To enhance water-related environmental values

To enhance water-related recreational and cultural values

BOX 5.12
THE THAMES REGION, ENGLAND: A BEST-CASE EXAMPLE OF THE INTEGRATION OF URBAN AND WATER PLANNING
(Slater *et al*, 1994)

In England and Wales, the Environment Agency is a statutory consultant on the formulation of regional and local plans. In the early '90s, the Thames Region National Rivers Authority (NRATR - now incorporated within the national Environment Agency) adopted a more active approach in achieving its water management-related objectives through the physical planning process. NRATR commented and helped to redraft the relevant national planning circulars and guidelines, put forward representations and objected to plans for the development of 57,000 extra dwellings in the South-East region by the year 2011 and promoted these policies in the London Planning Advisory Committee. Most importantly, the agency prepared model policies ("catchment management plans") that expressed its objectives in clear fashion and which could easily be compared and suited in the local development conditions and plans. NRATR devoted much effort to incorporating its model policies and interests into the plans prepared by all 33 London local boroughs in 1989-90 with great success. There was an average take-up of 80% of model policies in local plans.

A governmental mandate for the integration of the two planning processes is necessary as the different competencies may be hard to bring together. **Higher order policy frameworks** must clearly articulate direction and intent. A national water or land-use policy document with legal standing for example should explicitly require that water be considered a basic factor in regional and local town and country plans. The latter should explicitly state how water management goals and objectives are incorporated into their structure and decisions.

5.5.3 Integration with coastal zone management planning

In the narrow coastal zone, there is intense competition from different activities for limited and fragile natural (including water) resources. Planning for Integrated Coastal Zone Management (ICZM) is concerned with the allocation of the multiple resources and the multiple uses present along the coast through **land-use regulation** and **policy and physical interventions**. It is a **strategic, coordinative activity** bringing together the various competencies, planning and management

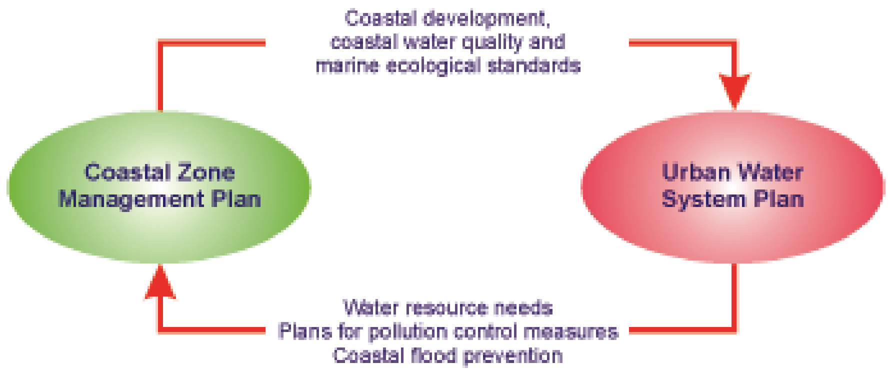


Figure 5.10
The relationships between urban water system and coastal zone planning

instruments to achieve shared objectives concerning the state and development of the coast. Box 5.13 presents the basic steps of the coastal zone planning process. Note that coastal zone land-use planning might be a subset of the overall urban land-use planning described above. Coastal zone planning, however, in addition to urban planning, includes measures that aim to protect coastal waters and marine ecosystems.

Figure 5.10 shows the relationship between the urban water system and coastal zone planning.

ICZM planning is a relatively new process. There are many ongoing initiatives but many Mediterranean areas still lack explicit coastal zone management plans. A Coastal Zone Management Plan is typically not the responsibility of one authority alone; it is a **programme** run by a partnership or an inter-departmental agency. Urban water utilities and related agencies in Mediterranean coastal areas should be **active partners** in such partnerships, where they exist or are planned. Integration should be two-way:

1. Objectives related to the coastal strip, waters and estuaries should be incorporated into the water system Master Plan. For example, pollution standards for wastewater or stormwater may be based on ICZM goals concerning the condition of fisheries and their habitats. Such goals may limit certain urban water management options. Beach erosion considerations for example, may restrict certain water supply works.
2. Water management goals should be taken into account when deciding on land-uses and infrastructures on the coastal zone. The principles of a water-sensitive coastal land-use design should be followed.

