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NATO Committee on the Challenges of Modern Society

CCMS

Integrated Water Management

"IWM-2003"

Pilot Study

Antwerp, May 21st-24th, 2003

"Integrated Water Management"

NATO/CCMS

PILOT STUDY

Antwerp, May 21st-24th, 2003

Residentie 'tElzenveld
Lange Gasthuisstraat 45

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Preface

Integrated water management
CCMS-NATO PILOT STUDY

PREFACE

H. E. Maurizio Moreno

Ambassador
Italian Delegation to the North Atlantic Treaty Organisation

H. E. Massimo Macchia

Italian Ambassador
to the Kingdom of Belgium

All living beings depend on water. In this respect, there is an increasing awareness that water is a limited resource in terms of both quantity and quality, with several living competitors needing it. Among them, human beings and the related anthropic processes can sensibly modify the state of a water system and of the related ecosystem.

The directive 2000/60/EC has introduced specific definitions, objectives and constraints as concerns water management; these aspects that are related to different issues, such as for example water quality management, policies, economic aspects, ecology, pricing, require the formulation of a common integrated and sustainable approach to manage a water system. This need is still more evident when a water system is laid on a trans-boundary area involving different Regions and Countries.

The NATO Scientific Program, and the current European VI Framework Research Program, both address with the global problem of water management; we therefore decided to support this Pilot Study proposed by Belgium in the framework of the CCMS-NATO Program in order to underline the need to cooperate against a common threat to the very survival of our planet.

The topics covered by this first CCMS-IWM workshop address those vital aspects. The contribution to this endeavour of representatives with difference backgrounds and experiences will thus help in the search for possible solutions to these problems. One of the main expected outcome of the Pilot Study is to put the basis of methodological approaches that might guide decision makers in a sustainable integrated management of a water system.

Confirming the attention that Italy devotes to the issue of sustainable development, we have the pleasure to announce that the next meeting of the CCMS-IWM Pilot Study will be hosted by Italy and will be held in the month of January next year in Genoa, European Capital of Culture 2004.

Introductions

"The NATO Committee on the Challenges of Modern Society (CCMS): its Key Objectives and the Pilot Study on Integrated Water Management"

Deniz Beten
Head of Threats and Challenges Section
NATO Public Diplomacy Division

The NATO Committee on the Challenges of Modern Society (CCMS) was created by the North Atlantic Council with the initial aim of addressing problems affecting the environment of the nations and the quality of life of their peoples. Its activities have been expanded over the years to include Partner countries in the Euro-Atlantic Partnership Council (EAPC) and more recently adapted to take into account emerging issues to security. The member countries of the Euro-Atlantic Partnership Council are the 19 member countries of NATO, plus the 27 Partner countries. The North Atlantic Council in Ministerial Session has decided that CCMS activities should also include experts from Mediterranean Dialogue countries.

The Committee meets twice a year in plenary session and annually with Partner countries (EAPC format meeting).

The Committee provides a unique forum for the sharing of knowledge and experience on technical, scientific and policy aspects of social and environmental matters in both the civilian and military sectors among NATO and EAPC Partner countries.

After more than thirty years of successful activity, the Terms of Reference for the CCMS were updated in 2000 to better reflect the programme's adaptation to NATO's new mission.
To provide the guidelines for future work, the following Key Objectives have now been identipfied:

(a) Reducing the environmental impact of military activities;
(b) Conducting regional studies including cross-border activities;
(c) Preventing conflicts in relation to scarcity of resources;
(d) Addressing emerging risks to the environment and society that could cause economic, cultural and political instability; and
(e) Addressing non-traditional threats to security.

After restructuring of the NATO International Staff, CCMS activities will in future be administered within a new public diplomacy division which will be tasked to inform citizens and opinion formers of the international community about NATO's roles, missions and activities, and to foster mutual understanding between networks of influential people.

The CCMS pilot study on Integrated Water Management fits perfectly well in the CCMS key objective "emerging risks to the environment and society that could cause economic, cultural and political instability" and will provide the framework to exchange information and share knowledge on issues related to water management between experts of NATO, Partner and Mediterranean Dialogue countries.

"Integrated water management Rational behind the NATO/CCMS pilot study"

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Ecosystem Management Research Group, dpt. of biology
Chair of Integrated Water Management, Institute for Environmental Studies
University of Antwerp, Belgium

General introduction

The main objective of the pilot study is exchanging and combining expertise in water system research, considering different dimensions of water management and their intra and inter relations (Fig. 1). The dimension *Integration of knowledge* represents the required competences; it includes natural scientific as well as social and economical aspects, considered as basic information about the functioning of water systems and the chains of the water users, both including proces knowledge as well as a monitoring and compilation of data. The *Organizational Integration* dimension concerns all relevant competences and participation of stakeholders and means an important support for the efficiency of the water management. The *Legislative basis* dimension is the regulating basic framework including and combining all legal aspects.

The knowledge brought together by means of the pilot study, has to contribute to the knowledge of Integrated Water Management in general, including the necessary differentiation, given the wide variety of conditions in the different types of basins or watersheds. Therefore both theoretical studies on the functioning of water systems, organisation and legislation as well as specific cases are discussed.

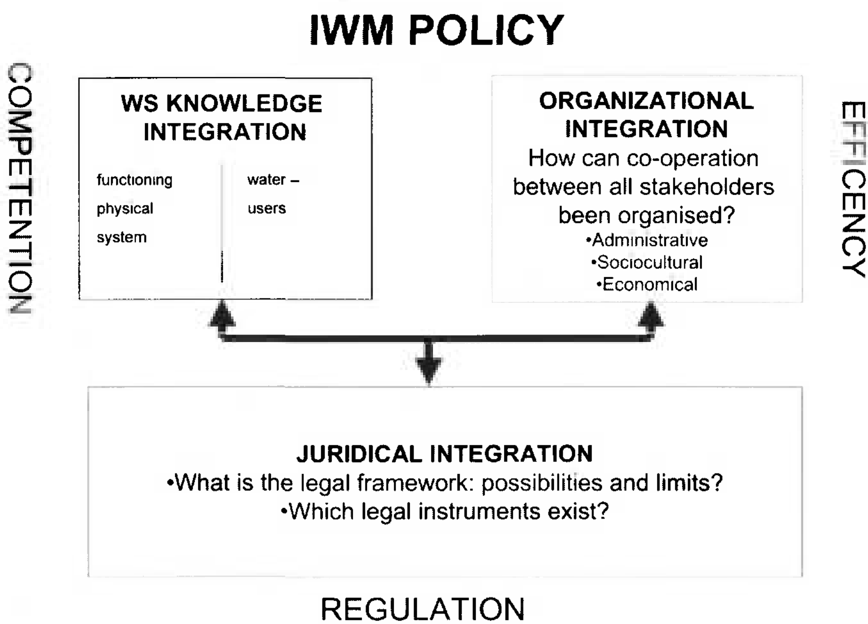

Fig. 1. Different aspects of Integrated Water Management (after Schneiders & Verheyen, 1998)

Setting the scene: a water system approach

Water is a "conditio sine qua non" for life and due to the increasing human population and our growing needs the amount of water needed is increasing steadily (Gleick, 2003). On the other hand the available water resources are declining. Furthermore, water is not only needed for man but also for all ecosystems on which man is dependant. The main question that has to be addressed is how to use and divide the available water between all users (man and ecosystems).

The water system can be visualized as a reactor, directing the precipitation through different pathways back to the atmosphere or sinks like deep groundwater. A water system is:

"a coherent and functional unity of surface water, groundwater, riverbed, riverbanks and technical infrastructure, including the occurring plant and animal communities and all associated physical, chemical en biological characteristics and processes" *(UA-VIWC, 1999, after Provincie Utrecht, 1998).*

It is clear that, in the past up till now, the water system has been changed to a large extend to fulfil our water demands. It is equally clear that the way we are using and changing our water system is not sustainable. In recent years, the concept of integrated water (resources) management has been developed. The idea behind this concept date back to the first UN conference on the human environment in Stockholm (1972), but mainly to Conference on Water at Mar del Plata in 1977. The next step was the International Conference on Water and Environment in Dublin (1992) where ideas were put forward to the UNCED conference later that year in Rio. Within Agenda 21 this was incorporated:

"The holistic management of fresh water as a finite and vulnerable resource, and the integration of sectoral water plans and programs within the framework of national economic and social policy, are of paramount importance for actions in the 1990's and beyond."

Integrated water resources management is based on the perception of water as an integral part of the ecosystem, a natural resource and social and economic good, whose quantity and quality determine the nature of its utilization. To this end,

water resources have been protected, taken into account the functioning of aquatic ecosystems and the perenniality of the resource, in order to satisfy and reconcile needs for water in human activities" (United Nations, 1993).
Uptil now, efficiency of water management was equated with maximum use of water resources by users (Calder, 1999). Environmental and ecological considerations as well as downstream users were given little attention. In a demand driven situation the response to water shortage was to augment the supplies, hence even more reducing the incentive to manage water in a sustainable way! This resulted in a severe deterioration of the natural functioning of the water system. This in turn impairs human use. The reduction of the flow e.g. can severely impact water use: it reduces the assimilative capacity and the discharge of pollutants may lead to toxic conditions and extra costs to public services for the treatment of water.
This brings us to a first crucial question: can we determine the carrying capacity of a water system and in what ways can we manage (increase) this carrying capacity?

Are we able to determine the carrying capacity of a Water System?

Carrying capacity of a watershed could be defined as the amount of water that is available for human use taking into account the amount necessary for the ecosystem so that they can still fulfil their ecosystem functions, which deliver essential ecosystem goods and services to our society (Fig. 2). How multiple use and often-conflicting demands can be brought in line with what the natural system can support?. During a long time, water management has been approached mainly (or even only) from a technological viewpoint. The water system was engineered and problems were solved technically when they appeared. River systems have been manipulated in order to fulfil functions and conditions for human activity without considering consequences, unless some local ones. As a consequence problems were delegated in space and time. In this way the carrying capacity is not considered.

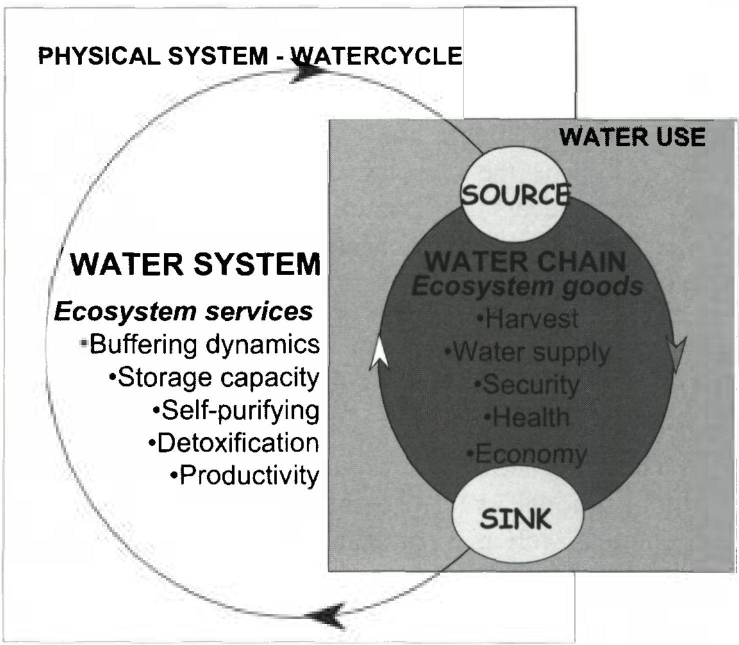

Fig. 2 The water system and the water chain (after Bergmans et al. 1999)

In order to determine the carrying capacity, a system approach is urged. Therefore we have to consider the physical as well as the biological water system and the water use processes (water chains) and their interrelations. Land use plays a crucial role

and especially agriculture and silviculture can have a pronounced impact on the availability of water. Further the different storage mechanisms as well as efficiency of water use and reuse determine the carrying capacity.
It is necessary for each water basin to create a balance between the “functioning of the water system” and “the impact of the water chain” on it. Therefore water uses should be tuned to the system and water users should change their attitude from adapting the system to the demand to adapting the use to the supply limits of the system.

Development of river basin plans
If we can determine the carrying capacity how can we then ‘translate’ the necessary conditions into planning and management? River basin management plans are the crucial instruments synthesising the different choices made. How to make theses choices?
Pricing may be a good approach. Sustainable development, protection of biodiversity, and the stand still principal are environmental principles that can influence the water system directly. The precautionary principle, a source oriented approach and rational water use should have an influence on the water chain as well as welfare and the human perception on the water system.

Main objectives of the first workshop

1. Getting an overview of the state of the art in the different countries
2. Defining objectives of the study (general + coming workshops)

3. Publication and dissemination of contributions and results
4. Methodology and planning

Getting an overview of the state of the art in the different countries

The first workshop aims to compile an overview of the policy concerning Integrated Water Management in the different countries, regions and relevant international legislation or agreements.

The main geographical regions that will be represented are North America (Canada and US), Central Asia (Aral and Caspian region), Southern Mediterranean and Europe. The Southern Mediterranean is considered apart since it concerns the region with the highest water stress in the world (European Commission, 2003).

Basins in other parts of Asia, Africa and in Latin America are not represented, but can be of importance in development projects.

Objectives

During the final workshop of the pilot study *Methodology, Focalisation, Evaluation and Scope of Environmental Impact Assessment*, directed by prof. R. F. Verheyen (Borràs et al. in Verheyen et al., 2002), participants agreed that water management of water systems need specific interest and that the complexity of the functioning of water systems with all related aspects requires a multidisciplinary approach. Topics that acquired specific interest were approaching basins and watersheds as a system, transboundary aspects, sustainable use of water systems, criteria to assess a water system, including indicators defining the carrying capacity of water systems. Therefore information on the functioning of water systems is a key element.

According that pilot study the following topics acquire specific interest:

- Approaching basins and watersheds as a whole, integrating knowledge in the field of natural sciences, social and political sciences, economical sciences, and considering the legal frames.
- A better integration between water protection objectives into other policy areas, especially agriculture, infrastructure and land use planning.
- Transboundary aspects, focussing on the difficulties met by the difference between geographical borders on one hand and political and administrative borders on the other hand. Water resources should be the cause of instability and even wars, and in more 'stable' conditions would be a source of mutual understanding, and sustainable development for neighbouring regions and countries.
- Rational protection and use of water systems considering also the quality of the ecosystem and respecting self – supporting needs for the functioning of a water system. Rational use includes also that the real price of water is considered, through reducing water treatment costs, increasing amenity value of surface waters and to a much more co-ordinated administration of waters. The ultimate benefit, of course, is that the sustainability of water use will be ensured.
- Promoting a transparent and participatory water management, which is not based purely on technical expertise or bureaucratic decisions, but one that takes better account of the actual needs of citizens and environment.

- Promoting the use of financial incentives for better environmental protection and the phase out of perverse subsidies.
- Criteria to assess a water system, including indicators defining the carrying capacity of water systems. Therefore information on the functioning of water systems is a key element.
- Water in general became an important policy item during the 1990s. The fundamental importance for food production, human health, poverty alleviation, ecosystem protection and regional peace and stability is recognised more and more by different international commissions, conferences and networks and has lead to international initiatives and to important developments.

Different international initiatives have been undertaken. This pilot study aims to focus on the way they are implemented in different countries and / or regions. The pilot study is not a research project, but aims to formulate conclusions derived from exchanging and discussing information and ideas. The added values of this pilot study are

1. the bringing together of a network of researchers, as well as policy makers as practitioners and
2. the sharing and exchanging of experience in different basins.

Both aiming to bring together different disciplines and policy fields. The cases will make clearer what can be shared and what makes absolutely a difference from one basin to another.

Methodology and planning

The pilot study addresses to specific issues, requiring an integrated approach. Therefore the pilot study participants

work alternately during plenary meetings and in working groups. The working groups are organized according the agreements made on the first workshop.
Each working group stresses on given topics, taking into consideration possible common grounds with other working groups. Case studies and theoretical research are the subject of discussion. Participants belong to research institutes, universities, governmental authorities and non-governmental organizations (NGOs).
Exchange of information and discussions mainly takes place during workshops. The pilot study will last three years. Two workshops a year will be organised, combining plenary and working group activities.
During the first workshop the participants met plenary: the expected outcome, as well as the issues and cases that should be addressed were defined more specifically. Working groups were formed and a detailed working plan has been developed.
Each working group prepares the theme for the next workshop. A working group leader coordinates the preparation and delivers a discussion text, a selection of cases and a program.
The next workshops will be partly plenary, including also separate working group meetings and an excursion to a relevant case. Therefore workshops should be organized at different basins.

Participating countries

Members of CCMS
Belgium, Canada, Greece, Italy, Luxembourg, the Netherlands, Norway, Poland, Portugal, Spain, Turkey

EAPC partner countries
Azerbaidjan, Estonia, Georgia, Latvia, Lithuania, Romania, Slovakia, Slovenia

Mediterranean dialogue
Morocco

Cooperation with other CCMS pilot studies
Environmental Decision-Making for Sustainable Development in Central Asia.

Coperation with international organizations
UNESCO - IHP – HELP (Hydrology for the Environment, Life and Policy), Joint Research Centre - Institute for Environment and Sustainability Land Management Unit

References

Bergmans A., M. Coenen, P. Konings, I. Loots, P. Meire, A. Schneiders, M. sys, P. Van Bockstal, J. Van de Welle, R.F. Verheyen, 1999. *Integraal Waterbeheer in Vlaanderen: concept, metodologie en structuren.* In opdracht van het Vlaams Integrala Wateroverlegcomité, Universiteit Antwerpen.

Boràs S., M. Coenen, N. Grishin, J. Kriauciuniene in Verheyen R.F., M. Coenen, edited by T. Baum, 2002. *Methodology, Focalization, Evaluation and Scope of Environmental Impact Assessment. Final Report.* NATO/CCMS Report No. 260.

Calder I.R. 1999. *The Blue Revolution.* Earthscan Publications Ltd., London.

European Commission 2003. *Water for Life.* http://europa.eu.int/comm/research/water-initiative/index_en.htm).

Gleick P., W.C.G. Burns, E.L. Chalecki, M. Cohen, K.K. Cushing, A. Mann, R. Reyes, G.H. Wolff & A.K. Wong 2003. *The World's Water 2002 - 2003. The Biennial Report on Freshwater Resources.* Island Press, Washington.

Provincie Utrecht, 1998. *Definitienota tweede waterhuishoudingsplan.*

Schneiders A. & R.F. Verheyen, 1998. 'A concept of integrated water management illustrated for Flanders (Belgium)' *Ecosystem Health*, Vol. 4, no 4, December 1998, Blackwell Science.

United Nations, 1993. *Agenda 21*, Chapter 18, paragraphs 18.6 and 18.8.

