SPS (NFA) 5th Workshop on

SUSTAINABLE USE and DEVELOPMENT of WATERSHEDS for
HUMAN SECURITY and PEACE

October 22-26, 2007

Istanbul, TURKEY

ABSTRACTS

in cooperation with

NATO CCMS Pilot Study Group on
Ecosystem Modeling of Coastal Lagoons for Sustainable Management
The water resources in Algeria are limited, vulnerable and unequally distributed. Additionally, these resources have undergone the harmful effects of the drought, pollution and inadequate management during the last two decades. The overall water potential in Algeria is estimated at 19 billion m$^3$/year (corresponding to approximately 600 m$^3$/capita/year). Thus Algeria is located in the category of countries facing water shortage, based on the threshold value of scarcity set by the World Bank as 1000 m$^3$/inhab./year).

Furthermore since the independence, it can be seen that institutional plurality and overlapping of legal framework have been an issue along the historical evolution of water management in Algeria. Only after the 1990's, following the establishment of national bases for water in 1996, awareness with regard to coherent, rational and global water management approach that was raised has lead to the adoption of a new policy in water management. A new policy developed and adopted for water management based on the principles of the uniqueness of the resource, its integrated management on catchment basin scale taking into consideration consensus, environmental awareness and water saving principles was set in 1996.

The important objective of this policy is summarized as follows:
- protection of existing resources
- development of water resources at maximum level and to the extent possible
- development of planning tools,
- efficient management through the national water plan
- demand management
- use of non conventional resources (treated water use in agriculture and industry, desalination of sea water and brackish water)
- institutional, legal and institutional reforms by restructuring of the institutional framework based on the components of the water sector by :
  • the knowledge of the resource
  • the mobilization
  • distribution of drinking water, industrial and agricultural water
  • sewerage, sewage treatment and treated water reuse
  • integrated management on catchment scale.

In order to achieve these goals, it is of utmost importance to ensure the efficiency of the program avoid mismanagement and inconsistencies observed in the past in Algeria, overcome the challenges which the water sector is confronted with and implement the new water policy enacted in 1997 by solving the problems and bottlenecks encountered in the water sector. One can currently observe raising national awareness related to water shortage in Algeria, as well as a real political good will to overcome this crisis. This was concretized by:
- the establishment of the Ministry of Water Resources in 2000.
- behavior of several ministerial and governmental Councils devoted to the problem of water
- adoption of a new law on water in 2005
- a consequent financing in the sector (more than 18 billion Euros for the period of 2006 - 2010)

This report mainstreams the following axes:
- fundamental elements of current assumption of responsibility for the water management in Algeria (the water resources and the committed process with regard to institutional restructuring: organization, administration, financing and implementation/achievement)
- overall evaluation of the possibilities for the improvement of the ruling management by the evaluation of the impacts of management schemes.
- Assessment of the possibilities for the improvement of the new water policy.
Austria has abundant natural water resources and belongs to three major river basins (namely the Danube, Elbe and Rhine).

99% of the Austrian population is supplied with spring and groundwater; moreover, the share of treated surface water of 1% is very small compared to many other European countries. The support of investments for urban water management (water supply and wastewater disposal) in recent years has particularly benefited the development of sewer networks and wastewater treatment plants. Due to systematic wastewater treatment, 87% of the Austrian rivers have already restored to quality class I or II (on a scale of IV). At present, 89% of the population is connected to public sewerage systems with corresponding wastewater treatment. Whereas the urban areas are already provided with wastewater facilities to a very high extent, effort is still needed in rural areas to meet the requirements of the European and Austrian legislation.

Since the end of 1991, water quality in Austria has been consistently monitored by private and public contractors commissioned by the Austrian Ministry of Life and the Austrian Federal Provinces. The objective of this program is to record the status of groundwater, rivers and streams in Austria, as well as any trends, in order to provide a reliable database that can be used to take informed countermeasures in the event that impacts or pressures are identified. Results show that most parameters related to drinking water quality are well below the specified limit values.

Besides protecting lakes, rivers and streams, it is particularly important to protect groundwater which is used as important drinking water resource. In certain parts – e.g. in intensively farmed regions – the groundwater is polluted by nitrates and pesticides. Countermeasures include farming practices with a clear groundwater protection focus (e.g. the Austrian Agri-Environmental Program ÖPUL). In general, Austria applies the principle of country-wide groundwater protection. About 9% of the territory of Austria is subject to specific water supply protection regulations.

In December 2000, the Directive of the European Parliament and Council “establishing a framework for Community action in the field of water policy” (so-called “EU Water Framework Directive”) entered into force. The EU Water Framework Directive was transposed into the Austrian Water Act through its year 2003 amendment. Essential innovations lie in the following principles and elements: water management based on river basin units (for Austria these compass the Danube, the Elbe and the Rhine), a mandate to improve conservation to at least a good ecological status of all water bodies in combination with a prohibition of their deterioration, as well as the active involvement of the public.

The current status of the EU Water Framework implementation in Austria includes the analysis and status assessment of the Austrian river basin districts, which were rated and classified by the level of risk of failing to reach the required good status. The next activities will include the drawing up of the first national river basin management plans, adapting the water quality monitoring network, and restoring those water bodies failing to meet the defined objectives.

Moreover, Austria has been involved for many years in the multilateral Transboundary Water Commissions formed to manage the rivers Danube, Rhine and Elbe, and Lake Constance.
PROBLEMS OF PROSPECT OF WATER RESOURCES MANAGEMENT IN AZERBAIJAN.
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Distinctive features, total amount used and the general stocks of water resources of Azerbaijan are considered. The agreement on use of water resources of the trans-boundary rivers is characterized the basic trans-boundary rivers and bilateral. Use and protection of trans-boundary water resources is resulted recommended necessary actions for rational.