BOX 5.13
THE STAGES OF AN INTEGRATED COASTAL ZONE MANAGEMENT PLAN (after UNEP, 1995)

1. **Preparatory activities**
- Definition of coastal area
- Identification of sectoral and cross-sectoral problems
- Proposal on general goals and objectives
- Preparation of development-environment outlooks and tentative strategy
- Identification of information gaps
- Proposal for planning procedure

2. **Analysis and forecasting**
- Issue oriented new surveys
- Analysis of natural and socio-economic systems
- Forecasting of future demands
- Generation of cross sectoral scenarios and selection of preferred scenario

3. **Definition of goals and strategies**
- Proposal for sectoral and cross sectoral goals and objectives
- Preparation of alternative strategies including legal requirements, financial implications and institutional arrangements
- Evaluation and selection of strategy

4. **Integration of detailed plans**
- Allocation of land and sea uses
- Proposal for implementation procedures (legal, institutional, financial) and relevant instruments
- Definition of implementation stages
- Draft plan presented to responsible body for approval

5. **Implementation of plan**
- Phasing of proposals and policies
- Application of economic, regulatory and environmental evaluation instruments in development control
- Adaptation of institutions

6. **Monitoring and evaluation**
- Redefinition of cross sectoral problems
- Identification of the inadequacy of instruments

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Water management is a key factor for sustainable urban development in coastal areas. By the same token, the sustainable urban development of coastal regions is necessary for the sustainable management of scarce Mediterranean water resources. Coastal cities in the Mediterranean are facing significant problems relating to the management of their water resources. Pollution, scarcity, droughts and floods are becoming more frequent and are triggering tensions and conflicts, both within cities and between cities and rural areas. The existing infrastructure is ageing while its replacement is costly. Continuous urbanisation, especially in peri-urban areas, poses costly demands for new infrastructure. Urbanisation pressures are particularly intense on the coast. Assorted activities and competing uses are concentrated in a narrow coastal zone (settlements, infrastructure, various economic activities, ecosystems, etc.). Coastal water resources have particular characteristics that merit a special approach due to the complex interaction between surface waters, groundwater and sea water.

Urban water management in coastal Mediterranean settlements is currently approached as a series of separated tasks: drinking water supply, sewage management and drainage. Many of the current problems are the result of a fragmented approach. There is a need to move to a more integrated management approach whereby the three tasks are managed together and furthermore, in close coordination with urban development and management, coastal zone management and water resource management at the river basin level. These Guidelines represent a response to these issues. The Guidelines are divided into two volumes. Volume I presents the principles and planning for urban water system management, while Volume II presents the most important instruments and tools. Our intention is to facilitate a broader use of these Guidelines. Our intention is to facilitate a broader use of these Guidelines. Volume I thoroughly explains the problems relating to integrated urban water system management, while the Volume II presents the tools and techniques needed for management in more detail. Accordingly, the Volume I is intended for all those who wish to get to know the problems of integrated urban water system management, while the Volume II is intended for those who wish to engage in the solutions to these problems.

The Regional Activity Centre for the Priority Actions Programme (PAP/RAC) is part of the Mediterranean Action Plan (MAP) of the United Nations Environment Programme (UNEP). PAP/RAC is focused on practical activities which are expected to yield immediate results contributing to the protection and enhancement of the Mediterranean coastal environment, and to the strengthening of national and local capacities for integrated coastal area management. PAP/RAC co-operates with a large number of specialised organisations in the UN system (UNEP, FAO, IMO, UNESCO, IOC, WHO, IAEA, WTO, UNDP), financial institutions (World Bank, European Investment Bank) and other international organisations (European Union, Council of Europe), and national and local authorities in the Mediterranean region.