"Integrated Water Management policy The river contract in Wallonia, an experience of a participatory water management"

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Premier assistant
Fondation Universitaire Luxembourgeoise

Placing a river under contract is the challenge taken up by the Walloon Region over the past ten years. Under this scheme, both government and private-sector players commit themselves by means of a contract to implement a programme to restore the river and its drainage basin's water resources. The river committee is a place for democratic speech in which the familiar rubs shoulders with the institutional, where citizens meet operators, where the life forces of society are finally brought together to take charge of their river's future and their relationship with the river.

This new mobilisation of forces along the waterway plots the course toward sustainable development on the scale of an entire subdrainage basin. It goes beyond the river to become a broader discussion of the way a community treats its environment. This exchange of ideas gives rise to a workable management tool that eventually leads to action programmes whilst factoring in all of the users' concerns.

1. The river contract in parallel with traditional management

Given the stakes riding on the future of water in Wallonia, new demands have arisen over the past ten years. These demands, which have been made by various players in the water sector but also by the life forces of civil society, led to the perception that there was a need to break with the traditional water management approach. Two of these new demands strengthened the desire for a new approach based on concerted action and consultation, namely,

- the increase in the number of uses of water, especially in the recreational sector, which increased pressure on the Region's water resources by creating user conflicts; and
- the population's increasing sensitivity to the various problems linked to water quality and environmental protection. This awareness, which has risen with the rising price of water, has led users and civil society to demand that they participate in water-resource decision-making.

This is the context in which the first river contract experiences in Wallonia got off the ground, proposing innovative management based on concerted action and discussion in partnership with the government and private entities active in a subdrainage basin. Information gleaned in France, where river contracts have existed since 1981, guided the first coordinators grappling with recognition of this new management tool on Wallonia's institutional landscape. Four trail-blazing river contract projects were thus developed in the early 1990s.

Following these first experiences and the enthusiasm that they generated around other watercourses, official recognition of the scheme was granted via the ministerial circular of 18 March 1993 concerning the conditions of acceptability and rules for drawing up river contracts in the Walloon Region. Henceforward, river contracts are part of the institutional landscape characterising water management in Wallonia. They exist in parallel with extant legislation. By setting a legal framework for implementing the river contract, the circular makes this approach 'official' in Wallonia. Since then, all new initiatives must abide by the terms of this circular. As stated in the circular, the river contract is defined as a 'protocol of agreement among all of the public and private players concerning objectives aimed at striking a balance amongst the many functions and uses of watercourses, their approaches, and the water resources of the drainage basin'. A new circular issued on 20 March 2001 reinforces this approach by giving it a long-term perspective and including the river contract in the Walloon regional government's Walloon Water Plan and subcatchment-area approach.

The river contract development approach consists of five phases (see Figure 1). The partners committed to the contract are assembled in a river committee that decides, on the basis of consensus and without constraint, a programme of action to be carried out by each of the signatories to the contract in line with his responsibilities.

PHASE	Length	Entities concerned	Documents generated
1. START-UP	from 6 months to 1 year	Initiator Municipalities Province(s) Walloon Region	Preparatory file
2. APPROVAL OF THE STUDY AGREEMENT	6 months	Water Minister Municipalities Project's author Appointee	Study agreement
3. EXECUTION OF STUDY AGREEMENT	3 years	River Committee (working parties) Project's author	Charter Draft river contract
4. SIGNING OF THE RIVER CONTRACT		River Committee	River Contract
5. MONITORING	12 years max.	River Committee	Annual follow-up report Review every three years

Figure 1. Steps in drawing up a river contract in the Walloon Region.

With the sixteen ongoing projects and projects in preparation, 42.9% of the territory of the Walloon Region (7,221 km²) and 48% (127) of the Region's 262 municipalities are now concerned by a river contract. This corresponds to a human population of 1,240,900 (or 37.9% of the total population of Wallonia).

The originality of the Walloon river contract model's methodology is visible primarily in the degree of consultation, concerted action, and consensus-based decision making, but also in the way that expertise is organised.

2. Concerted management and consensus-based decision-making

The consensus building approach can yield valid results only if a certain number of technical, administrative, and human conditions are met first. The consensus-building procedure must be able to make use of the following, regardless of the level on which it takes place: an area for dialogue amongst all of the public and private players linked to the water sector, allowance for the natural functions and uses of water, ecosystems management of service water seen through various levels of relations, integrated management that lies between regional planning and development and water management, a drainage basin approach, greater accountability of the users themselves, and more democratic and transparent management, in order to stave off conflicts. What is more, we notice among the committed partners the attraction of the novel experience of testing an original approach, the voluntary, non-compulsory nature. [of what], the improvement in their images, and the opportunity to extend their network of relations, as well as the wish to and satisfaction gained by participating in a new dynamic of development.

This type of approach is nevertheless not free from difficulties such as:

- the resurgence of conflicts as soon as the protagonists are allowed to express themselves, for the river contract increases contacts and thus the chances of clashes;
- the risk that institutions will feel less responsible, for the municipalities, which the circular makes out to be the prime partners, usually are not the 'locomotives' that they are expected to be;
- the difficulty that some – primarily public – partners have integrating the spirit of the approach into their usual decision-making culture, even though the consensus building procedures that have been defined officially in the decree of 1997 and circular 71 govern their functioning. These texts do not mention the 'river contract' echelon;
- the notion of concerted management is sometimes poorly defined. It is a decision or an opinion? Are they reached unanimously or by a simple majority of the members? Who ultimately holds the decision-making power? What about possible recourse and appeals? Isn't consensus building reduced in some cases to wheeling and dealing between managers who are no longer able to shoulder their responsibilities?
- Isn't there a risk of losing sight of the purpose (the heart of the problem) whilst focusing on the form (an agreement reached through consensus building is not necessarily a good agreement!)?
- the lack of validation, verification, and analysis of the way of functioning is felt.

3. The river contract's outcomes

The river contract is not limited to meetings with no tomorrow. It produces social and environmental effects daily.

A river contract's starting point is based on the fact that the people express a feeling of belonging to a watercourse and cultural attachment to a valley and agree on a philosophy and future goals. By identifying the stakes, tensions, even sometimes conflicts, the users feel that they are concerned by water to the highest degree. The river contract makes it possible to transcend a one-time stake linked to a local water use in favour of a comprehensive drainage basin approach. The stakes and tensions are apprehended by all of the players as a group. However, the river contract demands more than feeling concerned. The future partners must also subscribe to the consensus-building approach that it relies on.

On the environmental front, the contract gives rise to a holistic ecosystems approach and respect for the ecosystem's completeness. This integrated management is achieved as soon as all of the representatives of the various sectors are included in the decision-making. The solutions that are adopted in the resulting action programmes allow for technical, natural, manmade landscape, social, and other aspects that come to light during the consensus-building phase.

The contract triggers new dynamism and motivations in the partners. Besides the improved knowledge and more frequent reliance on expertise that the river contract produces, it also contributes by giving rise to a range of new activities that reflect all of the assets that the partnership encompasses. It can also reactive specific projects and accelerate the implementation of previously adopted decisions.

4. Conclusions and prospects

The Walloon Region's ten years of experience of the river contract has made it possible to assess how appropriate this tool is for sustainable water managed based on locally organised participatory management. Specifically, this asset management approach applies primarily to the management of watercourses and aquatic environments that are considered to be part of a heritage to bequeath to future generations. Allowing for the entire river ecosystem reveals this heritage's greater value. Water is seen as a homogeneous element and a common asset of all of the players.

The Walloon model of the river contract, which moreover has the international recognition of the OECD and the *Académie de l'Eau*, is one of the tools made available to Wallonia to implement successfully the new 'European Water Policy' (Framework Directive), in which the drainage basin approach is enshrined. The first step will be to continue assessing these contracts and to make optimal use of this know-how by including it, as a management reference, in the implementation of the subdrainage basin plans that the Walloon Region has underwritten. In the wake of the river contract experiences, nothing will be as it was before and Wallonia's decision-makers will have to allow for this in their political choices.
These local water management experiences could be shared with other Member States that use this type of approach.

Pooling information and exchanging know-how about integrated water management can only enhance the opportunities that the Framework Directive offers to subscribe to participatory management. This trend could be crystallised by more explicit commitments by the EC's Member States when the directive is transposed into their national laws.

References

Rosillon F. (2001), Vers le développement durable dans le domaine de l'eau : apports d'une gestion locale et participative. Application à la gestion de l'eau en Région wallonne à travers l'expérience des contrats de rivière. Thèse, FUL, Arlon, 271p + annexes.

Tricot B., Lejeune A., Nuttens B., Rosillon F., Vander Borght P. (2001), Guide méthodologique relatif au contrat de rivière. MRW, DGRNE, Direction des Eaux de surface, 72 p.

Website on the river contracts in Wallonia :
http://environnement.wallonie.be/contrat_riviere

"Water Policy and Management in the Flemish Region, Belgium"

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The Belgian government is structured in a Federal State, the Communities and the Regions, all three of which are equal from the legal point of view, but they have different responsabilities. The Communities are based on the concept of "language" and language is "dependent on the individual". The associated powers are culture, education and the use of languages. The Regions are a geographical subdivision of the country. They have the responsability for most aspects of the water policy and this is associated to the ministers of transport and environment.

This paper gives a brief overview of the latest developments in the organization of the water policy in the Flemish Region. The implementation of Directive 2000/60/EC from the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (WFD, Official Journal of the European Communities L 327/1-72, 22.12.2000) has played an important role in accelerating recent developments in Flanders. The water policy and water management will be approached at different authority levels.

International River Basin level

In December 2002, the Schelde and Meuse treaty wassigned by the ministers responsible for water policy in the riperain states of the International River Basins Schelde and Meuse. The Flemish region is part of both these International River Basins. These treaties resulted from implementing the WFD requirements into a former treaty, established in the framework of the Council Decision 95/308/EC of 24 July 1995 on the conclusion, on behalf of the Community, of the Convention on the protection and use of trans-boundary watercourses and international lakes (Helsinki Convention, Official Journal of the European Communities L 186, 05.08.1995). The Convention was signed on behalf of the European Community in Helsinki on 18 March 1992. It establishes a framework for cooperation between the member countries of the United Nations Economic Commission for Europe on the prevention and control of pollution of trans-boundary watercourses by ensuring rational use of water resources with a view to sustainable development. The River Basin Management Authorities are organized in International Commissions in which delegationleaders of the riperian countries have seats. The presidency for the operational and strategical coordination is taken alternately by the different countries. The technical and scientific support is organized in working groups. NGO's and external experts have an advisory voice. With the input of the riparian states the International Commissions are responsible for delivering a first International River Basin Management Plan in 2009, which has to be redrafted with a frequency of six years.

Flemish Integrated Watermanagement Committee

In Flanders water management and policy are spread among more than ten different authorities. Moreover the water systems are confronted with high pressure from a densely populated region and multifunctionlaity is required. Aiming to integrate these numerous and different actors in 1996 the Flemish Integrated Water Management Committee (VIWC, VIWC 2003) was created. The VIWC is a platform for exchange of information, discussion and cooperation between all relevant actors involving water policy and water management. Actually administrative reforms are planned. According to the reforms, the VIWC will be restructured into the Coordination Commission for Integrated Waterpolicy (CIW), responsible for coordination and planning for the government. Three ministers should share the competentce for water policy, as there are the minister of environment and nature, the minister of transport and the minister of spatial planning, but one minister should be responsible for coordinating and planning the water policy.

Parliamentary act on Integrated Water Policy

In July 2003 the Flemish Government passed the Flemish Parliamentary act on Integrated Water Policy (IWP-act). This act regulates the management levels, the organization and planning as well as the instruments for the water policy in the Flemish Region.

Organization and planning

Four management levels can be distinguished : the International River Basin District, the Flemish Region, the subbasins and the sub-subbasins. According those management levels, an organization structure has been developed (Fig. 1). The regional government participates as riparian state in the

International River Basin District. The CIW coordinates the functioning of the subbasins and integrates the subbasin managementplans for the IRBMP. According the IWP-act river subbasin management plans (RSBMP) should be available by 2006 for each subbasin in Flanders. These subbasin management plans can serve as building units for the international river basin plans and should be authoritative for the development of local water management plans.

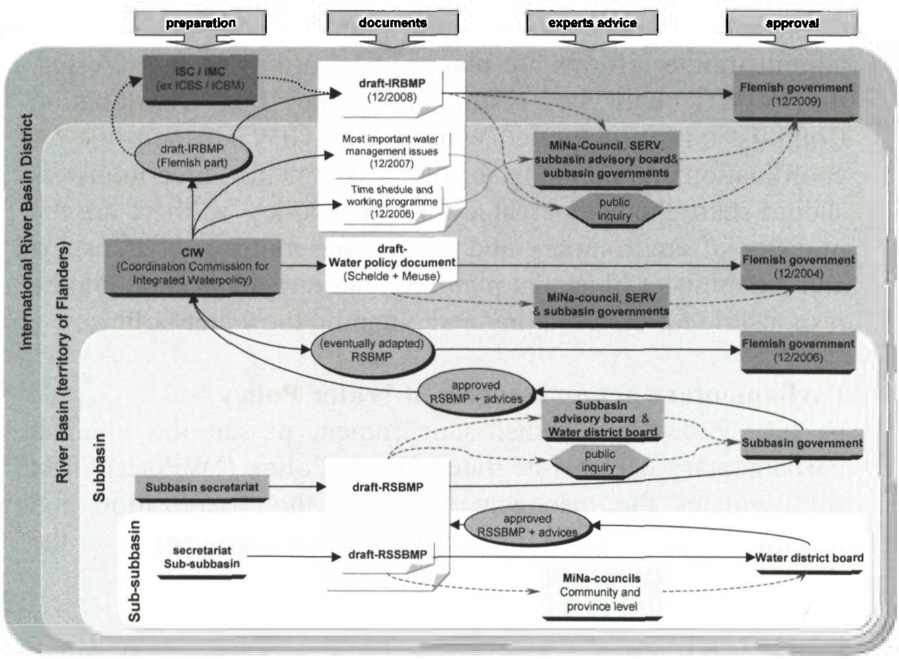

Figure 1 Schematic overview of the water policy structure in Flanders (Van Bockstal, 2003)

The subbasin authorities will be organised in a subbasin government (with decision rights), a subbasin advisory board

(with an advisory role) and secretariat (which will prepare the RSBMP and all required documents and reports).
For one or more sub-subbasins a water district board will be established and plans have to be developed fitting into the framework of the corresponding RSBMP.

Instruments
Three important instruments are introduced; 'water test', 'riparian zones' (oeverzones) and 'acquisition of land'. The watertest includes that the competent authority for a building application has to consider the water system, more precisely the existing RSBMPs have to be taken into account. The building licence will be delivered including conditions for infiltration of precipitation and for room for the river. In order to respect the natural working of a water system or for protecting nature or for protection against erosion or for protection against run off of sediments, pesticides, nutrients, riparian zones are defined in a basin plan or sub basin plan. Within these zones specific measures have to be respected.
Different scenarios of acquisition of land are possible when room for the river is needed or when houses are built in zones designated as problematic regarding the water system.

RSBMP
A RSBMP is actually being developed and applied in a pilot basin. The general approach is being represented in a schematic overview in figure 2. Of crucial importance in the adopted methodology is the development of 'Opportunity Maps for the Water System (OMWS). Each OMWS has to reckon with the requirements of the water system on one hand and to prevent overloading of the self-regulative capacity on the other hand.

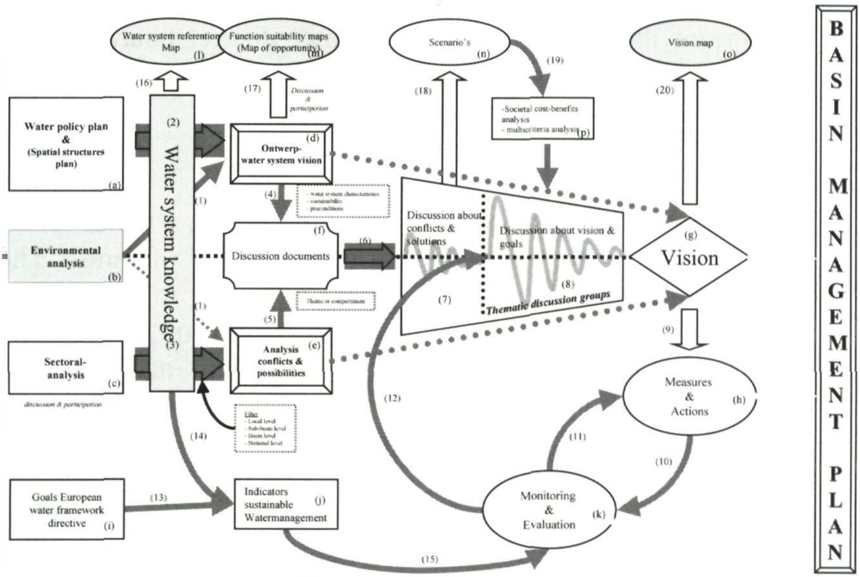

Figure 2 General methodologies for the development of a sibbasin managemnt plan (Staes et al. 2003)

Therefore boundary conditions are investigated by mapping the different major elements of the water system (Staes et al. 2003). At the time of redaction the OMWSs are discussed with the different sectors in order to figure out where the sectors meet conditions that are suitable for their activities. Afterwards the OMWS and all gathered information will be handed over to working groups of experts. The experts together with the policy makers and accompanied by an intensive particpation of all sectors will build a realistic vision. The drawing up of an action programme should be the first step towards the accomplishment of the developed vision (Staes et al. 2003). This pilot project will lead to general guidelines for the development of all RSBMPs in Flanders.

References

De Regeringen van het Koninkrijk België, het Brussels Hoofdstedelijk Gewest van België, het Vlaams Gewest van België, het Waals Gewest van België, de Franse Republiek, het Koninkrijk der Nederlanden, Gent december 2003, *Scheldeverdrag.*

De Regeringen van de Bondsrepubliek Duitsland, het Koninkrijk België, het Brussels Hoofdstedelijk Gewest van België, het Vlaams Gewest van België, het Waals Gewest van België, de Franse Republiek, het Groothertogdom Luxemburg, het Het Koninkrijk der Nederlanden, Gent 2003, *Maasverdrag.*

Flemish Government, 18 July 2003, *Flemish Parliamentary Act on Integrated Water Policy.*

Official Journal of the European Communities L 186, 05.08.1995, *Helsinki Convention.*

Official Journal of the European Communities L 327/1-72, 22.12.2000, *Directive 2000/60/EC from the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.*

Staes J., R. De Sutter, M. Coenen, K. Buis, A. Lust & P. Meire, 2003. 'Methodology for the development of river subbasin management plans: concept and application' in *River Basin Management II,* Series: Progress in Water Resources Volume 7, ed. by C.A. Trebbia, WITpress, Southampton, 524 p.