WATERSHED MANAGEMENT SYSTEM in FRANCE
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The French water agencies have a long experience of water management at basin scale since the 1964 water law. Their first objective was to collect taxes from all water users to provide a financial founding for water distribution and treatment within six large river basins that cover the all-French territory. Then in 1992, the concept of integrated water resources management has been implemented in a new water law in the aim of building water governance based on the global concept of sustainable development. The objective was to manage water at sub-basin scale. More recently, the EU water directive has also impacted the French water law with a new vision of water territorial management (i.e. the water mass unit). This territorial overlapping of hydrological units and administrative clusters is increasing the governance and decision making complexity.

This communication presents the water policy evolution and a state of IRWM plans in France. It also analyses the EU Water Directives implementation within the French case study (i.e. water law of 2006). Then a regional focus is given on the Euro case study (Paris Basin, France). This river is a very demonstrative case of a highly clustered hydrological unit of 6000 sq.km that is covered by many administrative and entities (4 level 1 and 4 level 2 EU nuts, 600 municipalities...) having various decision levels in water management and urbanization. This territorial complexity and its water governance (national, regional local services and their referents) is also affected by a demographical pressure of 675,000 inhabitants mostly concentrated in the three main floodplains (50%) and a massive agricultural pressure on water resources (i.e. 63% of the basin surface is covered by permanent crops). Scientific results from an experience return led on a thirty year return flood event have also revealed the existence of a post-disaster water community covering the all basin. This emerging community is rising from water management dysfunction and natural hazard but it can also provide an opportunity to enhance both water system and watershed membership perceptions for population, stakeholders and territorial decision makers. This communication concludes on the positive impacts of hydrological crisis for the implementation of IWRM plans.

SUSTAINABLE USE and DEVELOPMENT of WATERSHEDS
The case study for the Integrated trans-boundary water management in the Ural River Basin
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River basins are the most appropriate geographical units for considering the management of water resources. At the same time rivers and their associated ecosystems and biodiversity provide the basis of life for a large portion of the world’s population. There is now an international consensus on the need for an integrated approach to sustainable river basin management.
Though the issue of sustainable watershed management and development are widely discussed, many handbooks written and numerous attempts have been made to put this concept into a practice, there is no standard definition of the term “sustainable” and consensus on methodology to get to this state. One of the few undisputable points in this theory is that sustainable development of watersheds should consider three main components: economical, social and environmental. However, the history of human communities’ development in river basins shows that this can be hardly achieved. Some components are often neglected in favor of others.

From this point of view, the basin of the Ural River shared between Russia and Kazakhstan is a unique ecosystem. It allows to develop and to implement sustainable watershed management strategy taking into account all three components of traditional sustainable management. The ground for these activities can be unique self-supporting population of Caspian sturgeons in the river Ural.

Apart from its high economic value and flagship function the sturgeon is an indicator (umbrella) species for the river basin it inhabits. Moreover, living in the sea and migrating to rivers for spawning the sturgeon population links together the marine and riverine ecosystems and allows integrated transboundary management of the river basin to be developed.

The Ural is the only river in the Caspian Sea with a non-regulated water stream in an area of historical sturgeon distribution. The sturgeon population lives in the internationally shared Caspian Sea and migrates to the spawning places in Russia through the territory of Kazakhstan. Thanks to the absence of a barrier complex this is the only self-sustaining, viable sturgeon population capable of natural reproduction in the Caspian Basin.

This topic was brought up and developed by the Ural River Basin Project, a joint initiative by Central European University, number of Russian and Kazakhstan NGOs and environmental state agencies.

The rational policy and community-based management of sturgeon stocks can be the basis for basin sustainable development in the whole river. This project can help not only to preserve this flagship species, but also to solve social and economic problems by restoration of the traditional life style of local communities, which historically have lived in harmony with the river ecosystem.

The areas under the scope of the Project include different environmental disciplines and anthropogenic activities related to the well-being of the sturgeon population, taking into account its triple function in the river ecosystem: indicator species, flagship species and species of special concern. By adopting this holistic, integrated approach the Project will be a focal point for specialists on water quality, fishery, international and national environmental law, as well as sturgeon experts and facilitates the development of sustainable watershed management strategy.

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THE USE OF NUMERICAL MODELING IN ITALIAN WATERSHED MANAGEMENT

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The water framework directive (WFD) sets a general framework in which the European countries have to move. Here we take a closer look on the Italian contest and how the WFD has been introduced in this country. Administrative, legal and financial aspects are been discussed and points specific to Italy are pointed out. The Italian approach to monitoring water quality and the actuation of the WFD is presented and near future changes are highlighted. Finally, the use of modeling tools in planning, enforcing and controlling the application of the WFD is discussed and some examples are given. At the end conclusions are drawn.
WATER RESOURCES OF THE KYRGYZ REPUBLIC IN ASPECT OF PROVIDING ECOLOGICAL AND CHEMICAL SECURITY.
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All recent researches show the urgent necessity to take measures for protecting water resources of Kyrgyzstan. Chemicals used in agriculture and because of wastes of industries pollute them. In this work there are some recommendations and results of analysis taken to show the results of pollution. Also the present status of water systems of Kyrgyzstan is presented with views on further their development.

SOME REFLEXIONS ABOUT NATIONAL STRATEGY ON COASTAL AREA MANAGEMENT AND PROTECTION IN MOROCCO
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It is quite certain that coastal area protection and development require a national strategy development which must imply and associate government departments, operators and local communities. The contribution that we propose within the framework of this seminar is a personal contribution based mainly on the work achieved by the littoral cell (in french Cellule du Littoral) which initiated the start of a debate around coastal area in Morocco.

This contribution is structured around two major parts: firstly, it points out to the current state of coastal area (Part A), in order to propose the protection policy elements and development of this area (Part B).

WATERSHED MANAGEMENT PRACTICES IN THE PHILIPPINES
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Management is both a science and an art whatever is the object/subject being managed. While a watershed management policy may be placed on paper and thick documents, their translated actions may differ from watershed to watershed; perhaps without losing its essence or even reinforcing its intention or, on the other hand, threatening it with change for a better policy.

Watershed management in the Philippines is described in this paper from the perspective of a non-government organization participating with local governments and national government agencies in pursuing watershed protection, conservation, and development mandates. Agreements were signed to make this collaboration happen.