Van Bockstal P., 2003. *Organization and planning of Integrated Water Management in Flanders.* Minutes of the Flemish Parliament, 9 July 2003.Vlaams Integraal Wateroverleg Comité, http://www.viwc.be, July 2003.

"Introducing of IWM in Bulgaria"

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Historical aspects

European Water Policy Water Legislation (WL) is one of the most regulated areas of the EU ecological legislation. *The early years* of European Water Policy (EWP) started in the 70ies of the 20^{th} century with the first environmental program in 1973. The *First Legislative Wave* included the legislation related to the water quality standards used for different purposes. The Directives for quality of surface water intended for drinking water supply, for bath water quality, for water to support fish species life, for shelf water and for groundwater were issued. The Directives for quality of drinking water and for hazardous substances with its associated seven Directives for different substances, comprise sections concerning the water were issued too. *The second legislative wave* in the 80ies and the beginning of the 90ies on a review of the legislation, the shortcomings were identified and the necessary improvements were pointed out. The Directives for urban wastewater treatment and for the nitrates refer to this phase. Later, on the revisions of the drinking and bathing water Directives an Action Program for groundwater was developed, and a proposal for ecological water quality Directive was made. The Directives to protecting water against pollution, the Directives for the big accidents, for IPPC, for the birds and EIA were developed: In the further development of EWL the "combined approach" to water quality assessment was adopted in which were defined emission norms and water quality standards. Although a broad discussion some later, no significant improvement was achieved. To overcome the problems the EC accepted ***a proposal for Water Framework Directive (WFD) in 1997***. The requirements of WFD ensued from the necessity of IWM within the frameworks of River basins (RBs)**. *WFD became a reality in 2000*.** Practically the idea of RBs management is very old. It has arisen as early as in 1165, in Europe (Germany).

Bulgarian Water Policy *The first modern water legislation* was started *in 1920* when the *Law for Water Syndicates and the General State Program for Water* was enforced. *This program was developed on the basis of the RB principle*. The *Law of Water Economy* ceased the activity of the water syndicates *in 1953* but the state continued the construction of water systems and equipment according to this program in the course of more than 10 years. The water economy activity planning according to RBs was stopped in the 80ies and an attempt for *planning according to administrative units* was made. This approach turned to be *unsuccessful*. Later on, water management was treated not only in the first Bulgarian Water Law (BWL) issued in 1969, but also in all Laws related to water use and protection. *The BWL was amendment in 1977, 1984, 1986 and 1987.* ***Actually the process of real reform start in 1997 when the EC accepted a proposal for WFD.***

The New Water Legislation in Bulgaria

The Water Low *New BWL was published in 1999 but was enforced in 2000. The modification and riders of this new BWL were already made twice.*

The new aspect in the BWL is the zoning in four main RBs:

1. *Danube region* comprises the catchment areas of the eight Danube River tributaries on the territory of Bulgaria.
2. *Black Sea region* comprises the catchment areas of the rivers mouthed into the Black Sea from the northern to the southern border of the country.
3. *The East Aegean region* comprising the catchment areas of the Maritza River and its tributaries Toundzha and Arda Rivers. These rivers form a part of the Maritza River international basin in cooperation with Greece and Turkey.
4. *The West Aegean region* comprising the catchment areas of the Mesta and Strouma Rivers. The Mesta and Strouma Rivers, flowing in Greece, form an international basin in cooperation with Greece

In accordance with the BWL the IWM on the territory of the country *should be performed on a national and basin level.*
The management on a national level is performed from the Ministerial Council, Ministry of Environment and Water (MEW) and Supreme Consulting Council for Water. *The management on the basin level* will be performed by:

- *Basin directorates* to the MEW;
- *Basin councils* of the basin directorates.

The Regulations *Twelve Regulations that will assist the implementation of BWL were completed* according to the requirements of the agreements between EU and Bulgaria during the last two years.

Actual activities forward the implementation of WFD

Performed projects *To be assisted the process of the WFD implementation in Bulgaria a number of projects that are crucial have been developed,* as follows:

1. Strategy for unified water management in Bulgaria (1997);

2. National strategy for development of the water resources and for water protection (1998);
3. National program for construction of WWTPs (1998);
4. General schemes of water resources utilization in the river basin management districts (2000);

Also many other projects for all RBs and districts on the territory of the country have performed recently.

Current and forthcoming projects

1. Development of GIS of the water resources networks, imission and emission in the regions for basin management of water;
2. Development of RBMPs in Bulgaria in the range of the basin management of water;
3. Establishment and strengthening of the Bulgarian water authorities. The project will help to follow the rules of WFD and to have better understanding of Bulgarian situation;
4. Institutional strengthens at national and local levels for the implementation of drinking water Directive

Conclusion

- ➢ The basic law, regulating IWM, has been enforced in Bulgaria. This law corresponds entirely to the requirements of WFD for Integrated Water Management in River Basins;
- ➢ The regulations that correspond to the EC Directives and will contribute to the full action of the BWL have been developed and issued;
- ➢ All the obtained information and results from the considered projects could be used as a basis for the development of methodologies and guidance, and for development of the RBMPs;

- The process of WFD implementing in Bulgaria has just begun and a number of questions should be answered.
- Some factors affect on the application of EU Directives. For instance, such as the vaguenesses and administrative barriers before the business, and the lack of dialog between the administration and the business, and the science. The other factors are connected with the Handbook statement. It is not so clear, internal connected and consecutive, and should be developed, and make more precise.

"Integrated Water Policy in Canada"

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Canada is the second largest country in the world by land area and is governed as a confederation of geo-political divisions of 10 provinces and 3 territories (National Library of Canada, 2001). Canada is often described as a "water-rich" country, as it has 20% of the world's freshwater, 9% of which is renewable (Environment Canada, 1987). Nearly 60% of the freshwater resources drain northward and away from the major population centres (fig.1). Issues such as drought and pollution are increasing pressures on an already heavily used system (Macmillan, 1990). This interesting paradox between abundance and exploitation describes the fundamental need for a mechanism to protect Canada's water resources and to allocate supplies equitably among users (Environment Canada, 1987).

This paper presents the attempt at integration of water policy and water legislation from the community level up to the federal level across Canada. The federal water policy is described as well as some of the national water-related legislation. These policy statements and legislative guidelines provide the baseline information for decision making for the provincial governments. In Canada, most of the jurisdictional rights and arrangements for water use are controlled by the provinces; the province of British Columbia is used as an example to illustrate provincial water management. Within

British Columbia, the Fraser Basin provides an ideal case study, as the river flows through a diverse natural landscape with a number of different stakeholder groups and a variety of land use types. The Fraser is also one of many bodies of water in Canada that fall into the framework of transboundary waters. Issues and management of transboundary waters are presented from a Canada-wide context. Finally, the current and future focus areas for Canadian water management are presented to summarize the direction suggested for all levels of government to become more proactive and sustainable.

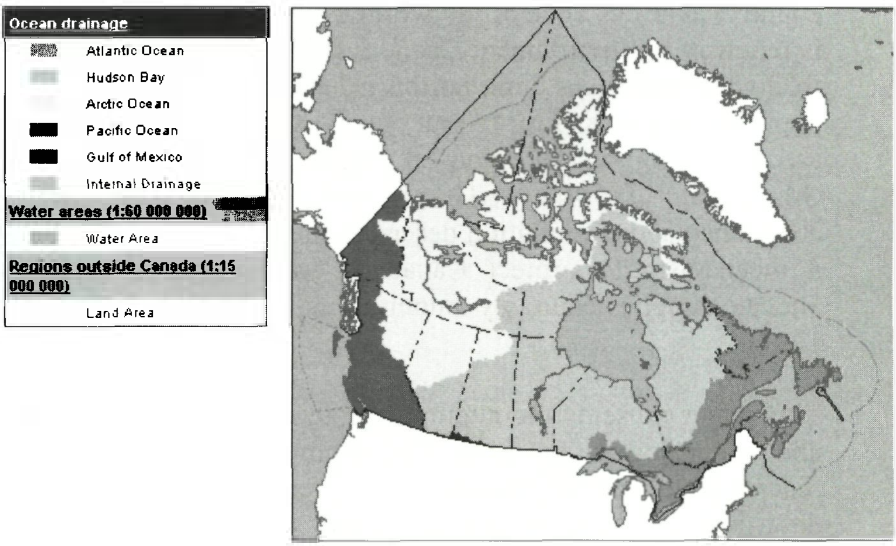

Figure 1. Canadian drainage map (Natural Resources Canada, 2003).

Federal Water Policy and Legislation

"To encourage the use of freshwater in an efficient and equitable manner consistent with the social, economic and environmental needs of present and future generations" Federal Water Policy Objective (Environment Canada, 1987).

The current federal water policy in Canada was written following a series of consultations and reports generated in the 1985 "Inquiry on Federal Water Policy" (Pearse et. al., 1985). The purpose of the inquiry was to identify and delineate the goals and actions of the federal government, particularly in areas such as information, expertise, technology and public awareness. The Canadian government considers water an "undervalued and neglected" resource and has set the policy objective, two specific goals, five strategies, and twenty-five specific policy statements in order to demonstrate its commitment to the concept of a fair value for water. Under the policy objective written above, the two goals of the federal government are to: 1) Protect and enhance the quality of the water resource, and to 2) Promote the wise and efficient management and use of water. In order to achieve these goals, general courses of action or strategies are identified in the areas of water pricing, science leadership, integrated planning, legislation, and public awareness (Macmillan, 1990). These five strategy areas are then further delineated into specific policy statements, including examples such as "Management of Toxic Chemicals", "Interbasin Transfers", and "Hydroelectric Energy Development" (Environment Canada, 1987).

The federal water policy is aligned to enhance and compliment much of the already existing legislation. It has been influential in the design of new legislation. The Canada

Water Act (Environment Canada, 1970) is the primary federal Act relating to water. It's two main functions are to define federal-provincial arrangements and to clearly define water quality management. Newly passed is the Canadian Environmental Protection Act (Environment Canada, 1999) and between these two pieces of legislation, a full set of Canadian Water Quality Guidelines have been established for both federal and provincial use (Environment Canada, 2003a). In addition to these key Acts, there is also legislation that directly and indirectly influences Canadian waters, such as the Fisheries Act, Navigable Waters Protection Act, Arctic Waters Pollution Prevention Act, and the Dominion Water Power Act (Environment Canada, 2003b).

It is clear in the legislation that the federal government has jurisdiction over navigation and shipping, inland and ocean fisheries, as well as transboundary waters. The federal government also has proprietary rights to water on any federal lands such as parks and native reserves. However, the Water Act of 1970 gives the provinces proprietary rights over domestic and industrial water, agricultural irrigation, pollution control, power generation, and recreational use. From the citizen's perspective, the provincial government exerts much of the control over their water quality and allocation.

Water Management in British Columbia

In British Columbia (BC) all water that is not on federal lands is owned by the province. The provincial government has a very important management role as BC has some of the highest quality water in the world. The diversity of the landscapes in BC are vast, ranging from coastal zones, to steep mountainous terrain, to semi-arid plateau lands, and a resulting diversity in water forms and quality (MacPherson and Tollefson, 2001). In British Columbia, permission to use surface water with a licence or lease must be approved under the BC Water Act, which is partner legislation to the Canada Water Act (Ministry of Water, Land and Air Protection, 1996). The Water Act is the chief provincial law controlling the use of freshwater. It regulates water withdrawal through a licensing system, with approvals granted through the provincial Water Management Branch. Each licence is determined by the water-use category, and the pricing is established as a rental contract. Examples of some of the price categories are given in table 1.

Table 1. Pricing of water in British Columbia (Land and Water British Columbia Inc., 1999).

USE CATEGORY	CONDITIONS	ANNUAL RENTAL ($)	APPROX. PRICE (1000 gal/yr)
Domestic	Up to 1000 gpd* Additional 500 gpd	$19.00 $9.50	5.2¢
Waterworks Local Authority	20 000 000 gpy Additional 100 000gpy	$140.00 $0.70	70¢
Irrigation	By local authority, 50 feet/yr By other, 40 feet/yr	$25.00 $22.00	0.0005¢ 0.00055¢
Pulp Mills	Each CFS	$382.00	20¢

*gpd = gallon per day, 1 gallon = 3.78 litres

The BC Water Act incorporates the federal standards for the protection of water quality and habitat. According to the Act, the primary drinking water quality standard is a specific coliform bacteria level, with other standards determined on a case-by-case basis (Christensen and Parfitt, 2001). Disinfection is required for all drinking water, testing is discretionary, although results must be reported to the provincial government, and public notification of health threats is required. These operational protocols have been relatively successful in providing citizens with clean and safe drinking water. However, some of the weaknesses evident in the current system include a lack of training and certification for operators and a lack of inclusion of groundwater resources into the legislation (Christensen and Parfitt, 2001, MacPherson and Tollefson, 2001). Fortunately, there are several other pieces of legislation that influence water use and management; these include the Forest Practices Code, the Community Watershed Guidebook, the Municipal Sewage Regulation, the Waste Management Act, the Safe Drinking Water Regulation, and the Health Act (Ministry of Management Services, 2003).

Case Study: The Fraser River Basin, British Columbia

The Fraser River Basin is an excellent river system for a case study of Canadian water management. It is one of the largest rivers in the country, drains 25% of the province, and is directly or indirectly accountable for 80% of the gross domestic product of BC (Fraser Basin Council, 2003). It is home to two-thirds of the province's population including many of BC's indigenous peoples, and also acts as a major provincial transportation corridor to eastern Canada and as a gateway to the Pacific Ocean and Asia. With 13 sub-basins within a diverse natural landscape, the ecological, economic, and social importance of the Basin is significant (Dorcey, 1991).

The history of governance of the Fraser River Basin may be described as a "reactive" system rather than "proactive". Nearly every establishment of a governing practice or body is as a result of a major natural or economic event (Rueggeberg and Dorcey, 1991). Table 2 depicts some of the major events and the resulting governance initiative that resulted in the Basin. One of the key features that has arisen out of recent developments in the Fraser Basin is a clear delineation of the major stakeholder groups. The Government of Canada, the Government of British Columbia, the various municipal governments, native peoples, researcher, industry, recreation, stewardship and advocacy groups all participate actively in the management of the basin.

Fraser Basin native peoples have occupied the watershed for over 10,000 years. The relatively recent recognition of aboriginal land clams has placed the First Nations in powerful political positions. Part of their power and seeking of governance is their historic and current presence in the watershed. Their long-term stability is said to stem from the cultural values of the indigenous peoples. They posses an enduring association and commitment to place, they enable local communities to maintain local control in decision making, they operate with an ethic of reciprocity and clear understanding of feedback mechanisms within the ecological system, and they are both adaptive and resilient with their scope and integration of resource use (Kew and Griggs, 1991). This suggests that adopting these value systems into water management may contribute to the integrative tools necessary for a sustainable watershed management system.

Another portion of the stakeholder framework that is gaining political credibility outside of formal government are the non-governmental organisations. These "citizens organizations" and interest groups are key in maintaining and pursuing social and ecological integrity goals. A primary example of this type of group is the Fraser Basin Council (FBC). This not-for-profit charitable organisation was established to "ensure the sustainability of the Fraser Basin". The Council brings together the stakeholders needed to make balanced recommendations, while maintaining roles as facilitators of dialogue, conflict resolution agents, and as stimulators of action. Perhaps the most laudable aspect of this group is their multi-interest Board of Directors. This 36-member panel has members from all stakeholder groups, as well as from every geographic region within the watershed (Fraser Basin Council, 2000).

From an ecological standpoint, one of the most important areas in the watershed is the Lower Fraser Valley and the Estuary. This area of the Fraser is under intense pressure with competing demands for space and resources. It is a highly urbanized area as part of the Greater Vancouver Regional District. It is an area under intensive agricultural production in the fertile delta soils. Concurrently, the Estuary is a major stop on the Pacific flyway migratory route for 750,000 waterfowl and 1.2 million shorebirds and is one of Canada's major port facilities (FREMP. 2001). In response to these growing pressures was the development of the Fraser River Estuary Management Plan (FREMP), fully established in 1985. FREMP is an integrative body, coordinating decision-making in the estuary for more than 30 agencies including all levels of government, Port Authorities and First Nations. The environmental results of this co-ordination and integration have been effective; contaminant levels of DDE and PCB's have dropped from approximately 3 mg/kg (wet wt.) in 1985 to less than 1 mg/kg (wet wt), fecal coliform counts have decreased from approximately 40,000 (mpn/100ml geo-mean coliform count) to less than 5,000 (mpn/100ml geo-mean), a net habitat gain of nearly 80,000 square metres since 1986, and a 100% compliance with log storage standards set by FREMP, are examples (FREMP, 2001).

Table 2. Major events in the history of governance in the Fraser River Basin (Rueggeberg and Dorcey, 1991).

YEAR	EVENT	GOVERNMENT ACTION
1892	Rapid development of mining community	Water Privileges Act
1912		Water Rights Branch
1913	Landslide at Hell's Gate causes severe damage to Pacific Salmon fishery	International Pacific Salmon fisheries
1948	Major flooding in Basin	Federal/provincial flood planning
1956	Increasing degradation of water in the Fraser as a consequence of discharges from the Greater Vancouver Area	Provincial water pollution control legislation
1976	Conflicts between environmental and economic interests	Creation of the Fraser River Estuary Management Study
1985		Establishment of Fraser River Estuary Management Program
1991	Increasing environmental damage in Basin with damage to fishery	Fraser River Action Plan
1997	Need for integrative body	Fraser Basin Council

The FREMP program and the Fraser Basin Council are two of the major integrative initiatives operating in the Fraser Basin. Their role in bringing together the essential inputs to decision making has been beneficial, and critical in working towards creating a sustainable river system that is balanced ecologically, economically, and socially.

Transboundary Waters

The Fraser Basin is just one of the many river and lake systems that cross the Canada-United States border. Other examples of well-known Canada-US waterbodies include the St. Lawrence River, the Great Lakes, the Milk River, and the Alsek/Tatshenshinni watershed. The concerns of both nations with respect to transboundary waters are centred around interest areas such as export levels, supply and demand, chemical use and release, loss of aquatic habitat and biological diversity, waste management, and international relationships (Agriculture and Agri-Food Canada, 2003). These concerns are not recent and have a long history between the two neighbouring countries. In 1909 the International Boundary Waters Treaty Act implemented the Boundary Waters Treaty, which outlined the quality and quantity of shared water resources. The Act also implemented the International Joint commission (IJC), which is an independent bi-national body with a regulator, investigative, and adjunctive role. The IJC's approval is required for any works in boundary and transboundary waters that may affect levels or flows at the boundary. The investigative role of the IJC is initiated by a submission of a reference from one or both governments, although the IJC has not yet been requested to arbitrate a dispute (Environment Canada, 2003c).

The IJC has been instrumental in evaluating the role of water in international trade agreements. The North American Free Trade Agreement (NAFTA) was implemented to prohibit restrictions on the exportation of goods (subject to certain exceptions) between Canada, the United States, and Mexico. The question of whether water is a good (commodity) becomes relevant when governments are faced with decisions about exporting bulk water. Within the NAFTA document, water in its natural state is not considered a good and is separate from water in commerce (Rolfe, 1994). However, what transforms water from a natural state to a good is not clear. There are two provisions with NAFTA that are relevant to the issue of bulk water export; Article 315 and Chapter 11. Article 315 states that "restriction does not reduce the proportion of the total exports of the specific good made available to that other Party relative to the total supply of that good of the Party", otherwise implying that once export and trade of Canadian bulk water has begun, Canadians could not restrict exports unless Canadians restrict their own market. The litigation that might arise from restricting exports is described in the Agreement in Chapter 11 on investment, where private (foreign) investors can challenge governments for breach of investment provisions. Litigation of this type has already begun, with the SunBelt water case in California, being the most currently impactive. The three countries in NAFTA do have the right to take preventative measures to protect water resources, but should bulk water removal be permitted, then Article 315 and Chapter 11 provisions would apply (Campbell and Nizami, 2001). Currently the Canadian Council of Minister of the Environment (CCME) from each province have agreed to prohibit bulk water export, but this agreement is non-binding and changes in the political climate can easily influence conservation commitments. According to Campbell and Nizami (2001) "Currently bulk water offers no great economic value, yet if the market value of freshwater was to increase, the economic viability and opportunities would likely be revisited". Canada has a long history of being a nation built on the sale of its natural resources and remains amenable to continued trade of this nature. However, opening the market for water could place the citizens in a place of peril and should be ventured into with the greatest caution and a more thorough understanding of the social, economic, and global hydrologic and environmental impacts of moving bulk quantities of water.

The Future of Integrated Water Management in Canada

On a small or large scale, incidents regarding water quality impairment are slowly waking the consciousness of Canadians with respect to water management. Up to this point, the governing systems have had a history of being *reactive* systems. The following list of current and future shifts to integrate water management within and across Canada comes with an implied *proactive* conception (Ministry of Environment, Lands and Parks, 1993). The future of integrated water management in Canada includes the following actions:

- Integration of groundwater management with surface water management; allocation, planning, regulation, and testing.
- Continued reduction of health, safety, and economic impacts of floods and droughts
- Protection from water quality related health threats
- Protection of aquatic ecosystems and species
- Conservation guidelines and regulations with economic incentives and education programs
- Full analysis of land-water interactions
- Adoption of watershed approaches and techniques.

Conclusions

Canadians are increasingly concerned about the security and quality of water. This is recognizable from the growing attention water management is receiving from governments, non-governmental organizations, First Nations groups, researchers, and industry users. National and international economic and geopolitics are a powerful force behind water management. In spite of all the attention, the current system remains largely a reactive system; for a long-term vision and planning, a shift towards proactive measures is needed. Innovations and consensus are essential in developing a model of sustainable water resources management. Specific, cohesive, representative groups, such as the Fraser Basin Council and the Fraser River Estuary Management Plan, are proving to be instrumental in improving water quality and providing consensus-based decision making tools. Continued integration of stakeholder groups with innovations in policy and legislation should continue to provide the backdrop for sustainable water resource management in Canada.

References

Agriculture and Agri-Food Canada. 2003. The quality of transboundary waters. http://res2.agr.gc.ca/publications/hw/04g_e.htm

Campbell, K., and Y. Nizami. 2001. Security or scarcity? NAFTA, GATT and Canada's freshwater. West Coast Environmental Law. Vancouver, BC.

Christensen, R., and B. Parfitt. 2001. IV Waterproof: Canada's drinking water report card. A comparison of drinking water regulations. Sierra Legal Defence Fund Toronto.

Environment Canada. 1970. Canada Water Act. Ottawa.

Dorcey, A.H.J. 1991. Water in the sustainable development of the Fraser River Basin. In: A.H.J Dorcey and J.R. Griggs (Eds.) Water in Sustainable Development: Exploring Our Common future in the Fraser River Basin. Westwater Research Centre. Vancouver, BC.

Environment Canada. 1987. Federal Water Policy. Ottawa.

Environment Canada. 1999. Environmental Protection Act. Ottawa.

Environment Canada. 2003a. Canadian Water Quality Guidelines.
http://www.ec.gc.ca/CEQG-RCQE/English/Ceqg/Water/default.cfm

Environment Canada. 2003b. The Freshwater Website: Legislation and Regulation.
http://www.ec.gc.ca/water/en/policy/legreg/e_legreg.htm

Environment Canada. 2003c. Acts administered by others with Environment Canada assistance; International Boundary Waters Treaty Act.
http://www.ec.gc.ca/EnviroRegs/Eng/searchDetail.cfm?intAct=1029

Fraser Basin Council. 2000. http://www.fraserbasin.bc.ca/

Fraser River Estuary Management Plan. 2001. http://www.bieapfremp.org/main_fremp.html

Kew, J.E. and J.R. Griggs. 1991. Native Indians of the Fraser Basin: Towards a model of sustainable resource use. In: A.H.J. Dorcey (Ed.), Perspectives on Sustainable Development in Water Management: towards Agreement in the Fraser River Basin. Westwater Research Centre. Vancouver, BC.

Land and Water British Columbia. 1999. Water Licences: Application Fee and Rentals.
http://lwbc.bc.ca/water/factsheets.html

MacPherson, P. and C. Tollefson. 2001. A fluid situation: Evolving drinking water law and policy in British Columbia. The Advocate. v.59:527-542.

Macmillan, T. 1990. An introduction: Federal Water Policy. Environment Canada,
Ottawa.

Ministry of Environment, Lands and Parks. 1993. A vision of new water management policy and legislation. In: Stewardship of the Water of British Columbia. Victoria, BC.

Ministry of Management Services. 2003. Complete Alphabetical Listing of Statutes with Associated Regulations. Government of British Columbia, Victoria. http://www.qp.gov.bc.ca/statreg/list_statreg.htm#tab_f

Ministry of Water, Land and Air Protection. 1996. Water Act. Victoria, British Columbia.

National Library of Canada. 2001. Canadian Confederation. http://www.nlc-bnc.ca/2/18/index-e.html

Natural Resources Canada. 2003. The Atlas of Canada: Drainage Patterns.
http://atlas.gc.ca/site/english/maps/freshwater/distribution/drainage

Pearse, P.H., Bertrand, F., and J.W. MacLaren. 1985. Currents of change: Final report on
Federal Water Policy. Canada Inquiry on Federal Water Policy. Environment
Canada. Ottawa.

Rolfe, J.B., 1994. Clarifying the Water: Canadian water, Canada's trade obligations and B.C. water policy. West Coast Environmental Law. Vancouver, BC.

Rueggeberg, H.I. and A.H.J. Dorcey. 1991. Governance of aquatic resources in the Fraser River Basin. In: A.H.J Dorcey and J.R. Griggs (Eds.) Water in Sustainable Development: Exploring Our Common future in the Fraser River Basin. Westwater Research Centre. Vancouver, BC.

"Greece: Towards a sustainable management of WR, through implementing WFD 2000/60 Present Status and Perspectives"

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A. Status: Natural characteristics, Anthropogenic problems and Difficulties in applying WFD

- **Natural characteristics**
  - Small area: 132.000 km2 (greater % is mountainous terrain), complicated geologic and topographic setting, very high length of coastal line: 16.000 km, many small-size islands.
  - Thus, there exist a great number but mostly small size river basins and water bodies.
  - High degree of biodiversity (fauna-flora) in separated, mostly small size, lakes, deltas, and wetlands (*protected by Ramsar, Natura 2000, etc*).
  - Mediterranean climate with high degree of spatial and temporal variations in meteorological parameters (precipitation, temperature, etc)
  - All major rivers in northern Greece are transboundary
  - The greater part of GW bodies are coastal and karstic aquifers
  - High (volume and rate) natural erosion and sediment transport from mountains to surface water bodies in the plain areas

- High degree of interactions among coastal aquifers, wetlands (lakes, deltas) and streams-rivers in the plain areas

- **Anthropogenic water-related problems**

  - Over exploitation of GW aquifers (especially coastal)
  - More than **85%** of country's WR for **agriculture** (especially irrigation using mostly groundwater)
  - Most Aegean Islands exhibit water deficit problems (espec. summer period)
  - Specific water-transfer problems for meeting the expanding demands of the cities of Athens and Thessaloniki greater areas
  - Pollution from sea-water intrusion and fertilizers
  - Pollution transfer from neighboring countries
  - Soil erosion due to forest-fires, specific land uses, urbanization, etc
  - Inefficient management of wetlands and flood and drought phenomena on a preventive and ecosystem focusing basis

- **Difficulties in implementing WFD**

  - Unsuccessful attempt for rational WR management through inefficient application of Law 1739/87, under which the country has been divided in 14 hydrological districts (no sound scientific criteria, complicated-chaotic administrative management by several ministries-authorities, lack and inexperience of related scientific personnel)

- Difficulty and lack of systematic and reliable national network for **monitoring**, collection, recording, evaluation and rational utilization of meteorological, hydrological and hydrogeological information as well as parameters related to the quantity and quality aspects of WR
- Difficulty and lack in systematic recording existing **uses and users** of WR
- Difficulty and lack in cooperation and coordination among responsible managerial authorities on national, regional and local level
- Inefficient cooperation among neighboring countries regarding the management of transboundary waters (rivers, lakes)
- Development policies, plans and programmes on national and regional scale have not been based upon or combined with long-term rational development and management (quality and quantity aspects) of WR.
- No integrated and holistic approach in WR management. Indeed, management of WR means (up to now), mainly, granting concessions for water withdrawal and use to cover local and sectoral needs.
- Existing mentality and ethics of related local populations are the controlling factors in structuring and applying water policies and management.

B. Perspectives

From facts to actions

- Within Europe, **Greece** exhibits a natural environment with **extremely high aesthetical and ecological values**.
- In this respect, the WFD represents a challenge and a unique opportunity for the country to safeguard the good status and the sustainable development of its ecological recourses, since water controls the qualitative and quantitative aspects of all ecosystems.
- The existing natural setting-characteristics and difficulties combined with deficiencies, inadequacies and lacks regarding scientific networks, data banks, legislative and administrative framework, economic and human recourses, ethics and mentality, reveal that:

❑ Greece has a long way to go for meeting the requirements of WFD in general and especially within the preset by the EU timetable (end 2015)

Thus, in order to cover the needs towards a sound implementation of the Directive, Greece should:

❑ Look upon water as the **most valuable public ecological good and use it through a "systems" oriented approach**

❑ Undertake a huge systematic effort at all levels of political, administrative and societal structure, benefiting from the existing practices and long experiences (relevant to rational WR management) in other European Countries

❑ Create a **new independent Water Authority** with a flexible structure, under the supervision of the Minister of the Environment

- Put forward fundamental changes of approach in shaping policies and making decisions as far as WR management (uses, demand, etc) focusing on the **holistic principle**, thus undertaking the necessary political cost, *and*
- Make large investments on funds and scientific personnel and research.

A Proposal regarding the Water Districts

Starting points and key-factors controlling the sound implementation of WFD are the selection and allocation of **Water Districts on river basin level** (Directive's fundamental provision).

In order to achieve an effective implementation of the Directive in Greece, **7 Water Districts have been proposed,** as an output of a combined optimum consideration and evaluation of:

- Geomorhological, hydrological and hydrogeological criteria
- Interactions among surface and groundwater bodies, both inland and in coastal areas
- Current administrative structure of Greece
- Existing natural difficulties and management deficiencies regarding inland and coastal water bodies

In each WD the above used criteria express their maximum possible homogeneity.

(**Notice**: *For **France** have been proposed **12** and for **Germany** **10 WD**)*

Proposal's example:
The Water District (WD) of Eastern Macedonia-Thrace (EM-TH)

The proposed new **WD of EM-Th** (**No 6** out of the proposed 7 WD), was formed as result of unification of existing WDs of Eastern Macedonia and Thrace (respectively No 11 and 12, out of 14, under Law 1730/87) and the north Aegean islands of Thassos and Samothraki. Since, they exhibit:

- Similarities in their geomorphological structure,
- Homogeneity in hydrological and climatic conditions, as well as they
- Belong to the same regional administration.

Some crucial characteristics and important facts regarding the WD of EM-Th are the following:

- There exist a dependence for meeting basic water needs from **transboundary rivers** (**Strymonas** and **Nestos** rivers are shared with Bulgaria and **Evros** river is shared with Bulgaria and Turkey)
- The two main water uses in this WD are **hydroelectric power production and irrigation**
- The quantity of its WR are adequately meeting existing needs
- GW (inland and coastal) bodies are independent and cover, mainly, the users of the agricultural sector
- Overexploitation of GW bodies and sea-water intrusion in coastal aquifers
- The economy of the District is based on primitive sector (agriculture and cattle-raising)
- High value ecosystems in wetlands: **Deltas** of rivers Nestos and Evros, **Lakes** Vistonis and Mitrikou.

"Strategy of integrated water resources management in Lithuania"

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1. Characteristic features of water resources in Lithuania

Lithuanian territory contains 22.2 thousand of rivers and streams, total length of which – 76.8 thousand kilometres. 17 rivers are longer than 100 km, 7 main river basins in Lithuania are transboundary and contain unequal size. 4 main river basin districts – the Nemunas, the Musa-Nemunelis, the Venta and the Daugava decided to be the main managerial units by implementing river basin management in the country. The main river basin - the Nemunas occupies 75% of territory. Total water resources in Lithuania contain 33.78 km^3/year, while 10.80 km^3/year – transboundary runoff. There are 440 ponds with more than 5 ha of surface area, 25 artificial water bodies with more than 100 ha of surface area, 50 hydroelectric power stations. Lithuanian territory contains 20 groundwater body aquifers, more than 350 thousand shallow dug wells. 90 % of population are connected to centralised water supply and sewerage network in big cities, while 44.8% of rural inhabitants are connected to centralised water supply, and 40% - to sewerage network. Lithuanian is abundant with groundwater resources of 3,2 mln.m^3/day, which are used for drinking water, and only 25% of presently existing groundwater resources are used for daily purposes.

2. SWOT analysis

Strengths. Water use during the last decade decreased almost 4 times, and due to this reason the wastewater discharges into surface waters decreased by 2.5 times. During the last five years a big number of wastewater treatment plans have been built and installed, and almost 90% of wastewater discharged to surface water bodies are treated. Pollution into surface waters by BOD and suspended solids decrease more than 5 times, oil products – more than 6 times, nitrogen – almost 3 times, and phosphorus – about 2 times, and pollution by heavy metals – more than 10 times. Due to this reason the tendency of the improvement of surface water quality is quite steep.

Weaknesses. More than 0.4 billion Euro have been invested into municipal water sector during the last decade, but still there is an urgent need for further investments in order to fulfil the European requirements on urban waste water directive. Several sewerage networks carry old-fashioned character (are of 20-70 years old). A big number of countryside inhabitants are drinking shallow water from dug wells, which usually are polluted by nitrates. Surface waters are suffering from eutrophication. Monitoring system of surface waters is not developed according the river basin management principles, and there is no diffuse pollution monitoring and assessment system.

Opportunities. By implementing the EU water sector directives (as nitrates, drinking water, urban wastewater, dangerous substances, groundwater, bathing water and the main – Water framework directive), there will be the opportunity to use the EU ISPA and Cohesion funds to solve centralised water supply and wastewater network development, improvement of wastewater treatment facilities, and selection of alternative sources for good drinking water quality. By using SAPARD funds – to implement good farming practices and reduce diffuse pollution from agriculture by nitrates and other dangerous substances. The use of cleaner technologies and recycling systems into industry will enable to save water resources by using them in the optimal way

Threats. By not using the ES funds, not attracting the private capital to water sector, and by failing to modernise wastewater treatment facilities, and by not enforcing the dischargers not to exceed emission limit values for various pollutants (especially for dangerous substances), pollution of the surface water bodies will increase together with economical growth of industry. The threat to human health will also increase, if the centralisation of drinking water supply network will fail. If competence for integrated river basin management will not be created, the long-term goal - to have good water quality status for surface waters, good chemical status for ground waters, and good ecological potential for heavily modified water bodies will fail.

3. Goals of integrated water resources management

The main purpose of the integrated water resources management in Lithuania is (a) to strive to such development of all economic sectors that it would be tuned to the preservation of clean and healthy environment, (b) to adjust protection of water resources to economic and social growth interests, (c) to ensure effective use of water resources, overall economic prosperity of population, and social guaranties, (d) and, during the strategy implementation period, to reach present average level of the EU countries according economic, social and water resources use indicators, and not to exceed the EU requirements on the emission limit values.

Long-term goal (2010-2020) – to develop updated, decentralised water resource management system, based on principle of integrated river basin management; to assure the supply of high quality drinking water to all Lithuanian population; to assure good ecological status of surface water bodies, good chemical status of groundwater bodies, good ecological potential of heavily modified water bodies; to develop effective prevention and protection of water ecosystems.

Mid-term goal (2005-2010)– to coincide the EU requirements in water sector in order to achieve the effective use and protection of water resources, and to achieve the effectiveness of municipal water management sector by optimal use of state, municipalities and private financial resources and the resources of the EU structural funds.

Short-term goal (2003-2005) – to create legislative and institutional environment and system of technical measures, to build the institutional-administrative capacity to implement integrated river basin management in the country as a basis for the implementation of the integrated river basin management system.

Short-term measures

- to create the administrative-institutional system for the implementation of integrated river basin management and to encourage inter-ministerial communication and collaboration;
- to develop information management system for water resources use and integrated water quality assessment according river basins and river basin districts;
- to implement water resources management reform – to create the structure for river basin management;
- to reorganise municipal water management system;
- to prepare the conditions (legislative, organisational and administrative) for the reporting under various water-sector directives;
- to achieve the high responsibility of the companies to implement dangerous substances reduction programmes of measures, and to assure the protection of surface and ground waters from the pollution by dangerous substances;
- to assure good quality drinking water supply to the North-Western part of the Lithuanian inhabitants where there are high concentrations of fluoride;
- to ensure collaboration between governmental institutions and research institutions in order to develop the team or forum of experts on integrated water resources management inside the country;
- to create public information, consultation and involvement system for the development of the river basin management programmes and action plans for river basins.

4. Conclusions

Integrated water resources management strategy for Lithuania has showed that there are a big number of steps towards the achieving good water status for all waters. The main goal and the purpose of good water status for surface and ground waters carries interrelated tasks and measures. Those are:

- improvement of water protection, water resources management and legislation basis for economic activities and sustainable growth;
- preparation and implementation of water resources information system for management and decision-makers;
- institutional strengthening at various governmental institutions' levels: national, regional, local;
- development of the pollution prevention strategies and reduction programmes for point sources;
- seeking to achieve good drinking water quality;
- protecting of bathing places;
- development of cleaner production technologies and methods.