The paper describes the challenges met in carrying the objectives or purposes of the agreements in the venue of a local watershed called the Tigum Aganan Watershed. Structure, practices, financing, administration, decision making and responsibilities are described in this local watershed Board, including the legal basis for its existence. The administration of national agencies over watersheds in the country and over a specific watershed, the Tigum Aganan Watershed, is also described. Issues and concerns experienced by other watershed management units led by local governments, (considered local initiatives) are reported and discussed in a national association called the Philippine Watershed Management Coalition, another non-government organization. Transfer of knowledge, deepening of understanding of issues and exchange of strategies in solving problems are shared during meetings.

In general, this paper describes the formal structure of watershed management and the informal process of policy formulation for watershed management brought about by participation from local government, private sectors, community-based organizations and non-government organizations.
The author describes watershed sub-regions in Poland: 1) the Vistula River Basin (194,400 km²), 2) the Odra River Basin (119,000 km²), 3) the coastal drainage area of Poland (26,000 km²). These sub-regions represent about 20% of the Baltic Sea catchment’s area, however they contain almost 50% of agriculture land and almost 50% of the total population of the Baltic Sea catchment’s area. Apart from this, Polish territory is highly industrialized and intensively agriculturally used. Therefore, Polish watershed areas have a key position for environmental conditions of the Baltic Sea. Most of the Polish rivers preserved natural water courses and high level of biological diversity. The Vistula River, second largest Baltic river, is regarded as the last natural (not regulated) big river in Europe.

As a part of the Baltic region, Polish drainage basin is under international regulations. In 1992, Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention/HELCOM) was signed. This convention covers the Baltic Sea and its drainage basin. One of the most important “land” activities of HELCOM is Pollution Load Compilation (PLC), among others, covering the river load monitoring and assessments. The other one is the Joint Comprehensive Environmental Action Program which has elaborated strategy for a long-term actions to restore the ecological balance of the Baltic Sea (that includes identification and removal of Hot Spots in the drainage areas). Polish catchment’s area is also under EU regulations and therefore under EU Nitrate and Water Framework Directives and under EU Common Agriculture Policy (CAP). The Odra river, the 10th largest Baltic river, the trans-boundary river between Germany and Poland, is also a subject to regulations of Convention on the Protection and Use of Trans-boundary Watercourses and International Lakes, 1992.

Poland has adopted policy that river basins are the best units for management. For this purpose, in 2001, seven Regional Boards for Water Management (RWMB) were established, subordinated under Ministry of Environment. RWMBs are responsible for water management in river basins. They are allowed to act as investors and a part in trials in courts. Tasks and duties related to environmental protection and water quality are under the Chief Inspectorate for Environmental Protection which works under national Environmental Protection Act and accompanying regulations. In practice, these duties are realized by sixteen Provincial Inspectorates for Environmental Protection. Financing of sewage treatment facilities and water quality programs are realized by the National Fund for Environmental Protection and Water Management.

In the early 1990s, Poland went through severe political and economical transformations which resulted in market based economy and improved environmental practices. Construction of many sewage treatment plants and serious decrease in fertilizer consumption resulted in decreased pollution load from Polish catchment’s area to the Baltic Sea. Some positive environmental changes along the Polish coast of the Baltic Sea have been noticed, however, the expected decrease in eutrophication in coastal areas has not been not observed.

In general, due to better sewage treatment facilities and better environmental practices, there is considerable improvement in river water quality in Poland, however, there is still a lot to be done, to improve administration, finances, public participation in water management and to integrate river basin management to coastal management.
WATER RESOURCES MANAGEMENT IN PORTUGAL.
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INAG, (www.inag.pt) is the Portuguese Water Authority in Watershed Management. This institution belongs to the Environment Ministry and is responsible for the implementation of European Directives and of National Legislation and designs the monitoring programs that are implemented locally by the regional authorities (7 on total, 5 in the continent and two in Azores and Madeira Archipelagos). Results of monitoring programs and of any activities relevant for Water Resources Management are published on the web (www.snrh.pt) being accessible to anybody interested on the data.

Water supply for domestic consumption and urban waste water management are carried by municipalities or by inter-municipality companies providing services to groups of municipalities. Águas de Portugal (www.adp.pt) is a holding managing companies providing services to 75% of the Population. INAG defines the level of treatment required for each plant having into consideration the water quality goals and the legislation (Urban Waste Water Treatment Directive and Water Framework Directive).

Water for irrigation is provided mostly by artificial reservoirs. Reservoirs built exclusively for providing irrigation water are paid by the National Authorities and their water quality is managed by INAG, being the water use managed by local farmer’s associations. The larger reservoirs are built for irrigation and electricity production and are managed usually by an electricity company that must accomplish INAG guidance in extreme situations of drought or flood. The largest reservoir in Portugal is managed by a dedicated company (www.edia.pt).

The National General Directorate for Agriculture and Rural Development is in charge of irrigation planning at the national level, of providing technical support to the farmers, being a major actor in the implementation of the EU Nitrates Directive. This Directive aims to control the concentration of nitrates in the groundwater and imposes restrictions to fertilization whenever high levels are detected. Universities and National Research Laboratories and Private Companies provide services and advice to the National Authorities and develop technologies required for the integrated management required by the new management policies which are evolving on the sense creating a catchment authority, transversal to Ministries and Regional organizations. Details on management tools and organization will be provided in this talk.

WATER RESOURCES MANAGEMENT IN ROMANIA: CHALLENGES AND OPPORTUNITIES
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Sustainable use and development of watersheds become a major target of the national, European and global strategies and policies for sustainable development. This is based on recognition that: i) the lotic and lentic systems are major components of the biophysical structure of natural capital which play a key role in providing a wide range of resources (e.g. water, food resources) and services (e.g. flood detention, recharging and discharging aquifers; nutrient retention and release, trace elements retention); ii) the structure, water quality and their functions – production, regulation, information and support – were modified and degraded, in all EU countries (including Romania) in a proportion ranging between 50 – 90 percent (Castro et al. 2002, Nivet & Fraizer 2004, Revenga & Kura 2003, Vadineanu et al. 2003); iii) the water quality and the integrity or health of the lotic and lentic ecosystems are the results of long term integration of the cumulated stress of both human and natural pressures, acting at the watershed scales; iv) there is a need to shift the former sectoral and reductionistic based management of water resources towards integrated / or ecosystem and adaptive management at the catchment’s scale (EU - WFD) and; v) the management plans and decisions for sustainable use and development of watersheds have to rely on evaluation.
– in physical and monetary terms – of the impact of human pressures upon the water ecosystems structure and functions and, the quality and density of resources and services flows.

Taking into consideration the above guiding requirements and the major social, political and economic changes emerged during more than 16 years of transition and negotiation of the EU accession and integration, the presentation is focused on the current status of the new emerging institutional, governing, legislative and administrative frameworks. A particular attention will be given to: i) the eleven administrative units (hydrologic basins and watersheds) which cover the river network at the national scale; ii) land use and landscape structure; iii) water course management; iv) main hydraulic infrastructure; v) major drivers and pressures impacting on water quality and water ecosystem health; vi) first classification of “water bodies” and assessment of their “ecological status”; vii) former economic analysis and new requirements for “environmental and resource cost and benefit analysis”; viii) the current institutional framework including stakeholders network and their involvement; and to many difficulties the EU – WFD implementation process is facing as well as major emerging water policy issues and risks.

WATERSHED MANAGEMENT IN THE RUSSIAN FEDERATION

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Watershed management was introduced as a main management principle in Russia in 80th. Nowadays the Russian Water Code, as a main legislative act in the country, provides a legal basis for implementation of this principle. Water resources of Russia are subdivided according watershed principle, and watershed administrations are established in the big regions of the country. But practically, the watershed approach is weakly implemented yet for many reasons. As an example, the state of art of approaching to watershed management in the very west region of Russia, namely, the Kaliningrad Oblast, will be discussed with details. The specific attention will be given to problems of trans-boundary of shared water resources. All examples will be taken from the Kaliningrad Oblast, all which water resources (river basins and coastal lagoons) are shared. Specific attention will be paid for international projects in the region, for the problem of non-coincidence of administrative and watershed structure of the territory.

OVERVIEW OF WATER MANAGEMENT IN TURKEY: ISSUES, CONSTRAINTS, ACHIEVEMENTS, PROSPECT

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The major systematic aspect of water related activities in Turkey is central planning. At the national level, Five-Year Development Plans’ objective (FYDP) is to ensure the optimum distribution of all kinds of resources among various sectors of the economy. The latest, 9th. plan covers the period of 2007-2013 with the major goal related to environmental protection and public infrastructure development. This plan underlines the fact that rapid urbanization and industrialization process is a pressure on the sustainable use of water resources; that although progress has been made, uncertainty with regard to institutional plurality and fragmentation across sectors remains. This issue is a big challenge on the way to substantial reforms with regard to water resources management. Therefore better cooperation and coordination is needed between institutions. Water management is gradually improving towards a sustainable development policy by internalizing the concepts of water demand management in the municipal, industrial and agricultural sectors.
WATERSHED MANAGEMENT IN THE UNITED STATES
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A watershed approach provides an effective framework for dealing with water resources challenges. Watersheds provide drinking water, recreation, and ecological habitat, as well as waste disposal, industrial cooling water, and navigation. Consequently, much depends on the health of watersheds. Watersheds are threatened by wastewater and non-point source runoff, which load the surface waters with excess organic matter, nutrients, pathogens, solids, and toxic substances. Direct physical alteration, such as paving and stream channelization, changes the natural hydrologic regime and natural habitat. Estuaries are of particular importance as they have great economic, ecological, recreational, and aesthetic value. The approach to protection, management, and restoration of these water resources in the United States, and the respective roles of Federal, State, County, and City governments, as well as the private sector and volunteer groups, will be presented. Protecting and sustaining watersheds requires that water resource goals be prioritized within a coordinating framework.

POLITICS AND LAW FOR TRANS-BOUNDARY WATER RESOURCES MANAGEMENT AND REGIONAL SECURITY IN CENTRAL ASIA:
ACHIEVEMENTS, PROBLEMS AND PROSPECT,
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As is known, problems of trans-boundary water resources management (WRM) in Central Asia (CA) encompass a huge conflict potential, are one of key among other regional problems and are an integral element in national and regional policies and security. Regional water politics is reflected in the key political-legal documents accepted by Heads and Governments of Central Asian States (Declarations and Statements: Kyzyl-Orda, 1993, Nukus, 1995; Issykkul, 1995; Almaty, 1997; Tashkent, 1998, 2001; Ashgabat, 1999; Dushanbe, 2002; etc.; Interstate Agreements: Almaty, 1992; Kyzyl-Orda, 1993, Turkmenabat, 1996; Bishkek, 1998), and it should be considered as doubtless achievement. Within Independence the major attention and attempts is focused on sustainable WRM of main trans-boundary rivers of CA - Amudarya River and Syrdarya River (regional level). At the same time, issues of WRM of trans-boundary small rivers (TSRs) are of same importance (local level). In CA problem of water distribution from TSRs exists in the Fergana Valley (Tajikistan-Uzbekistan, Kyrgyzstan-Uzbekistan, Kyrgyzstan-Tajikistan), Chu and Talas Valleys (Kazakhstan-Kyrgyzstan), Tashkent oasis (Kazakhstan-Uzbekistan), Kopetdag zone (Turkmenistan-Afghanistan, Turkmenistan-Iran). Interstate water distribution (IWD) from TSRs is especially sharp in the Ferghana Valley. IWD was coordinated by Parties and set in 1980 by the appropriate Protocols of the Ministry for Water Resources and Land Reclamation of USSR in centralized order. WRM of TSRs in the Ferghana Valley was greatly complicated in recent decade. Breach of the established water distribution results in intensification of social intensity in frontier areas located in TSRs' basins that can be easily transform into international conflicts. In these conditions development of new normative-legal base concerning WRM of TSRs is obviously necessary, as last years the reality have changed. Approaches of the integrated WRM can be accepted for a basis of WRM of TSRs for avoidance of possible conflicts in the future, and it will serve to strengthening of regional security.
The Analytic hierarchy process (AHP) is used to build up and solve participatory decision making model and thus improve management of selected regional hydro system in northern Serbia. Recently, serious conflicts in this case study area are evidenced among governmental bodies, local authorities in municipalities, responsible water management companies, ecologists, public bodies etc. The reason for conflicts is lack of funding, improper legislation or absence of precise water policies, low efficiency in water taxation, obstruction of societal and political representatives to participate in management, etc.