These are the basic actions of the integrated river basin management vision which should be realised to achieve good status of all water resources in Lithuania.

"Integrated water resources management in Morocco"

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Like many other countries around the world, Morocco is also facing the problem of development and sustainable management of its water resources. The country is characterized by an enormous geographic disparity of its water resources and is also exposed to harsh climatic conditions. It is in the major party of its territory arid and semi-arid land, and hence the availability of water is limited by the climate conditions.

The global yearly estimated rainfall on the whole country averages 150 billion cubic meters (Bm^3), of which 121 Bm^3 evaporates and only 29 Bm^3 remains as a potential of surface (78%) and underground (22%) water potential, representing less than 1000 m^3/year/inhabitant.

The divertible water's capacity is roughly 20 Bm^3 per year, and presently, almost 13.7 Bm^3 are available for the main uses which are agricultural, domestic and industrial purposes. The water resources are limited and are subject to many natural and man made constraints which impact on their both quantity and quality.

The continually growing demand of water caused by population growth, is worsened by the deterioration of water quality, the degradation of natural ecosystems, the silting of dams' reservoirs, the successive years of drought, and the inefficient use of water in irrigation.

To overcome these constraints, Morocco has positioned among the most important priorities in all its Social and Economic Development Plans, over the last three decades of the last century, the necessity to rationally manage the water resources.

An intense interest was attached to the mobilization of the surface water resources in order to insure the development of the country, which relies mostly in agriculture. More than two thirds of this surface water was then mobilized and huge infrastructures were built for meeting this objectif.

During the years eighties, many successive drought-years have occurred and the distribution problem of water and its quantitative management was felt. With the fast increasing demand for water, the occurrence of pollution problems induced by human pressure and financial scarcity, a global vision of water resources which takes into account the quality and the quality aspects of the resource and considers all uses and users, according to the general interest of the national community, is starting to be adopted.

The necessity to unify and reformulate in one unique law, all the texts and rules governing the management of water resources, was felt. Policy reforms were then undertaken and an integrated approach to water resources management was included in a new law on water which was promulgated in 1995 (law 10-95). This law encompasses a set of jurisdictional instruments, and has for a main objective to help face the challenges of a growing water scarcity driven by an increasing demand, a degradation of water quality and rising costs of water production.

The implementation of this law is not yet totally effective, and it is being applied gradually and in step by step. The most controversial aspect and the one that is not very straightforward for application is the charges for water uses, 'user-pays', mainly in agriculture. This concept is difficult to accept, principally by people that were historically used to free access to water resources. The organization of those users within associations is being implemented in many parts of the country.

The creation of the River Basin Agencies is an innovative decision of this law. These agencies are public institutions, endowed with the moral personality and financial autonomy, and are in charge of managing and developing the water systems and the hydraulic public domain of one or a group of river basins. Seven River Basin Agencies were created and are presently operational. The first one was created in 1996, and the remaining in the year 2000.

They are charged to elaborate the integrated water management master plan at the level of their respective territory, monitor the adoption of this plan, deliver authorizations and concessions of the hydraulic public domain while guarantying its preservation, and provide all financial means and technical assistance to projects which aim the prevention of water pollution or the management and utilization of the hydraulic public domain.

The financial resources of these Agencies, other than subsidies, gifts, and loans, are mainly composed of royalties versed by users of water ('user-pay') or by the disposal of used water on the basin, either by domestic or industrial producers ('polluter-pays').

The water demand management is implemented by means of water saving incentives, through progressive tariffs of potable water proportionally to the volume consumed, and through the reviewing of the irrigation water tariff to better reflect the scarcity and also through financial subsidies for improving irrigation efficiency and transport losses. Policy also based on information providing on ways of water saving (reduction of losses in the distribution, leakages and poor user efficiency, ..), and on rising awareness about water scarcity is implemented in all sectors of water uses.

The reduction and efficient use of water in irrigation is being promoted through a broad program based on the improvement of the hydraulic performance and the agricultural productivity, and on the strengthening of the management capacities of the irrigation agencies, namely the regional offices of agriculture.

"Towards Interactive Water Management in international River Basins"

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This paper deals with the developments in the concept of water management, as can be learned from a multidisciplinary and historical exploration.

In modern water management a *multidisciplinary approach* is essential. It considers both natural and social sciences. A study for sustainable water management has to incorporate science from many disciplinary fields. Furthermore, a normative objective as sustainability requires both descriptive and prescriptive knowledge.

Exploring the field of social sciences shows trends in society like the major changes that are connected to the present modernisation process. The most eye-catching are globalisation, internationalisation and regionalisation. It is obvious that the decreasing importance of national borders has its influence on water management too. But there are other trends as well, for example, the "economisation" of decision-making. Everything has a price nowadays, and for every decision the financial profit seems to be the most important factor. Because common economic thinking does not imply the long term effects and the non-financial consequences, most environmental factors are not adequately taken into account. Another tendency can be called the "horizontalisation of governance". It refers to the change in relations between citizens and authorities. The command and control paradigm, that allows the government agencies to determine from an hierarchical position what citizens should do, is considered not to be realistic anymore. In modern society, citizens participate in the decision-making process in a more or less horizontal position compared to agencies. All these trends have impact on the way the waters are managed.

Exploring the field of natural sciences learns that water is only one component of a water system. The consequence for water managers is a holistic approach. Furthermore, it appears that not all man-induced changes are perceived as problems. We can learn for history that every period has its own recognised problems and resulting water policy. In the Dutch history of water management five different stages can be distinguished. In every new historical phase, new policy objects are added to the ones that were in the spotlight in the phase before. The first phase, flood control, started even before the middle ages. Then, water management was limited to its roots: *safety-management.* After some centuries of experience, people found out that they not only could keep the water out, but also could actively reclaim land from the sea. This second phase can be called water *quantity management.* Even in the twentieth century, land reclamation went on, but the functions of the water itself obtained more and more attention. For example, the inland navigation became increasingly important. Later, sectors like agriculture, industry, drinking water etc., also called for attention from the water managers. The third stage appeared: *sectoral water management.* In the eighties, all these increasing demands resulted in the awareness that the sectoral approach reached its limits. It is just not possible to fullfill all the demands of every different sector at the same time.

The watersystem based *integrated water management*, the fourth stage, began in The Netherlands around the mid eighties of last century. Not the demands of the different stakeholders, but the ability of the total water system to supply all these sectors became the starting point. This holistic, or comprehensive approach came up at more places in the world and nowadays everywhere people are working on the implementation of the ideas of integrated water management.
But, as could be expected, this process did not finish. A fifth stage is about to follow and can be characterized as *interactive water management*. Again, the development is directed to more complexity.
The interactive view has two dimensions:
1. interaction between the water manager and the factors of the total water system;
2. interaction between the water manager and the different actors in society.

The concept of interactive water management now consists of four basic components;

- the water system approach as a starting point
- the river basin concept as a policy object
- interactive management of water system and people
- sustainable development as the ultimate goal

Combining these components with the mentioned trends of modernisation, provides a good view of an institutional outline of future water management, with a dominant role for interaction. In an international context, three main steps on the road to interactive water management can be identified. The first step is focused on coordination between water managers of the different countries. Most international river basins are in this phase or make at least preparations to enter this phase. The second step is based on co-operation of water managers in different countries. Only a few examples can be found in present international water management. The third step is rather idealistic; it contains supra-national water management of complete transboundary river basins. In this phase an intensive interaction exists between the central international water management institution and the river system at the one hand and with the people of the basin at the other.

Some of the elements of this fifth phase nowadays come to practice in the work of leading international river institutions in the world, like the international Rhine Commission and the USA-Canadian International Joint Commission, which amongst others deals with the Great Lakes. Examples are the many restoration projects of natural systems in river basins and the way public participation is organised.

In most other transboundary river basins, the way to interactive water management at an international level is much longer. For science, the time has come to answer major questions, concerning for example the advantages and disadvantages of these new developments and the suitable *institutional arrangements* for such a new phase in history.

"To a new transdisciplinary culture of water"

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Sustainability requires some interconnected processes of changing society: a new production of knowledge, the consideration of cultural issues, the recognition of the territorial system as a linked social-ecological ecosystem and the understanding of self-organization processes. All these processes influence water management.

In the 16^{th}- 17^{th} centuries the "Cartesian Paradigm" was characterised by rationality, by duality, by linearity, by reductionism and analytic thinking. It contributed to the separation between humanistic culture and experimental sciences and to the origin of disciplinarity. Notwithstanding the present rising perception of complexity of the environmental systems, this traditional production of knowledge still influences all the sectorial and environmental policies through the "Engineering paradigm" understanding as a societal guidance (Friedmann, 1987) which considers a flexibility in the supply of natural resources.

Along the 20^{th} century, the evolution of sciences demonstrated the existence of several levels of reality and proved that the reality is dependent from the observer. General Systems Theory, Cybernetics and other new theories introduced innovating concepts of systems that led to the emergence of the "Systemic Paradigm" which contributed to the integration of sciences, i. e., interdisciplinarity.

From the 1970s onwards a new production of knowledge is happening. Authors such as Edgar Morin who introduced the "epistemology of complexity", Joël de Rosnay with the "symbionomy", Prigogine and Stengers with the "new alliance", Fritjof Capra who presented a holistic, systemic and ecological approach and Maturana and Varela with the concept of "self-poietic systems", are advocating the emergence of a new production of knowledge. Rosnay (1995) advocates the present construction of the "Complexity Paradigm" which deals with concepts such as complexity, non-linearity, uncertain, chaos, self-organization, recursivity and reflexivity. This new paradigm needs the opening of barriers of the subjects, of the connectivity of different fields of knowledge, it needs a dialogical and recursive thought, it considers systems of multiple levels of reality and aims, and it finally needs a unified linguistic domain. Therefore the transdisciplinarity emerges (Gibbons *et al.*, 2000).

The complexity is linked with the variety of elements and interactions of a system, the non-linear aspect of interactions and organized totality and is characterized by the emergence of unprecedented events which are not predictable.

We realize that nowadays there are relevant environmental and social systems that have a great complexity and a high degree of uncertainty. Funtowicz and Ravetz (1990) consider that new issues like risk and environment have common features: uncertain facts, values in dispute, high stakes, pressing need for decision-making. If so, they propose the necessity to develop "a new scientific method, neither value-free nor ethically neutral" which is defined as Post-normal science. They consider that the essential function of quality assurance and critical assessment can no longer be performed only by a restricted corps of insiders (such as scientists and experts), the dialogue must be extended to all those who have a stake in the issue. Therefore, local and traditional knowledge are determinant to this new science.

Effectively, culture embodies the basic principles of society and its way of living. It promotes human rights and diversity, the attendance of equity distribution of resources (considering ecological sustainability) and patterns of self-sufficiency and efficiency, the respect of different values and cultural practices which attend the specificity of each ecosystem or territory. Local communities are often the most prudent ecosystem managers (UN *et al.*, 2000) so they can emphasise the attendance of ecological integrity of ecosystems. It is necessary to promote, create and maintain the active participation of citizens (including minorities and vulnerable people), they are key actors to influence the decision making process. People, with their heritage and multiple culture actions, must strengthen their intellectual and social capabilities to enable solve problems, to behave autonomously through self-organization processes.

We advocate that the existing interconnectivity between natural and societal systems, the feeling, by the communities, of belonging to some place and the collective social responsibility for the maintenance of ecological integrity imply the importance of recognition of the territorial system as a linked social-ecological ecosystem. To have a stable landscape of social-ecological system it is necessary that it is more complex, more resilient and, from the human perspective, it is important to determine whether the state of the system is "socially acceptable" (Redman *et al.,*2000).

On the other hand, the complexity requires the understanding of the concept of “self-organization”: it refers to the ability of a system to be able to construct and change its own behaviour or internal organization; in a recursive way, the order in the system forms spontaneously from chaos and a process of adaptiveness happens so that the system adjusts to new situations (Prigogine and Stengers, 1986). The more complex a system, the more complex its control system must be in order to provide a "response" to the multiple disturbances produced by the environment (Morin, 1994).

We consider that this concept of "self-organization" could be applied to territorial systems in an attempt to aid understanding about how they may have the potential to develop, organize and respond to internal and external changes more effectively. This consideration put in relevance the necessity to construct social capital (focuses on networks) that attend to the territorial resilience, i. e., the capacity for learning and adaptation through experimentation, considering innovating solutions and development of multiple responses to multiple challenges.

The need to address sustainability and the attendance of the complexity are demanding new approaches in planning and management of natural resources which are influencing territorial planning and management in a substantive and process way. Therefore, it seems necessary to have an adaptive ecosystem approach (Kay *et al.*, 1999), which is characterised by flexibility in learning through change, integration of a new science with values, dealing with multiple cultural perspectives in a transdisciplinar attitude.

Considering the specific case of water, the present perception that freshwater is a finite and vulnerable natural resource, that it is a social and an economic good and that it is inextricably linked with the global environment (its movement by gravity, and through evaporation and condensation, contributes to driving the Earth's biogeochemical cycles and to controlling its climate) are demanding increasing attention. The complexity of the theme increases with the diversity of the characteristics of water, in terms of quantity and quality, that vary in time and space.

The pressures facing the hydrological system and water resources are the rapid growth of population and urban communities who increase in demands (in general), the changing land-use and land-management practices and the climate changes (there are some uncertainties about this). All of these contribute to the origin of impacts on flooding patterns, groundwater recharge or water quality in a cumulative and synergetic way. On the other hand, the potential changes in the cycling of water could have very significant impacts across many sectors of the economy, society and the environment.

There are increasing conflicts of use of water between different stakeholders' interests.

In dry climate areas, the needs of water are increasingly become an objective of military action or an instrument of war; there exist upstream and downstream conflicts over water resources within watersheds (within states and between neighbour states); conflicts over abundance; conflicts of interests in water use: from irrigation communities, industrial enterprises, domestic use (all the intervening actors have different objectives); water without quality causes problems of public health and risks of water threatened ecosystems in all space scales.

The exploration of water resource needs to be sustainable, that means that it must attend to the environmental principles of sustainability for general natural resources proposed by Daly (1990). Considering its social dimension, we must attend that the human right to water is fundamental to meet basic needs, as

the United Nations Committee on Economic, Social and Cultural Rights determines in November of 2002. Communities must attend systematically to the principle of equitable use of water based on an upstream-downstream hydro-solidarity.
In general, considering water policies, in "developed" and developing countries (such as Portugal) the attending of the "Hydraulic paradigm" (Moral and Saurí, 1999) has dominated water supply management approaches, which have been to develop new supplies and to construct structures to utilise available supplies to meet water needs. Nowadays, the attention to water demand management is increasing. This last is focused on lowering or mitigating proposed demands in a more socially beneficial manner that rely on socioeconomic techniques (like economic policies, water pricing, public education, recycling, laws, land use) and usually are not capital intensive structures. These kinds of options promote sustainability.
Portugal has a mosaic of climates, landscapes, economic activities and traditions. In a continental scale, we can say that in the North there are plenty of water resources but in the South, with its Mediterranean clime, in dry periods, there is some scarcity. Presently, Algarve (located in the south) is not suffering from water shortage because of the last climacteric wet periods, but we must have a long-term vision.
In Portugal, in the last two decades, there have occurred increasing demands of freshwater infrastructures systems caused by: the increasing urbanisation (the activity of tourism and the urban diffuse characteristics contribute for these demands) and the increasing areas of agricultural irrigation. The main policy attention converged to the domestic sector (trying to attend basic needs) and the implementation of

sanitation and wastewater treatment. More recently, the public and private main attentions are supply options to the agricultural sector.

The quality of water is beginning to be an increasing problem, mostly in the agricultural activities (in a diffuse way), in the urban sprawl (disperse dwellings without wastewater treatment) and in the industrial sector.

Although there are important laws in transversal contexts of environmental protection which promote the defence and conservation of fresh water resources, in practice, the water supply options dominate all policies. But, in recent years, there have been emerging criticisms from some Non-Governmental Organizations that are influencing academic stakeholders. One of these, the Foundation for a New Culture of Water, in an Iberian context, are promoting social movements, academic workshops, scientific investigations and congresses, spreading that water systems should be understood and managed as living ecosystems and as identity community patrimonies, natural well being, beauty and arising of feelings. It considers the concept of “patrimony water” which attends its social, ecological, environmental and landscape values (Moral, 2002). It advocates a sustainable management of water which must be more equitable, participating and efficient and attend more to water demand management and in this context it gives special attention to the integrated water planning in territorial and land use planning.

Presently, in Algarve (South of Portugal) the Update of Algarve Territorial Plan is being done by the Public Regional Direction of Environment and Territorial Planning and by invited experts.

In most of the territory of the region of Algarve (not considering the small territory of the catchment area of the Iberian River Guadiana) the percentage distribution of use of freshwater is: irrigation for agriculture (65%), domestic uses (29%), irrigation for golf courses (4%), industrial uses (2%) (DRAOT, 2001). We can realise the importance of the agricultural activity in the water use and think about the potential role of agricultural land management practices on the vulnerability to water quality changes.
The team responsible for the Integrated Water Planning (experts from our Department of Civil Engineering) is trying to develop an adaptive approach that attends to a pro-active participation of stakeholders that will influence the scenarios' analysis and the formulation of adaptive actions. This collaborative participation (still in process) in integrating water planning is an innovating approach in territorial planning in Portugal and it is influencing the other colleagues who are developing the plan. Finally, the institutional leaders are increasingly interested in the participation of local stakeholders and the development of more focus group and so, there is an institutional changing of attitude about public participation issues.

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References

- DALY, H. (1990): "Commentary: Toward some operational principles of sustainable development" in *Ecological Economics*, 2, pp. 1-6.
- DRAOT (2001): *Plano de Bacia Hidrográfica das Ribeiras do Algarve*, Faro: Direcção Regional do Ambiente e Ordenamento do Território do Algarve.
- FRIEDMANN, J. (1987): *Planning in the Public Domain: From Knowledge to Action*, Princeton University Press.
- FUNTOWICZ, S. and RAVETZ, J. (1990): "Post-normal Science: A new science for new times" in *Scientific European*, Supplement to Scientific American, October 1990, pp. 20-22.
- GIBBONS, M.; NOWOTNY, H.; LIMOGES, C.; NOWOTNY, H.; SCHWARTZMAN, S.; SCOTT, P. and TROW, M. (2000): *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*, London: Sage.
- KAY, J. J.; Regier, H.; Boyle, M. and Francia, G. (1999): "An ecosystem approach for sustainability: addressing the challenge of complexity" in *Futures*, vol. 31(7), pp. 721-742.
- MORAL, L. and Saurí, D. (1999): "Changing Course. Water policy in Spain" in *Environment*, vol. 41, n.º 6, pp. 12-36.
- MORAL, L. (2002): "Apresentación" in *III Congreso Ibérico sobre Gestión y Planificación del Agua*, Universidad de Sevilla, Sevilla, [on line]

http://www.us.es/ciberico/ sevillapresentapoit.html 14.05.2003.