The decision-making model (hierarchy) has in total four levels and 13 decision elements. The overall goal is set at the top of hierarchy as a ‘benefit for all’. Second level consists of 3 criteria (economy, social, ecology) and 5 more decision elements are defined at the third level as primary system purposes (irrigation, drainage, used waters, industrial water supply, and other purposes). At the bottom of the hierarchy, four management strategies are posted as the decision alternatives, defined by authorized water management company. Model is established by consensus and then assessed by five key interest groups gathering in total 23 individual participants. At the final stage, the best strategy is identified by aggregating the alternatives’ weights obtained in groups, assuming also that groups may have different importance in deriving final solution.

Successful structuring and solving the participative decision-making model, based on AHP methodology, indicated promising and scientifically sound approach in supporting overall water management in the Vojvodina Province in Serbia. Results of this practically performed experiment recommend this modeling and solving concept for further use, at least in situations similar to this Serbian case study example.

Modeling in catchments involves a wide range of activities including, characterization of the precipitation, the study of river flow, infiltration in the vadose zone, groundwater flow, interaction of water and plants, transport of salts, mineralization of organic matter. Traditionally these subjects are addressed by people from different disciplines (meteorologists, hydrologists, agronomists, hydrogeologists, biologists, etc.) which have developed knowledge and tools applicable to specific compartments of the catchments (e.g. river network models, vadose zone models, groundwater models). In many cases these tools were focused on water quantity, and in some cases they also include water quality.

Traditional infiltration models for the vadose zone oriented towards the parcel scale studying the problem in a 1D grid using very detailed formulations (e.g. HYDRUS1D and RZWQM). Spatial steps use to be of the order of centimeters and time steps of the order of seconds. These models were fundamental for assessing processes determining the fate of water and salts in the soil, but were limited by boundary conditions which had to be measured or object of strong simplifications, especially the lower boundary which requires the knowledge of the ground water table that is determined by larger scale processes.
On the other side of the spectrum are the traditional catchments models based on large spatial units (designated by Hydrological Response Units in the SWAT model). The HRU identify portions of the catchment with similar characteristics (soil, land use and slope) and the model computes the water quantity and quality inside each of them and exported by each of them to the downstream HRU. This type of model requires more empirical information that the "land plot model", but can be run for the whole catchment.

The knowledge gathered in the models described above can nowadays be combined into integrated grid models able to simulate both spatial scales and also the river network and the surface runoff. MOHID Land (www.mohid.com) belongs to this kind of model. This talk will describe the model and major applications.

**SUPPORTING TOOLS FOR DECISIONAL PROCESS WITHIN WFD: FROM EU CONTEXT TO MODELKEY PERSPECTIVE**

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The European Water Framework Directive (EU WFD; 2000/60/CE) prescribes a series of tasks for properly assessing and managing river basins with the ultimate aim of protecting and restoring the overall quality status of European surface waters by 2015. In this context, Decision Support Systems (DSSs) and tools are needed providing water managers and decision-makers with specific functionalities for integrating environmental and socio-economic factors, for comparing and selecting management alternatives, for assuring stakeholders involvement and participation, for communicating and visualising results in a transparent and simple way. Currently, different DSSs are available addressing specific assessment and management needs within EU WFD. In particular, a risk-based DSS is under-development within the MODELKEY EU project (2005-2010) whose main objectives are i) to evaluate risks posed by pollutants and other stressors on aquatic ecosystems by interlinking exposure/effect models and testing tools, ii) to integrate environmental and socio-economic information for targeting management actions and iii) to facilitate groups of experts and stake-holders involvement. The main outcome of the system is the calculation of Integrated Risk Indices (IRI) based on Weight of Evidence and Multi-Criteria Decisional Analysis. The MODELKEY DSS responds to the EU WFD requirements, nevertheless it is a flexible system adaptable also to other legislative contexts.

A review of developed or in progress systems and tools supporting the EU WFD implementation will be presented and the main functionalities and technical features of the MODELKEY DSS software will be described.

**APPLICATION OF WATER QUALITY MODELLING AS A DECISION SUPPORT SYSTEM TOOL FOR A PLANNED RESERVOIR AND ITS WATERSHED**


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Istanbul, the largest metropolis in Turkey and one of the most populated metropolis in the world, is facing risk of water scarcity in the near future. Analyses indicate that one of the alternative solutions coping with this problem is water transfer from another watershed. Water supply from Melen watershed, located approximately 200 km away from the city is considered as the most feasible option for trans-boundary water transfer to Istanbul due to its water potential and relatively less degraded water quality. However, further analyses have shown that a reservoir will be needed to enable supply of required amount of water for Istanbul in low flow seasons in the Melen Watershed. Therefore, State Hydraulic Works (DSI) plans a reservoir, which will be located at the downstream region of the watershed. Being at the downstream region of the watershed, the water quality of the reservoir will be affected by human activities in the watershed, thus measures to prevent pollution as much as possible need to be taken before the reservoir construction. Quantifying the response of the planned reservoir to external pollution loads is an important step in planning and management in the watershed. Mathematical modeling is an option for estimating the future water quality and understanding the possible responses of the reservoir to various pollution loads. In this
study, a water quality model capable of simulating hydrodynamics, transport and water quality in reservoirs is used as a tool for preliminary estimation of effects of several management options in the watershed. Model results indicated that, all of the point sources in the watershed must be controlled by advanced wastewater treatment and diversion from the streams and planned reservoir. Model results also indicated that controls of agriculture based diffuse loads by 30% to 40% are expected have a distinct positive effect on the water quality in the reservoir.

**COMBINED USE OF WATERSHED MODELS TO ASSESS THE APPORTIONMENT OF POINT AND NON POINT LOAD SOURCES TO SURFACE WATERS**

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The sustainable management of watersheds is critical since it touches many aspects of the anthropogenic use of natural resources. The quality of water resources are a central issue in the watershed management. Over the last few years it has grown worldwide the need to implement tools for a knowledge-based management of the environmental resources and processes. Particularly there is the need to evaluate the response of the system to different pressures and different management alternatives. This is normally done through a Scenario Analysis which in many cases implies the use of modeling tools and the creation of a G.I.S. archive of the available knowledge. Understanding the source apportionment of pollutant loads driven through the watershed to a coastal lagoon or evaluating the socio-economical consequences of a new environmental policy or the effect of a natural or not natural catastrophe are all issues that can be studied through a sound scenario analysis. On this perspective, diffuse pollution’s effect on surface and groundwater is often difficult to quantify. Diffuse pollutants enter the environment through a multitude of pathways at different temporal scales. During rainfall events most of the diffuse pollutant load follows the surface runoff pathways and, at the net of the plant uptake, reaches the aquifers. A fraction of this load follows the sub-surface runoff pathways and may possibly reach the surface waters after a certain time lag. Very rarely the sub-surface pollution events can be directly correlated to a specific rainfall event. In this study some case studies are presented where river and watershed modeling tools are combined with factor analysis techniques to identify the effect of the sub-surface runoff on the water quality of specific stream reaches. Through this approach the sub-surface runoff was proven to be a significant source of diffuse pollution even in dry weather conditions.

**GIS ANALYSIS OF SUSTAINABLE DEVELOPMENT INDICATORS FOR COASTAL WATERSHEDS**

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GIS spatial and quantitative analysis was applied to estimate the indicators of sustainable development of the coastal territory by example of the Kaliningrad Oblast (Russian Federation).

Target territory was identified using  
(a) administrative structure of NUTS5 units and  
(b) zones within coastal catchments (according to time lag of pollution spreading in rivers streams).

To develop specific set of indicators for coastal watersheds the recommendations of EU Working Group on Indictors and Data were adapted. Comparison of indicator parameters was fulfilled between coastal and non-coastal target territories.
The role of ecological endpoints in watershed management

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Ecological endpoints in aquatic systems can play an important role in watershed management, since they are often easily measured in the field, and unlike chemical and physical measures, integrate over time. Endpoints of interest include the abundance/quality of a commercially or recreationally important fish stock; the composition of ecological communities, as an indicator of watershed health and integrity; and the diversity of species or the presence of sensitive, rare, or unique species, for conservation and aesthetic and cultural value. We discuss several methods, tools, and approaches currently used to incorporate ecological endpoints into watershed management in different countries.

The study of coastal lagoons of Kara-Bogaz-Gol,

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On the basis of the bay up-date condition analysis and published information, there was made prognosis of the bay hydro-minerological regime for the nearest years. Depending on the Caspian sea level, the brines mineralization, which will be accompanied by halite sedimentation and conditions incompatible with Artemiya life will be created, can be reached in 20-30 years in case if the sea water inflow to the bay is 20 km³, find in 5-7 years in case if the inflow is about 10 km³.

Totally for the period from 1999 til 2006 in Kara-Bogaz-gol bay about 60 species and varieties of algae from 5 division were found.

Hot spots and sensitive areas of the Turkish coasts

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Countries surrounding the Mediterranean Sea and Black Sea signed the Barcelona Convention (1976) and Bucharest Convention (1992) respectively and Turkey is the one of the contracting parties for both of them. In this content, they formed the "Mediterranean Action Plan (MAP)" and "Black Sea Environment Program" to control water pollution in the Mediterranean and Black Sea, respectively. According to Land Based Sources Protocols (LBS Protocol) of those conventions, Land Based Sources Strategic Action Program (LBS SAP) were prepared in both region. Hot spots (HS) and sensitive areas (SA) which were defined as priority areas in LBS SAP’s were determined for Mediterranean and Black Sea coastal areas.

Last ten years in Turkey, environmental, economical, cultural changes and data evaluated from UNEP MAP MED-POL National Monitoring Program and Black Sea Monitoring Program me indicated the necessity of revision of HS’s and SA’s (TÜBİTAK MAM, 2004). For this purpose, an initiative of preparing a joint project with research institutions and the Ministry of Environment and Forestry has been started.

The main targets of this project are: to review the HS and SA of the coasts of Turkey based on scientific data evaluation methods, to provide the use of newest concept, idea and technologies in order to protect ecosystem in our coastal regions and to reduce the wastewater input from land based sources; to improve the management strategy of HS and SAs; to help to achieve responsibilities of Turkey defined both in LBS SAP and LBS NAP compliance with LBS Protocols of Barcelona and Bucharest Conventions; to
contribute to effectuate improving local inhabitants’ livelihood means economically while improving their environment in a sustainable way with their participation within both HS and SA borders and also at national level; to contribute to enhancing of integrated environmental studies which is necessary in environmental sciences; to contribute to form expert teams and to raise young scientists in the area of applied marine sciences studies.

**WATER FRAMEWORK DIRECTIVE AND THE PROBLEMS OF DEFINING THE ECOLOGICAL STATUS IN TRANSITIONAL AND COASTAL WATERS**

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The European Water Framework Directive (WFD) have establish the concept of Ecological Quality Status (EQS) as a way to assess the biological quality of surface waters. The EQS will be mainly based upon the composition of different biological compartments in the ecosystem, such as phytoplankton composition, abundance and biomass, and composition and abundance of other aquatic flora and of benthic invertebrate fauna. For transitional waters, the composition and abundance of fish fauna are also included. The scientific community, together with the institutions charged with the application of WFD, is trying to develop methodologies for defining the reference conditions and the ecological status of the main water bodies in Europe. Several biotic indices are being tested and discussed for different coastal or transitional waters systems, based on some or several of the EQS compartments of the ecosystem. The results are sometimes contradictory, and a water body may be classified as being in a pristine state or in a bad state condition, depending on the methodology used. Some of the biological indices are based on the relative abundance of sensitive or less sensitive species to increasing concentrations of organic matter. But the tolerant species may also be tolerant to natural stressors such as low water renewal in estuaries or coastal lagoons, making it difficult to distinguish a naturally stressed habitat from an anthropogenic stressed habitat. In this presentation some aspects of the implementation of the WFD directive will be discussed, with special focus in the methodologies applied in the benthic invertebrate fauna compartment.