- MORIN, E. (1994): *Ciência com consciência*, Mem Martins: Publicações Europa-América.
- PRIGOGINE, I. and STENGERS, I. (1986): *A nova Aliança. Metamorfose da Ciência*, Lisboa: Gradiva.
- REDMAN, C.L; GROVE, M.J.; KUBY L.H. *et al.* (2000): "Toward a Unified Understanding of Human Ecossistemas: Integrating Social Science into Long-Term Ecológicos Research", [on line]
- http://www.lternet.edu/documents/Publications/sosciwhtppr/index.html 15.11.2002.
- ROSNAY, J. (1995): *L'homme symbiotique - regard sur le troisième millénaire*, Paris: Editions du Seuil.
- UN, WB, WRI (2000): *World Resources 2000-2001: People and ecosystems: The fraying web of life*, United Nations Development Programme, United Nations Environment Programme, World Bank, World Resources Institute, [on line] http://business.wri.org 14.05.2003.

"Farmers: user and producers of water"

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1) Agriculture, a relevant factor for integrated water management.

In many countries agriculture is a major user of water. Nevertheless, taking into account that the capacity of water sources are strongly related to the agricultural land use it is quite clear that agriculture plays also a crucial role in the supply of water.

Most of the problems faced by the management of water stemps from the difficulty to establish the price of water that is suitable to equilibrate the supply and the demand. Actually, the degradation of water sources is strongly influenced by the land use but it has not been possible to pay for land uses to produce water in quality and in quantity. Considering the dispersion of agricultural demand, the limitations to control and manage water distribution systems can not be properly addressed if the cost of water distribution across space is not taken into account. Being so water drainage and treatment becomes much more complex when agricultural uses are considered. Furthermore agriculture is a major victim of floods and droughts. Social and economic problems related to water have always a major protagonist in agriculture. Finally, the effects of major climate changes always have an agriculture component.

Summing up, agriculture is responsible and victim for the problems that affect the use of water. Being so, agriculture has to be also part of their solution.

2) Key questions.

Water regulation is necessary. Firstly, because water resouces have features of common goods. Secondly, because water distribution involves very high costs. Thirdly, because water supply usually involve different constituancies or even various countries. And finally, because there are many positive and negative externalities associated with the use and production of water.

Nevertheless water regulation has been embedded with policy failures and biased principles. Mostly because it is assumed, without discussion, that integrated water management can and must be undertaken through centralised organisations controlled by the State.

Before the design of more appropriate tools and organizations the approach to integrated water management must be initiated trying to get answers to fundamental questions:

a) How to allocate water between conflicting uses? Between agriculture and other uses, between upstream and dowstream uses, and between present and future uses?
b) How to face a variable water supply? With small or big dams, with land use planing of river basins or with land use liberalization, by water transferences between basins or through through migration of activities?
c) How to define the price for water production and water use? Through different prices according to the productions and uses, defining tariffs to cover the costs of production and distribution, or through the frre distribution of water.

3) Agriculture and integrated water management.

Agriculture land use is one of the main human factors that influence the production of water in terms of quantity and quality and it is also the activity that consumes more water in many countries. It makes no sense that the integrated water management take place only when the water is captured and piped or stored, and be ignored when it is generated in the basin or finally discharged in the downstream. In fact, the adapted spaces that are in the begining and in the end of the pipes and reservoirs must also be part of the water system to be managed, and these areas are mostly agricultural adapted spaces.

Furthermore, it is possible to foresee that the previous management objects, formed by tubes and reservoirs, would not be the same when all the system, upstream and downstream, becomes part of the management object. In other words the existing water organisations would change radically if the agricultural sector is to be included in the management system. Firstly, because many other managers will join the management system; they are mainly the farmers upstream and downstream the traditional water supply systems whose decisions on land use interfere directly with water production and consumption. Secondly, management becomes more complex because the conflicts between small and larger scales become more explicit within and between basins. Finally a change in the management system is due because the conflicts of many public interests will also become clearer: environmental protection and water supply, rural development versus urban welfare.

4) Challenges for a new culture of water

We know that the suggested basin plans represent an important effort to collect information but there is a major difficulty to calibrate the managemente tools such as licenses and taxes when the pollution sources are diffused as occurs with agriculture. We also know that in many countries water management is based on the idea that non-used water is lost water and it is this idea that supports the plan to manage the water through tubes and reservoirs. Being so there is an implicit conflict between water management in tubes and reservoirs and the management of water in the environment. The existing perspective leads us to the sustainability of water resources. The second perspective much more related to agriculture, concerns sustainability of sites and cultures.

5) - Agricultural competitiveness and preservation of water resources.

There are positive and negative effects associated with water availability for agriculture. On the one hand there is a positive effect on the profit of farmers influenced not only by the access to water but also by the cost of the all the inputs, the technological knowledge and the prices of the outputs. On the other hand, there are costs and benefits for all the society such as environmental costs and productivity increases. From this perspective agricultural acompetitiveness and the preservation of water resources add up for the same addition. All depends on the final result beside the distribution of costs and benefits among persons and their communities.

6) The price of water

The price of water for agricultural uses should be the same as for other uses should those other uses have the same marginal cost. Actually water prices must be equal to the marginal cost of production plus the environmental damage due to production and use. The problem is to estimate and enforce those costs. Theoretically they should vary across sapce and time bearing in mind the opportunity cost associated with the production and use. For example the water production cost in a mountain should be related to the opportunity cost associated with the shift on land use from a more profitable pasture, that produce less water, to a less profitable forest, that generate more and better water. On the other hand the cost to use water by a farmer close to a town nust be the same as the one established for the domestic consumer at the same moment and place. The problem is to implement those principles.

7) What should be the price of water for the irrigation associated with a big dam like Alqueva in the Guadiana river in Portugal?

Certainly there must be estimates about water prices before the irrigation project so that investors can evaluate their projects. Nevertheless water prices must change according to the irrigated areas, years and seasons. The idea is that the price should reflect not only the marginal cost of water distribution but also the environmental costs associated with water use. Prices must also change in order to signal shortage of water, regulate consumption and avoid bad consequeneces from droughts. Because the construction of Alqueva dam was justified by strategic reasons there is no need to include the cost of the dam in water prices but only the marginal cost of distriubution plus the marginal environmental cost.

8) - Conclusion.

Agriculture can be either a user of a producer of water. One farmer is preserving water resources when he decides to maintain a wild forest instead of a production forest or a pasture in order to produce and sell water in quality and quantity instead of wood and beef. The question is to know how much we need to pay more for water or less to allow pastures and wood forests so that the farmer can shift his activity to produce water.

"Experience with integrated water management and steps taken for implementing directive 2000/60/EC"

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A sustainable water management policy requires key issues such as: principles, objectives and terms, plans and programs, legal and institutional framework giving to government the possibility to manage the water resources, cooperation at all levels, involvement of water users and public in the decision making process.

New principles sustain the modern water management concept: water is a good with economic and social value, access for everybody to water resource, water management integrated on river basin scale, user pays, polluter pays and ecologic criteria. Also new is the tendency to extend the state involvement in administration and management of water resources doubled by the public participation in decision making process.

Water management practice is long-established in Romania being based on the concept with the following characteristics: waters belong to public domain, Government has the right to control any water use, excepting unorganized one for human and animal water supply, by the system of consents and permits, institutional organization is established on river basin level, water policy is implemented by means of Master Plans inter alia.

Integrated approach in water management might be discussed in territorial terms i.e management on river basin scale and from the point of view of aspects to be considered which means quantity and quality.

Both territorial and quantity-quality sides of integrated water management concept have been adopted in Romania since rather long time ago by reason of the local water characteristics:

- Resources: relatively poor (potential usable = 61 bill.m^3/av.year), unevenly distributed in time and space, 90 % based on surface waters (rivers, water reservoirs and natural lakes) and 10 % on groundwater
- Most important resource (Danube river) - marginal position at the Southern limit of country territory
- All main rivers are tributaries to Danube (15 river basins)
- Hydrological characteristics:
  - droughts in winter and summer, floods in spring
- Demand characteristics:
  - industrial and domestic water supply: slight seasonal variation
  - agriculture: peak in summer
  - energy production: higher in winter

Territorial water management integration has a tradition of about 80 years. Law on water regime entered into force in 1924. General Water Directorate within Ministry of Public Works and local Water Agencies have been established in 1924 and functioned till 1955, being replaced from then on by an independent national water administrative body (named committee, council, company or administration) with directorates/affiliates on each river basin. Ministry of Water and Environmental Protection was created in 1990.

Speaking about integration of water quantity dimension with water quality one, one can distinguish four stages:

- up to 1974

  Water quantity management oriented mainly to planning and design of main water reservoirs and flow diversions, with elements and activities regarding water quality protection.

- 1974 – 1990

  Water Quantity and Quality Management based on system approach: master plans on river basins; planning and design of other water reservoirs and flow diversions; control and implementation of new legislative acts such as: Water Law 8/1974 (provisions for water consent and permit, master plan on river basins), Law 1/1974 on National Program for Water Basin Development, Law 5/1989 on Rational Management and Use of Water Resources, STAS 4706/1988 (introducing maximum acceptable limits of chemical, biological and microbiological indicators for 4 quality categories of surface waters)

- 1990 – 2000: also Water Quantity and Quality Management in the framework of Environmental Protection: revised and updated master plans to reflect new economic circumstances, control and implementation of old and new legislative acts such as: new Water Law 107/1996 (provisions for water consent and permit, updated master plan on river basins); Water Management Strategy (1995); Environment Protection Law (1995); STAS 4706/1988 still in force; Law 14/1995 to ratify Convention for the Danube River Protection

National System for Water Quality Surveillance was set up in 1980 for surface waters and in 1987 for groundwater and has the following features:

- 21,900 km rivers: 318 control points (65 - daily, 240 – monthly); 1 control point for each 745 km^2 (in accordance with EUROWATERNET); more than 40 parameters
- Groundwater: 3600 points for quantity and 1434 for quality

- 2000 - forward: steps to Integrated and Sustainable Water Management in the spirit of 2000/60/EC Directive

Framework has been created since 1990 to involve more actors in water management process: Other ministries (agriculture, food & forests; public administration; public works, transport & housing; industry & resources; public finance; development & prognosis; education & research; health & family), Local administration, Water users and Public apart from Ministry of Water and Environment Protection, territorial Environmental Protection Agencies, "Romanian Waters" National Company (Administration), water basin directorates, Water Basin Committees.

In terms of legislation, at least the following references should be made.

National Strategy on Water Quality (2000) set up very ambitious directions out of which some have been accomplished: River Basin Committees (in 2000), new standards for classification of surface water and groundwater quality status (in 2003 for surface waters); main conditions to establish the protected areas (methodology to identify sensitive areas as required by Urban WWT Directive was carried out in 2002).

A more realistic work is Position Paper of Romania for chapter 22 – acceptance, approximation and implementation of EU environmental legislation (2001, 2002) that contains commitments on the approximation of 2000/60/EC and daughter directives.

All of these directives have been already transposed but for some of them Romania required a transition period between 7 and 15 years as needed. This is the most challenging situation that requires combined efforts of all actors involved in water management in our country.

On short term the following actions should be made:

End the process of legislation approximation; Update Strategy of Water Management, Modify the Water Law, Institutional strengthening at central level

On medium term:

River Basin Committees to be set up on a new legal basis; More authority to river basin Directorates;

Increasing role of local authorities for protection and ecologic rehabilitation of rivers; Development of a new economic mechanism for water management in general and for investments; River basin management plans have to be produced (this is a different concept compared with the traditional river basin master plan especially in terms of environmental objectives definition); Update the present monitoring system; Associations of water users to be set up (especially for irrigation).

On long term:

Implementation of new legislation and control; Rehabilitation of flood control structures; New water supply networks, sewage systems and wastewater treatment plants; Increasing role of public in decision making process; Development of multidisciplinary researches; Standard technologies; International cooperation.

Barriers:

- incomplete framework for public information and consultation
- public lacks knowledge of water management problems (excepting those related to hazards such as floods and droughts)
- law level of legislation implementation
- insufficient funds.

"Integrated River Basin Management : what does it mean for Poland?"

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General introduction

Poland is situated in the Central Europe, where western, Atlantic type of weather meets the continental ones. It results in a great temporal variety of yearly meteorological conditions manifested by significant changes in rainfall and evapotranspiration. The mean annual precipitation is highest in Carpaty Mountains in the south of Poland exceeding 1500mm, amounts over 700mm in the costal areas in the northern part of the country and it is equal to 500mm in the predominating lowlands of central Poland.

In general, there is abundance of rainfall over evapotranspiration on Polish territory. The excess of water is mainly drained by the Wisła River (168 699 km2 catchment in Poland) and the Odra River (106 057 km2 catchment in Poland). Other rivers drain only 37 922 km2 of Polish territory. The Odra River and The Wisła River belong to catchment of the Baltic Sea. Less then 13% of Polish water resources come from outside the polish territory.

The land use in Poland is balanced between agricultural lands (59,4%), forests (29,0%), open waters (2,7%), residential areas (3,3 %), communication and wastelands (4,8%).

The mean annual surface runoff in last 50 years amounted to 62 km2. This gives the per capita annual resources of 1600m3, which belongs to the smallest in Europe. The biggest problem however is in the dry years, when the total outflow is less then 38 km3 per year. Looking for available resources e.g. with 95% of probability of occurrence and reduced by minimum biological flow one arrives to 15 km3 and 250m3 per person per year. Other outflow index – per land area is also small and equal to 5.5 l/s*km2, which is a half of average for Europe.

Poland has relatively rich and clean underground water resources. There are 180 Main Underground Water Reservoirs (i.e. potential well output 70m3/h and pumping output over 10000 m3/day) of total area 163 441 km2, 53 % of water resources has quandary origin. The water quality suffers from point sources pollution around big cities. Locally upper aquifer is endangered through manure deposition.

The population of Poland is 38,6 mln. Habitants. Poland is divided into 16 voievodeships, 373 districts and 2489 communes. The present water intake per capita is equal to 310 m3/year, what is less then half of European consumption. Around 20% of water is used for municipal, 9% for agriculture and 71 % for industry.

Governance

In February 2000, the Minister of the Environment created the Office of Water Management. The activity of the Office is aimed at harmonizing the operation of the Regional Water Boards (RWB) and assistance in organizing actions serving the rational use, preservation and protection of water resources. There are seven RWB's, which operate in the water regions having the following tasks:

- identification of the status of water resources and the state of flood protection in a water region;
- analysis of catchment conditions for issuing the water permits;
- control measures.

In the field of water management RWBs maintain the control structures and the hydraulic installations, carry out investments in water management infrastructure, maintain waterways for inland navigation, and participate in flood prevention and ice – breaking actions. 16 Provincial Boards of Land Improvement and Water Facilities, submitted to local authorities and to the State Agency of Farmlands, control surface waters, which are not administered by RWBs.

Their directors govern waters situated on the territory of the National Parks. Water permits for water resources utilization are granted by the Heads of the Districts, who govern the districts and fulfill this task as a responsibility within the government's administration.

Spatial planning tasks are carried out by local authorities: provincial, district and communal. The environment monitoring and the control of respecting the law belong to the Chief Inspector of the Environment Protection. On the territory of a voievodeship the Provincial Inspector of the Environment Protection fulfills this task

Draft SWAT Analysis

Strengths:

- High natural values of number of medium sized rivers, especially lack of their fragmentation due to hydraulic infrastructure;
- Very high natural values of number of floodplains of medium and big size rivers, including wetlands in different protection status;
- Positive trend in water quality due to investments in sewage treatment plants both in cities as well as in industrial facilities, collapsing of the heavy industry;
- Low level of inland waterways development and good developed railway structure;
- Working practice of management on river basin scale via Regional Water Boards;
- Good working Water Permits system;
- Introduction in number of cities water metering leading to significant savings of water;
- Lack of industrialized, based on intensive irrigation agriculture;

Weaknesses:

- Weak co-operation between key departments of Polish Ministry of Environment (the Water management Dept. and the Nature Conservation Dept.) and between different ministries dealing with water issues (e.g. between Ministry of Environment and Ministry of Agriculture);
- Very low budget investments in modern water management facilities (monitoring, floodplain restoration projects, river basin management plans, etc) or modernization of the old hydraulic structures;
- Relatively weak Polish tradition of resolving conflicts by the mean of dialogue between governmental authorities and

broad array of groups of interest; weak tradition of public participation;

- Limited numbers and weakness of environmentally-oriented Polish NGOs who could play key role in implementing WFD;
- Lack of national water management plan;
- Lack of national wetland restoration plan;
- Big and difficult to fill gap in understanding in practical terms "integrated management" between Polish hydrologists and environmentalists even in currently run governmental programs.

Opportunities:

- Necessity for Poland to restructure approach to water management in order to meet requirements of WFDan other EU Directives;
- New tool in dealing with dam issues in form of the World Commission for Dams Report;
- Significant number of old hydraulic infrastructure, which can be environmentally sound modernized;
- National Water Management Plan, which is currently developed, may include the newest approach to water management.

Threats:

- Generally very challenging deadlines for implementing WFD in EU countries;
- Very limited amount of time left for present Polish water managers for revolutionary change of their "state of minds", especially the way in which water is perceived

through the perspective of WFD and the need of introducing participatory process in decision making;

- Assuming that “information” is equal to “participation” also by river basin stakeholders;
- Development of intensive, farm type of agriculture subsidized by CAP.

References

Rada Ministrów – “Polityka ekologiczna państwa na lata 2003 – 2006 z uwzględnieniem perspektywy na lata 2007-2010”. Warszawa, grudzień 2002 r.

GUS – Rocznik statystyczny “Ochrona Środowiska 2002”

Instytut Geografii i Przestrzennego Zagospodarowania PAN (1994) - “Atlas zasobów walorów i zagrożeń środowiska geograficznego Polski”

Instytut Meteorologii i Gospodarki Wodnej (1996) - “Stan i wykorzystanie zasobów wód powierzchniowych Polski”

Instytut Meteorologii i Gospodarki Wodnej (1999) – “Zasoby wodne kraju” (przegąd stanu na dzień 31 października 1999)

Kleczkowski A. S. (1990) – “Mapa obszarów głównych zbiorników wód podziemnych (GZWP) w Polsce wymagajacych szczególnej ochrony”, Instytut Hydrogeologii i Geologii Inżynierskiej AGH

Okruszko T. et all Wetland and Water Index II, Poland National Report, (2003) WWF draft version

Państwowa Inspekcja Ochrony środowiska (1999) – “Stan czystości rzek, jezior i Bałtyku na podstawie wyników badań wykonywanych w ramach państwowego monitoringu w latach 1997-1998”

"Planning of wastewater collection and treatment facilities on the river basin scale"

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INTRODUCTION

The great quantity of water resources, though not equal distributed in time and space, is one of Slovenia's greatest comparative advantages. Also, for the time being quality of potable water distributed to 85 % of the Slovenian citizens corresponds the EU drinking water standards. Potable water is distributed without any pre-treatment of groundwater resources to the users. Unfortunately the same cannot be expressed for the quality of surface waters and of potential risk of different sources of pollution, particularly disbursed municipal sources, to the quality of groundwater in the near future.