**BIOIDENTIFICATION OF XENOBIOTICS AS A BASIS OF WATER MANAGEMENT**

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We have been developing non-traditional methods of the identification of pollutants, using various hydrobionts as biological objects and the study of the mechanism of toxic action of xenobiotics. The experiments were carried out with using of *Daphnia magna*. *Daphnia magna* is a Crustacean in the order of Cladocera. This aquatic animal extensively used as a test organism in aquatic toxicology due to their small size, short life cycle and amenability to lab culture. *Daphnia magna* is the most sensitive test-object in relation of different pollutants among all known biological objects including experimental animals. Experiments were performed with a 2-days old culture of *Daphnia magna*. The toxicity of xenobiotics was determined by the value of LC50, a concentration of the compounds causing death to 50% of hydrobionts during incubation with toxicants for 24 hours. In the first stage of the work, toxicity of organophosphates (Dipterex, DFP, DDVP, Paraoxon, Malathion, Malaoxon), heavy metals ions (Hg, Pb, Cu, Co, Cd, Cr, As, Al), organochlorines (Aldrin, Dieldrin, Endrin, Aroclor, DDT, Lindane, PCBS etc.), cyanides (sodium cyanide) and pyrethroids (Cypermethrin, Fenvalerate, Deltamethrin, Permethrin, Allethrin, Resmethrin, Phenothonin, Kadeshthrin, Cyphenothrin) was determined. The effects of a number of antagonists on the toxicity of xenobiotics were studied. At the first time we discovered that in experiments to *Daphnia magna* some muscarinic cholinoreceptor blockers (atropine, amyzil etc.) reduced a toxic the effect of organophosphates. In the case of heavy metals the chelating agents (EDTA, Dithioethylcarbamate, Unithiolom, Sodium thiosulphuricium, L-Aspartic acid) were effective, for certain organochlorine
poisonings - anticonvulsive drugs (diazepam, phenobarbital), for cyanide poisoning sodium nitrite and anticyane. In the case of pyrethroid’s poisonings the antagonist of glutamate receptor (ketamine) and agonists of GABA-receptor (phenazepam, ethanol) reduced the toxicity of xenobiotics. As far as these antidotes have a specific treatment action only against definite classes of pollutants, we have elaborated the sensitive express-methods of biodiagnosis of pollutants for water management.

**HOMEOSTATIC MECHANISMS IN COASTAL LAGOONS ECOSYSTEMS: MAINTAINING WATER QUALITY DESPITE CHANGES IN USES IN THE CATCHMENT BASIN**

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Coastal lagoon ecosystems are dynamic and open systems dominated and subsidized by physical energies that made them environments with frequent physical and chemical disturbances and fluctuations. Species strategies respond to these situations according to a continuous of life-history strategies, $r$ vs. $K$. The $r$-strategy involves increased reproductive effort through early reproduction, small and numerous offspring with large dispersive capability, short life span and small body size of adults and provides a selective advantage in such unpredictable or short-lived environments. This would explain why usually coastal lagoons are between marine habitats with highest biological productivity. All this has lead to the assumption that coastal lagoons are immature ecosystems, maintained by physical constrains in an early stage of the ecological succession, showing low complexity and scarcely developed homeostatic mechanisms.

The Mar Menor is a hypersaline coastal lagoon in the south-western Mediterranean. With a surface area of about 135 km², it is one of the largest coastal lagoons on the Mediterranean coast. Waters were oligotrophic and primary productivity was mainly benthic, based on macrophytes.

In the last years, nutrient input dynamics in the Mar Menor has changed as a consequence of changes in agricultural practises. The agriculture on the watershed has experienced a deep transformation in the last twenty years by changing from extensive dry crop farming to intensively irrigated crops receiving surface waters diverted from the Tajo river, 400 km North, to Segura river, since 1986. Arrival of surface water for irrigation relaxed the aquifers overexploitation thus raising the phreatic levels and making the main watercourse on the watershed maintain a continuous flow feed by ground water to the lagoon. Due to overfertilization with nitrogen used in agriculture, nitrate levels in the water are actually ten times higher than before. Instead the eutrophication process and phytoplankton proliferation expected, the waters maintained their quality under reasonable levels due to an un-expected top-bottom control of the food web. This response of the system open new perspectives in the knowledge of structure, complexity and homeostatic mechanisms of coastal lagoons.
The Chesapeake Bay -- the largest estuary in the United States -- is an incredibly complex ecosystem. The most critical situation facing the health of the Chesapeake Bay ecosystem is not the result of a single activity. It is the combined and cumulative result of many individual activities throughout the entire natural drainage area, or watershed. The Bay watershed is an enormous 64,000 square-mile. The area supplies drinking water, provides recreation and respite, and sustains human and an abundance of fish and wildlife. The cumulative effects of all the individual actions of everyone within a watershed may be, and often are devastating to the quality of water resources and affect the health of living things including humans. Management for sustained use of water and other ecosystem resources requires a watershed based approach. A watershed approach is the most effective framework to address today’s water resource challenges. The Chesapeake Bay Program is a unique regional partnership that has led and directed the management and restoration of the Chesapeake Bay since 1983. The Chesapeake Bay Program watershed approach is a coordinating framework for environmental management that focuses public and private sector efforts to address the highest priority problems. This paper presents the basic elements of the Chesapeake Bay Program watershed approach.

MULTI CRITERIA DECISION ANALYSIS AND INFORMATION REQUIREMENTS FOR OPTIMIZATION OF BASIN MANAGEMENT

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River basins in most of the Southeastern Mediterranean countries suffer from water scarcity due to rapid demographic and economic development, urbanization, industrialization, tourism, and an often inefficient agricultural sector as the dominant water user. Low availability of renewable water, overexploited groundwater, pollution, inefficient infrastructure, pronounced seasonality with unfavorable demand patterns aggravate the situation. The Gediz River Basin along the Aegean coast of Turkey is a typical case where two major problems, water scarcity and pollution, need to be addressed for sustainable management of its water resources. The case demonstrates the entire range of prototypical water management problems in the region and their potential solutions.

The case is studied within the scope of an EU FP6 sponsored project entitled OPTIMA (Optimization for Sustainable Water Management). The proposed paper aims to present the methods and the obtained results of the project for the Gediz basin, where the current situation and possible future changes in water demand and supply are estimated on the basis of prevailing trends. A simulation based water resources planning and optimization system is developed and applied to address both quantity and quality, water demand and supply, surface and groundwater, water technologies and efficiency of use, allocation strategies, costs and benefits. A web based client-server implementation supports distributed use and easy access, and a participatory approach involving local stake holders for multi-criteria optimization and decision support. The optimization uses heuristics and concepts of genetic algorithms, based on a realistic, detailed, dynamic and distributed representation of the river basin. The underlying dynamic (daily) simulation model describes the water resources systems at a basin scale including the groundwater system for conjunctive use. The model covers the physiographic and hydrological elements, but also aims to represent the institutional and regulatory framework, and the socio-economic driving forces. The primary optimization identifies sets of non-dominated pareto-optimal solutions in heavily constrained scenarios. The multi-criteria approach covers global and sectoral demand and supply balances, reliability of supply, access, cost and benefits, including environmental and social aspects.
ISSUES ON PROTECTION OF WATERSHED SYSTEMS.
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After the collapse of the Soviet Union protection and rational maintenance of water resources demand attention as there is the decrease of state control, normative requirements, degredation of water cleaning systems. All these factors lead to the worsening of ecological situation not only in Kyrgyzstan but in whole Central Asia. Also this leads to pollution of water resourses by chemicals, change of climate, change of the structure of biodiversity, melting of mountain ice and etc.

Above-mentioned reasons and pollution of water resourses of Kyrgyzstan are also connected with worsening of the system of water supply systems. It is obvoius on the example of Issyk-Kul and Son-Kul lakes and Mayli-Say, Shakavtar, Terek-Say rivers where there is a problem with storing of wastes.

The problem of protection of high-mountain lakes of Kyrgyzstan are often percepted by some countries of the Central Asia as only covering Kyrgyzstan, however, pollution with various chemicals, waterning of territories in case of crash of artificial dumps in the mountains are a real danger for all regions of the Central Asia.

This problem demands the consolidation of efforts of these countries in order to have preventive measures worked out by representatives of all interested countries.

In the article there are given sollutions and recommendations for the improvement of ecological status and water resourses of Kyrgyzstan.

GLOBAL CHANGE AND THE STATE PROGRAMME TO REDUCE LAND-BASED DISCHARGES TO THE CURONIAN LAGOON.
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The drainage basin of the Curonian lagoon covers more than 60% of Lithuania. The state programme focused to reduce land born nutrient pollution and improve the water quality in the Curonian lagoon is discussed . The implication of global change and the efficiency of suggested measures are discussed.

CAPACITY BUILDING IN THE WATER SECTOR: THE PORTUGUESE CASE STUDY
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From 1993 Portuguese Water Sector has been through a major change, having as most important results good service coverage, compliance with regulations, economic and technical rationality as well as environmental sustainability.

Part of success relies on two particular instruments: i) the institutional arrangement (multimunicipal system) that has been implemented to build and operate the water and wastewater infrastructure; ii) Águas de Portugal, the new agent that was created by the Government to work with the old players (Municipalities), bringing new ideas, expertise and funds to local water services.

To understand the process it is important to recall that, like in other similar countries, when Portugal became an EU Member, the small dimension and financial weakness of Municipalities (that hold most legal competencies in water supply and wastewater transport and treatment) was not allowing an adequate progress to comply with EU regulations. Also investment made by most Municipalities was not showing adequate cost-effectiveness.
The creation of a multi-municipal system is a first step, when Central and Local Administration start to cooperate in a particular region. The next step will be the creation of a regional company, putting together a Government owned company (under commercial law) – Águas de Portugal (AdP) – and the local Municipalities. A contract is then signed between Portuguese Government and that new company, defining with enough detail the configuration of water and wastewater systems, the population served, the funding available, the rate structure, the services to be provided, etc. The multimunicipal system, and the regional company that will run it, are two parts of the same solution, that is perceived as a win-win situation by Government and Municipalities and, consequently, has been a relevant factor in the improvement of environment and public health indicators: 3 billion euros have been invested by AdP subsidiaries between 2000 and 2006.

Portuguese Government estimates that another 3 billion euros will be invested in the water sector between 2007 and 2013 and AdP is expected to play a major role in the process.

COMPARATIVE ANALYSIS OF WATER MANAGEMENT PRACTICES IN MEDITERRANEAN COUNTRIES
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Water resources potential exhibits an important discrepancy in Northern and Southern Mediterranean countries. The water availability and dependency of countries on external resources have shaped their water policies to a great extent. Although centralized and traditional in many instances, the Mediterranean countries are subject to mutation with regard to their legal framework and institutional structure since the adoption of regional binding documents by the contracting parties (e.g. the Barcelona Convention and its protocols) and regional actions like Mediterranean Action Plan initiated by the UNEP. Sustainable development objectives enunciated at the Rio Conference have been a driving force for the Mediterranean countries to re-evaluate their environmental policies, of which water management is considered to be the most important component. The legal and institutional framework related to the management of continental freshwater has been analyzed in Mediterranean countries with regard to water rights, the role of the State, institutions, planning, allocation, investment and cost recovery issues. After this analysis, a synthesis highlighting the major shortfalls and the corresponding solutions that the countries envisage in practice is given. This study was initiated and supported by the UNEP/MAP Blue Plan in 2000 and updated in 2005.