In accordance with National Programme for Adoption of the Acquis Communautaire, the EU environmental legislation was transposed to the national legislation through the Environmental Protection Act, the Water Act and to the corresponding Ordinances and Decrees, adopted in period 1999-2002, by which the sector specific EU standards and corresponding implementation schemes and periods were defined. The National Environmental Action Programme is the basic strategic document, which define the national environmental policy and main objectives of different environmental sectors. Corresponding to directions, stated in Environmental Protection Act, main environmental objectives, stated in the National Environmental Action Programme, the sectoral Action Plans for implementation of the investment-intensive Directives in water, waste and air sectors were elaborated. The activities under the Action Plan for Urban Wastewater Collection and Treatment focus on the implementation of technical measures (programmes, investments) for reducing discharges into waters from municipal sources of pollution, and protecting the quality and quantity of waters earmarked for drinking water supply.

The main objectives of Actin Plan are to achieve the second quality class of surface waters, to introduce the sustainable protection and use of water resources, based on Water Framework Directive principles, to respect the functioning of aquatic ecosystems and in accordance with drinking water standards, to protect the quality of drinking water resources – particularly groundwater and carst surface water resources.

Specific geographic an demographic conditions in the Republic of Slovenia caused extremely costly solutions for reduction of municipal sources of pollution in case each of aglomeration or municipality solves the problem separately. Namely, there are only a few high populated urbanised areas in Slovenia, the rest of territory incorporates disbursed populated areas, located usually in lowlands on the surface of groundwater resources. In sense of optimising the costs of reduction of municipal sources of pollution to water, the river basin approach has been implemented in Slovenia in this particular sector already before the Water Framework Directive was in power. The different technical solutions could be optimised much more feasible and less costly on the river basin level, beyond the municipal borders, than behind the municipal borders.

PRESENT STATE OF URBAN WASTEWATER COLLECTION AND TREATMENT

Briefly the present state of wastewater management in Slovenia can be presented the following:

- only 53% of inhabitants are connected to the public sewage system
- sewers are not watertight
- only 30% of inhabitants are connected to wastewater treatment facilities
- numerous of small municipalities, established in rural areas
- lack of an integral approach to the reduction of municipal sources of pollution between municipalities
- lack of an integral approach to the reduction of sources of pollution between different sectors (e.g. industry, agriculture with livestock-breeding farms)
- risk of acute eutrophication of natural and artificial lakes
- risk of pollution of groundwater sources

Taking under consideration the above listed problems in wastewater management sector, it is important to adopt a broad-based approach to problems of water pollution and water protection, based on the River Basin level. The criteria defined by the legislative and programme documents enables the adoption of an integral approach to wastewater management within individual River Basins as ecological units, i.e. the introduction of the sustainable use and protection of the quantity and quality of waters while respecting the functioning of aquatic ecosystems and limits of water reserves, with an emphasis on the protection of drinking water and the ecological balance of the basin.

MAIN WASTEWATER MANAGEMENT OBJECTIVES

The main objectives expected to be achieved, defined by NEAP, NDP and corresponding Action Plan are the following:

- protection of groundwater aquifers and surface waters, used for potable water supply;
- reduction of pollution to waters, proclaimed for sensitive areas (e.g. lakes and reservoirs, Coastal Adriatic Sea)
- reduction of direct discharges of wastewater to nature lakes, wetlands and other nature and biodiverse protected aquatic environment
- protection of bathing waters
- protection of fish and shellfish waters
- reduction of discharges of wastewater to transboundary waters

ESTIMATED COST OF IMPLEMENTATION OF ACTION PLAN AND AVAILABLE SOURCES OF FUNDING

The following table represents the estimated costs and sources of funding for implementation of Action Plan

Sources of founding	**Estimated costs** mio EUR
State Budget - wastewater pollution tax	320,90
State Budget – direct co-financing (grant)	55,70
Municipal Budget	96,10
European Programmes grant	90,00
Private co-financing	114,90
TOTAL	677,60

The available financial sources for implementation of Action Plan are the following:

- state budget
  - state budget direct co-financing (inclusive EIB Framework Loan)
  - waste water pollution tax (introduced in 1996)
- municipal budget
  - municipal budget direct co-financing (inclusive Eco Fund non-commercial loans, granted to the selected priorities of the NEAP)
  - municipal tax
  - charges for water consumption and collection and waste management
- EU co-financing programmes - grants
- private sector: concession contracts (B.O.T. models), joint co-financing with public sector

INSTITUTIONAL SCHEME FOR IMPLEMENTATION

In Slovenia those responsible for the integral sustainable water management are Ministry of Environment, Spatial Planning and Energy at the national level and municipalities at the local level, sharing the responsibility for the implementation of national policy, as well as other institutions, non-governmental organisations and the public, whose joint objective is co-ordination of different interests pertaining to the use and protection of water.

In the field of municipal wastewater collection and treatment, co-ordination of activities between the local and national levels is particularly important. Refer to the Environmental Protection Act, the state, i.e. the are Ministry of Environment, Spatial Planning and Energy, is responsible for the overall management of water, including municipal water supply and wastewater collection and treatment, while the municipalities, i.e. the local level of management, are responsible for the implementation of those activities. Efficient wastewater collection and treatment therefore demand that the two levels should co-operate at all stages of the strategic planning, preparation, implementation and management of concrete investments.

BASIC SELECTION CRITERIA FOR IDENTIFICATION OF PRIORITIES FOR IMPLEMENTATION OF ACTION PLAN

The basic criteria are the following:

- compliance with EU environmental policy objectives

  - preserving, protecting and improving the quality of water environment
  - introducing sustainable water management, based on river basin management principles
  - protecting human health.
- location of municipal source of pollution (groundwater areas, sensitive areas, nature protected areas)
- river basin approach in sense of demonstration of:
  - quantitative most-effective reductions in pollution (environment-efficiency criteria),
  - long-term optimal maintenance (affordability criteria),
  - cost-effectiveness of investment and operation (cost-efficiency criteria)
- implementation EU technical and environmental standards
- introduction of strong partnership between central and local authorities
- contribution to economic and social cohesion of Slovenia with the EU (showing the highest net economic and social benefits)

The integral approach to all of the above mentioned criteria within individual river basins as ecological units enables the determination of priority fields for the implementation of measures to reduce discharges into waters from municipal sources of pollution. The degree of vulnerability or sensitivity of areas within individual river basins as defined by the above mentioned criteria is the criteria for determining both the priority areas and the timetable for the implementation of individual measures in those areas.

SENSITIVE (VULNERABLE) AREAS
Eutrophication areas (all natural lakes, coastal sea)
Groundwater areas dedicated for potable water supply (alluvial and Karst aquifers)
Wetlands and biodiverse areas
Areas of watercourses reserved for bathing water
POTENTIALLY SENSITIVE (VULNERABLE) AREAS
Prospective eutrophication areas (artificial barrages)
Cross-border watercourses
Areas with intensive industrial and agricultural production (livestock-breeding farms)
Small-self purification capacity of watercourses (small self-purifying capacity)
NON-SENSITIVE (NON- VULNERABLE) AREAS
Large-self purification capacity of watercourses (great self-purifying capacity)

IDENTIFIED PRIORITIES FOR IMPLEMENTATION OF ACTION PLAN

The following table represents the identify priorities for implementation of Action plan, located in sensitive and potentially sensitive main River Basins of Slovenia.

THE SAVA RIVER BASIN	
The Sava-Bohinjka Sub-River Basin	
Investments	Prioritisation criteria

Investment project Wastewater collection and treatment of Sava Bohinjka Sub-River Basin programme incorporates:
• extension of the sewage network
• construction of
  • Bled-Radovljica main collector
  • Bohinjska Bistrica UWWTP – 11,000 PE
  • Radovljica UWWTP – 30,000 PE
	Sensitive area according to **criteria**:
	• eutrophication area – natural lakes
	• bathing water (Bohinj, Bled)
	• protected area of Triglav National Park (Bohinj)
	• refer to Water Framework Directive, the programme provides integral measures of wastewater management of Sava Bohinjka Sub-River Basin

The Middle Stream Sava Sub-River Basin:	

Investment project Integral protection of groundwater of Ljubljansko polje incorporates:
• extension of the sewage network
• construction of
  • Ljublajna CWWTP – 390.000 PE
  • main collectors to CWWTP Ljubljana
  • wastewater collection and treatment facilities of other municipalities located on Ljubljansko polje aquifer
	Sensitive area according to the **criteria**:
	• protected area of water supply sources (alluvial aquifer – Ljubljansko polje)
	• refer to Water Framework Directive, the

<table>
<tr><td></td><td>programme provides integral measures of municipal wastewater reduction to groundwater resource</td></tr>
<tr><td colspan="2">The Middle Stream Sava Sub-River Basin:</td></tr>
<tr><td>Investments</td><td>Prioritisation criteria</td></tr>
<tr><td>Investment project Wastewater collection and treatment of Middle-Sava Sub-River Basin incorporates:
• extension of sewage network
• construction of
  • Litija UWWTP – 11,000 PE
  • Zagorje UWWTP – 17,000 PE
  • Trbovlje UWWTP - 18,000 PE
  • Hrastnik UWWTP - 11,000 PE</td><td>Sensitive area according to criteria:
• eutrophication area – artificial lakes of the future chain of hydropower plants on the Sava
• refer to Water Framework Directive, the programme provides integral measures for wastewater management in Middle-Sava Sub-River Basin</td></tr>
<tr><td colspan="2">The Down Stream Sava Sub-River Basin</td></tr>
<tr><td>Investment project Wastewater collection and treatment of Paka Sub-River Basin incorporates:
• extension of the sewage network
• construction of Velenje (Velenje, Šoštanj) UWWTP - 50,000 PE</td><td>Potentially sensitive area according to criteria:
• area with intensive mining production – joint treatment of mining effluent
• refer to the Water Framework</td></tr>
</table>

	Directive, the programme provides integral measures for wastewater management in Paka Sub-River Basin
Investment project Wastewater collection and treatment of Krka Sub-River Basin incorporates: • extension of the sewage network of Novo mesto and other 19 municipalities in Krka Sub-River Basin • construction of wastewater treatment facilities of Novo mesto 45,000 PE and other 19 municipalities in Krka Sub-River Basin	**Sensitive area** according to the **criteria**: • reduction of discharges into watercourses with poor self-purifying capacity • refer to the Water Framework Directive, the programme provides integral measures for wastewater management of Krka Sub-River Basin

The Down Stream Sava Sub-River Basin	
Investments	Prioritisation criteria
Investment project Wastewater collection and treatment of Down Stream Sava Sub-River Basin incorporates: • extension of the sewage network of Sevnica, Krško and Brežice	**Sensitive area** according to **criteria**: • eutrophication area – artificial lakes of the future chain of

<table>
<tr><td>

- construction of
  - Sevnica UWWTP - 10,000 PE
  - Krško UWWTP - 280,000 PE
  - Brežice UWWTP - 13,000 PE

</td><td>

hydropower plants on the Sava

- protected area of water-supply sources (alluvial aquifer – the Krško-Brežiško polje)
- reduction of discharges to watercourses with cross-border impact (border area)
- refer to the Water Framework Directive, the programme provides integral measures for wastewater management in Down Stream Sava Sub-River Basin

</td></tr>
<tr><td colspan="2">THE DRAVA RIVER BASIN</td></tr>
<tr><td>

Investment project Wastewater collection and treatment of Mislinja Sub-River Basin incorporates:

- extension of the sewage network in Dravograd, Mislinja, Slovenj Gradec
- construction of
  - Dravograd UWWTP- 9,000 PE
  - Mislinja UWWTP – 1,500 PE
  - Slovenj Gradec UWWTP - 20,000 PE

</td><td>

Potentially sensitive area according to **criteria**:

- reduction of discharges into watercourses with poor self-purifying capacity
- protected area of bathing waters
- refer to the Water Framework Directive, the programme provides integral measures for

</td></tr>
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	wastewater management of Mislinja Sub-River Basin
Integral Protection of Groundwater of Dravsko-Ptujsko polje incorporates: • extension of sewer system of Ptuj and other municipalities located on Dravsko-Ptujsko polje • construction of wastewater treatment facilities of Ptuj UWWTP – 30,000 PE and other municipalities located on Dravsko-Ptujsko polje	**Sensitive area** according to **criteria**: • Urban Waste Water Directive • protected area of water supply sources (alluvial aquifer – Ptujsko polje groundwater)
THE SOČA RIVER BASIN	

Investment project Wastewater collection and treatment of Soča River Basin incorporates:
• extension of the sewage network
• construction of
    • Bovec UWWTP - 6,500 PE
    • Kobarid UWWTP – 4,100 PE
    • Most na Soči UWWTP - 1,000 PE
    • Nova Gorica UWWTP - 45,000 PE
• extension of Ajdovščina UWWTP-20,000 PE
	Potentially sensitive area according to **criteria**:
	• protected area of the Soča River (Soča trout)
	• the programme provides integral measures for wastewater management of Soča River Basin
	• reduction of discharges into watercourses with cross-border impact

COASTAL SEA RIVER BASIN	
Investment project Wastewater collection and treatment of Coastal Sea River Basin incorporates: • extension of the sewage network • construction of	**Sensitive area** according to the **criteria**: • coastal sea eutrophication area • protected area for

• Koper, Izola UWWTP - 85,000 PE • Piran UWWTP - 35,100 PE	bathing water • protected area for fish and shellfish water • refer to Water Framework Directive, the programme provides integral measures for wastewater management in Coastal Sea River Basin

BASINS CASE STUDIES

"The Maritza River Basin"

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Background

The Maritza river basin is the biggest one in Bulgaria with its watershed of 21 084 km^2 which is 1/5 of the territory of the country (Figure 1). It includes various physical-geographic areas and landscapes such as Thracian lowland, Sub-Balkan kettles and several mountains.

Figure 1

The climate is continental with slight Mediterranean influence. The average annual precipitation sum is 550-660 mm but has irregular monthly distribution. The maximums are in May and June, and the minimums are in February, July and August. The Maritza River takes its source from the Rila Mt. and discharges into the Aegean Sea. It has about 100 more important tributaries. The river length on Bulgarian territory is 321,6 km and the river basin is characterized with rich surface and ground waters. The Maritsa River basin with the catchment areas of its tributaries Toundzha and Arda belongs to the East-Aegean river basin management basin. The watershed of Toundzha River is 7 980 km^2 and its length is 350 km. The Arda River is 241 km in length and its watershed is 5 200 km^2. They both mouth in to the Aegean Sea. These three rivers form in the country a part of the international river basin in cooperation with Greece and Turkey. Bulgaria has signed long ago the "Agreement between the Republic of Bulgaria and the Kingdom of Greece for the Use of River Water". There is no such a document between Bulgaria and Turkey.

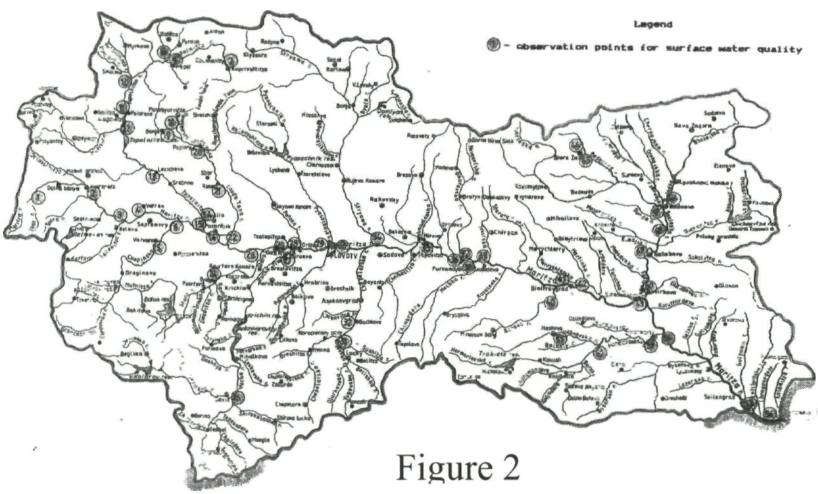

Figure 2

Peculiarities of the river basin

The considered River basin has favorable topographic, climatic and hydrologic conditions, fertility of the soil, and mineral resources. The population is 1 547 777 millions. These circumstances have provided the possibility for intensive development of agriculture and industry, the numerous population and significant hydro-technical construction. A large-scale multi-purpose water resource system has been build up including big irrigation systems and the most high-headed hydro-power cascades in the country. Many protected areas, wetlands and sensitive zones, reserves, et so on are located in the considered watershed.

The vigorous economic and demographic development of the region determines significant water demands for irrigation, domestic and industrial water supply, hydro-power generation, recreation, fishery, water quality improvement, meeting ecological needs, etc. At the same time the various human activities mentioned above and the high density of population in this River basin strongly affected the environment and particularly the water component. In many cases the water quality parameters do not meet the corresponding standards or river discharges at some sites are too small to provide the habitats of water ecosystems.

For this reason, the region under consideration had the highest priority in activities for protection and rehabilitation of water. On the Figures 2 and 3 the observation points and pollution sources for surface water quality that are studied are shown. After that were initiated many other projects that are listed below. There are only few wastewater treatment plants (WWTPs) in this region and the building of new ones are provided. During the First Workshop on IWM in Antwerp some other of the obtained results for this River basin were shown (Figures 5 to 10). They were: scheme of water resources use, hydro graphic network of the river, general water resources scheme, scheme of water supply sources, water quality by different category chemical parameters (2),WWTPs.

Activity for implementation of integrated water management (IWM) in the Maritza River Basin

During the last 9 years a considerable number of national and international projects have been developed :

- Strategy proposal for UNDP assistance in the management

and rehabilitation of environment in the Maritza river basin (1994);

- Environmental management in the Maritza river basin, JICA and Ministry of Environment and Waters (MOEW) (1998);
- Schemes of water resources utilization in the river basin management districts, Contract between the Institute of water Problems and MOEW (2000);

Preliminary study for identification of sensitive zones in the in the Mesta, Struma, Arda, Tundja and Maritza river basins according to the Directive 92/271/EEC criteria (2003)

"The Schelde: managing a heavily impacted river"

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General introduction: The Schelde and its catchment

Both the catchment and the river Schelde itself (total length 350 km) are very small compared to most other European river basins. Nevertheless the river crosses three countries (F, B, Nl) and the basin is divided over 5 riparian regions (Table 1) since Belgium is a federal country.

France	Wallonia (B)	Brussels (B)	Flanders (B)	The Netherlands	Total
6.680	3.787	162	9.375	1.859	21.863
31%	17%	1%	43%	8%	100%

Table 1: Surface (km^2) of the Schelde basin in the 5 riparian regions.

It is characterized by a very high population density (477 inhabitants/km^2) that results in many different pressures on the system. Remarkable is that 160 km of the river is under tidal influence. Hence, the Schelde estuary is one of the largest in Europe and also one of the very few with a complete gradient from fresh to salt water tidal areas (ICBS-CIPE, 1994). For a more detailed description see Meire et al. (1991), papers in Meire and

Vincx (1993), Heip and Herman (1995) and Ysebaert et al. (1993,1998).

Impact of human activities

The impact of human activities is analysed according the different structures and relations in the ecosystem (Fig. 1).

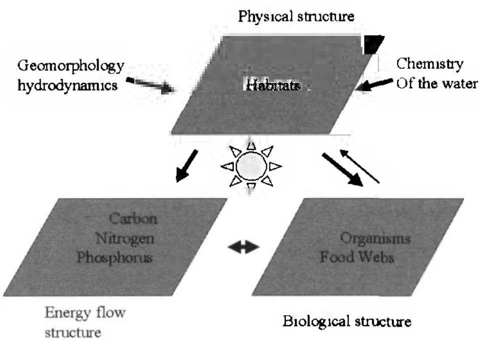

Figure 1. Different components of the ecosystem: the physical structure and the structural and functional biodiversity (after Buis & Meire 2002)

Habitat loss was very common in the past century. Along the estuary about 15 % of all intertidal areas were reclaimed for industrial and agricultural purposes during the last 100 years (Van den Bergh et al. 1999). Also throughout the entire basin, valuable habitat is lost mostly to urbanisation. Of the remaining habitats much is degraded due to human uses. More than 15 million cubic meters are dredged yearly to maintain the fairway to the harbour of Antwerp. This has an important impact on the geomorphology of the estuary. However all the dredging for nautical or hydraulic reasons throughout the basin and especially in the small rivers and brooks have a tremendous impact as often everything is removed from bank to bank.

The habitat structure is also to a large extent the result of the hydrodynamics. Both the sea and the runoff from the basin influence the estuary. At the mouth of the estuary sealevel rose by some 30 cm last century. This together with the dredging and embankments caused the tidal amplitude to increase by more than 1 meter near Antwerp in 100 years. Several characteristics of the tide changed significantly also affecting the morphology. On the other hand the total amount of fresh water reaching the head of the estuary decreased significantly as about 60% of the discharge of the river is diverted to canals in France and Flanders. This of course has an important impact on the salt intrusion in the estuary. Within the basin, human impacts resulted in general in much higher peak discharges and a shorter lag time between the peak of the rainfall and the discharge peak in the river. This together with an increased urbanisation of former floodplains results in more frequent floodings of houses and more economic damage during each flood.

The aquatic system is also under permanent stress caused by a high load of urban, industrial and agricultural waste water. Although recently large investments were made in water purification plants, up to 45% and 25% of the loads from nitrogen and phosporous are coming from non point sources (ICBS 1994), hence the problem of eutrofication is likely to become very important. Now we see already massive growth of macrophytes in the Nete catchment (Bal 2001). As these macrophytes increase strongly the roughness of the river they have an important impact on water levels. Hence removing these plants becomes an important management activity throughout the basin often resulting in serious loss of biodiversity.

Both habitat structure and waterquality determine the biodiversity of the system (Fig. 1). In large parts of the estuary, the Schelde and its tributaries, biological communities are very impoverished. The impact of water quality on biota is well known but more and more it is obvious that also habitat structure itself impacts biodiversity. Indeed species richness is well corellated with habitat area, largers habitats having more species. On top of this, the loss of connectivity between habitats also negatively affects species diversity.
Notwithstanding these problems, investments in water purification plants result in improving waterquality, especially concerning the oxygen status of the rivers. In respons e.g. fish communities in the brackish part of the estuary are recovering (Maes et al. 1998) and waterbird populations increased (Ysebaert et al. 2000)

The third pilar in our approach (Fig. 1) is the functional biodiversity. Different ecosystem functions such as:

- the regulation of biological processes (productivity ...)
- the regulation of hydrological processes (prevention of flooding, water storage,...)
- the regulation of biogeochemical processes (storage and (re)-cycling of nutrients, water purification,...)
- the regulation of geomorphological processes (control of erosion, retention of sediments,....)

have been identified by de Groot (1992) and Costanza et al. (1997). The impacts on the system as described briefly above, result in a decrease of these ecological functions. Soetaert and Herman (1995) showed that the removal of nitrogen in the Schelde estuary by biogeochemical processes decreased, leading to higher loads reaching the coastal sea. The loss of retention capacity for water in the basin results in higher peak discharges. This in turn results in the flushing out of phytoplankton reducing the primary productivity (Muylaert 1999).

Towards an integrated management

To achieve sustainability, the ecosystem functions should be restored to a level where the ecosystem reaches the carrying capacity needed for current and future anthropogenic demands. A very simple paradigm as starting point is given in Fig. 2. The watershed is a system. Human impacts have an impact that results in increased losses from the system. More water is lost from the system due a reduced retention. This causes inundations downstreams, water shortage in drier periods, losses of sediments due to erosion because of higher current velocities etc. More nutrients are lost due to a higher input and less internal recycling.

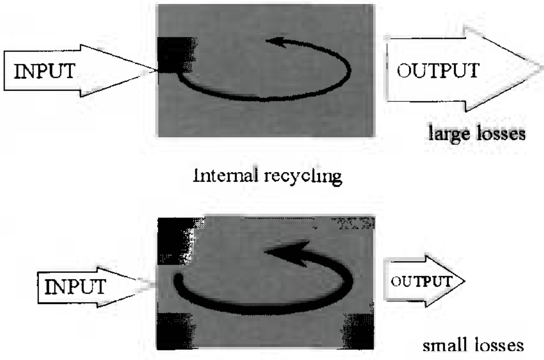

Figure 2. A system approach of a watershed. Management should reduce input, enhance internal recycling to reduce the losses from the basins.

Sediments are transported downstream were sedimentation increases, resulting in problems for both hydraulics and navigation etc. Finally biota are lost resulting in reduced self purification, less productivity…

An integrated approach should therefore aim at reducing the input to the system (e.g. of pollutants) and highly increase the internal recycling possibilities of the system. This means to a large extend restoration of crucial habitats like wetlands. Indeed their capacity for water retention, water storage, water purification etc. is very high.

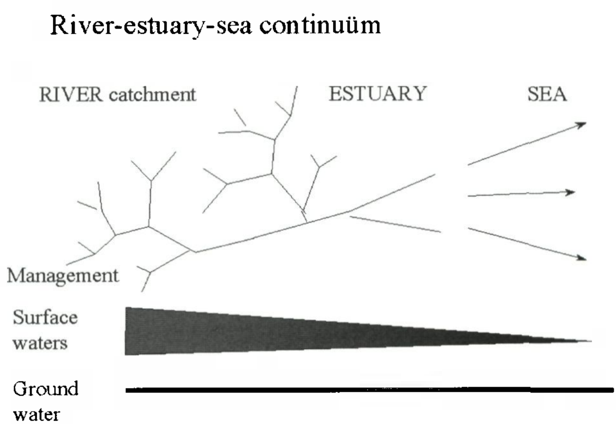

Figure 3. River-estuary-sea continuüm indicating the importance of managing surface waters as far upstream as possible.

This should be done within the whole catchment as it forms one continuum from source to mouth (Fig. 3). The possibility to manage the surface waters (both quality and quantity) is much easier upstream than downstream. The estuary is the last opportunity to manage the waters before reaching the coastal sea. Once here it is not possible anymore to manage neither water quantity nor quality. The groundwater compartment is very difficult to manage throughout the basin. Therefore, increasing the carrying capacity of the watersystem to accommodate the different human uses should start with the restoration of ecological functions within the river basin. This will result in an increase of goods and services to be delivered by the ecosystem of watersystem towards the socio-economic system (Fig. 4). Ecological engineering will be of major importance to create and restore the necessary habitats along the whole river continuum. Classical engineering will be crucial in reducing the input to the system and enhancing recycling of water within the water chain. Legislation, policy and organisation of all services concerned will be necessary to achieve sustainable development within this catchments (see Meire & Coenen this volume). As however the continuity of our human society entirely depends on the goods and services delivered by the watersystem there is no other option.

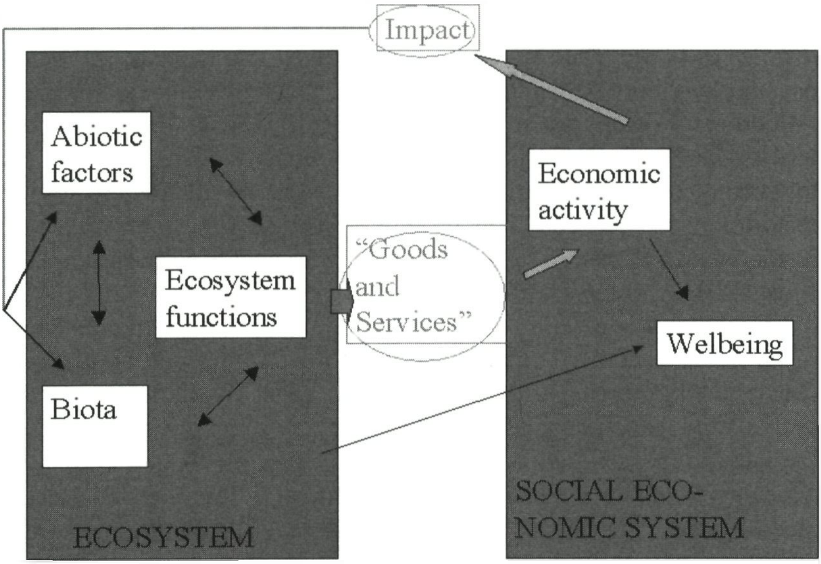

Figure 4. Relation between the ecosystem and the socio-economic system indication the crucial role of the ecosystem goods and services to be delivered by the ecosystem.

References

Bal K. 2001. *Het effect van macrofyten op de afvoercapaciteit van waterlopen. Een experimentele benadering.* Scription for obtaining the degree of Masters in Biology, promotor is prof. P. Meire, University of Antwerp, Antwerp, 93 pp.

Baeyens W., B. van Eck, C. Lambert, R. Wollast, L. Goeyens, 1998. 'General description of the Scheldt estuary'. In: Baeyens W. (ed.), 1998. *Trace metals in the Westerschelde Estuary.* Kluwer Academic Press, Brussel

Buis K. & P. Meire, 2002. *Voorstel voor een algemeen concept om ecosystemen en hun onderlinge samenhang in rivierstroomgebieden te beschrijven*. In opdracht van de Vlaamse Milieumaatschappij en Rijkswaterstaat, directie Zeeland in het kader van een ecologisch actieplan voor het eerste Scheldeactieprogramma (SAP)

Costanza R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. O'Neil, J. Paruelo, R. Raskin, P. Sutton, M. van den Belt, 1997. *The value of the world's ecosystem services and natural capital*. Nature 387: 253-260

de Groot S., 1992. *Functions of nature: evaluation of nature in environmental planning, management and decision-making*. Wolters-Noordhoff, Groningen

Heip C.H.R., P.M.J. Herman (eds.), 1995. *Major biological processes in European tidal estuaries*. Hydrobiologia 311, 266 pp.

Maes J., P.A. van Damme, A. Taillieu & F. Ollevier, 1998. *Fish communities along an oxygen-poor salinity gradient (Zeeschelde Estuary, Belgium)*. Journal of Fish Biology 52, 534 – 546.

Meire P., M. Vincx (eds.), 1993. *Marine and estuarine gradients. Proceedings of the 21th Symposium of the Estuarine and Coastal Science Association*. Neth. J. Aquat. Ecol. 27, 496 pp.

Meire P.M., J.J. Seys, T.J. Ysebaert & J. Coosen, 1991. 'A comparison of the macrobenthic distribution and community structure between two estuaries in SW Netherlands' In M. Elliott & J.-P. Ducrotoy (Eds.), *Estuaries and Coasts: Spatial* *and temporal intercomparisons*. Olsen & Olsen, Fredensborg, Denmark: 221-230.

Muylaert K., 1999. *Distribution and dynamics of Protist Communities in a Freshwater Tidal Estuary. Verspreiding en Dynamiek van Protistengemeenschappen ineen Zoetwatergetijdengebied.* PhD thesis, University of Gent, Gent.

Soetaert K., P.M.J. Herman, 1995. *Nitrogen dynamics in the Westerschelde estuary (SW Netherlands) estimated by means of the ecosystem model MOSES.* Hydrobiologia (1-3): 225-246 Sep.1 1995

Van den Bergh E., P. Meire, M. Hoffmann & T. Ysebaert, 1999. *Natuurherstelplan Zeeschelde: drie mogelijke inrichtingsvarianten* Rapport IN. 99.18, Brussel

Ysebaert T., P. Meire, D. Maes & J. Buijs, 1993. *The benthic macrofauna along the estuarine gradient of the Schelde estuary.* Neth. J. Aquat. Ecol. 27: 327-341.

Ysebaert T., P. Meire, J. Coosen & K. Essink, 1998. *Zonation of intertidal macrobenthos in the estuaries of Schelde and Ems*. Aquat. Ecol. 32: 53-71.

Ysebaert T., P.L. Meininger, P. Meire, K. Devos, C.M. Berrevoets, R.C.W. Strucker & E. Kuijken, 2000. *Waterbird communities along the estuarine salinity gradient of the Schelde estuary, NW-Europe.* Bio
diversity and conservation 9:1275-1296

"Management of transboundary waters on the external European Union border – a pilot study of the Lake Peipsi/Chudskoe Basin"

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The paper addresses issues specific to planning of water protection measures in transboundary water basins located on the external European Union border. The case study of the Lake Peipsi/Chudskoe, a large transboundary lake shared by Estonia and Russia, is used to demonstrate issues of management of transboundary waters on the Eastern European fringe.

Introduction

Transboundary water management is faced with the task of successfully solving complicated problems dependent on the specific conditions created by the interaction of two or more political systems (Gooch at al., 2002).

Transboundary water basins shared by EU countries and EU accession countries or otherwise EU accession countries and New Independent States of the former Soviet Union are usually new emerging or reconstructed borders, as it is in the case of the Estonian – Russian border, where institutions, including procedures for communication and cooperation are still in transition and where transboundary stakeholder networks *are still weak and not yet institutionalised.*

Another important feature of transboundary areas on the European external borders is a growing gap in socio –

economic development and living standards on different sides of the EU external borders. In the case of the Lake Peipsi/Chudskoe, on the Russian side, there is much less of the local funding as well as less to compare to the Estonian side international funding is available to support implementation of environmental protection measures and therefore economic basis of water protection is much more poor on the eastern side of the border. If this gap between the two sides of the border area grows very high, it is likely there will be little mutual understanding between the organisations and stakeholders on different sides of the border and as a result trust and cooperation across the border can decrease.

These issues and conditions specific to the transboundary waters located on the EU external borders should be taken into account when developing programs for water management in these transboundary water basins. Transboundary water basins located on the EU external borders should be managed interactively, i.e. through regular communication and consultation among all major stakeholder groups in these basins as neighbouring countries sharing these water basin have lots of differences between each other in the institutions, social and economic development; and are in a process of economic and political transition. As the situation in these border transboundary basin changing all the time, the water planning and management has to be interactive.

The described below experience of preparation of a transboundary Lake Peipsi/Chudskoe Basin Management Program is described that demonstrates how these conditions were taken into account in the process of planning intercatively water protection measures in the Lake Peipsi/Chudskoe Basin.

Lake Peipsi/Chudskoe basin – water management issues

Lake Peipsi/Chudskoe is the fourth largest lake in Europe with a large drainage basin. The lake basin's major environmental problems are connected with water eutrophication and reduced fish stocks. Eutrophication due to significant nutrient loads in Lake Peipsi/Chudskoe represents a major threat for the water quality of the lake directly connected to the Baltic Sea by the Narva River. Water eutrophication, which is expected to increase in correlation with the economic recovery of the region, is regarded mainly dependent on the development in the agricultural sector (Stålnacke, Roll, 2002). In addition, the potential increase of the agricultural production in future without improvement in agricultural practices can considerably affect potential of the lake for supporting important Baltic Sea area habitats for wildlife.

Researchers in the MANTRA East research project elaborated integrated scenarios for the development and environment in the lake Peipsi/Chudskoe Basin for the period of 15 – 20 years based on which formulated their statement on what are the major environmental issues in the lake basin and what should be done to improve the environmental situation.

The scenarios were developed using the story-line methodological approach and using qualitative as well as quantitative information as input into the scenarios. Points of entry of the scenarios' development are the transboundary aspects and regional development (international cooperation and economical development) and their consequences for nutrient emissions/riverine loads and lake water and ecological quality. Driving force variables included population, wastewater treatment connection rate, the fertiliser use, livestock amount, crop yields, atmospheric deposition and amount of agricultural lands. The following scenarios were elaborated (Gooch, 2003):

I. Business as usual scenario (BAU)' that includes continuation of present trends where it is expected that the economical situation will remain the same and pollution loads and emission remain on the level of end of 1990s.

II. 'Target/fast development scenario'. Estonia is described in this scenario by a fast adaptation to the EU and Russia – by domestic fast economic and social development.

III. 'Crisis scenario'. According to this scenario, conditions radically deteriorate into 'crisis' in both countries.

IV. 'Isolation scenario' where Estonia has a slow and unwilling adaptation to the EU and Russia is characterised by the isolation from Europe and a growth of nationalist sentiments.

V. The last scenario is a combination of scenarios II and III where Estonia is expected to have fast development and Russia remains in a crisis.

Results of the studies of the environmental state in and development of the scenarios for the Lake Peipsi/Chudskoe Basin showed that given the 5 scenarios of the future regional development, the riverine nutrient loads into the lake is expected to generally decrease (Mourad et al., 2003). The target/fast development scenario (II) results in a substantial larger Ntot input to the lake. The Crisis scenario (III) yields the largest Ptot load. No scenario predicts larger nutrient loads than in the communist period. Based on the scenarios development, scientists developed the following assessment of the environmental state in the lake basin and policy recommendations (Mourda et al., 2003):

- Eutrophication due to significant nutrient loads in Lake Peipsi/Chudskoe represents a major threat for the water quality of the lake and present ecological state of the lake is moderate;
- Change of the amount of arable land is a major factor controlling nutrient loads to Lake Peipsi;
- Although connection to wastewater treatment plants and larger removal efficiencies for these installations can solve hygienic problems locally, strategies for nutrient load reduction should mainly focus on agricultural nutrient runoff, especially in the Russian part of the drainage basin.

Legal and administrative framework for the transboundary water management

The environmental situation/regional development scenarios developed by the scientists will be incorporated in water management plans that are being prepared by authorities in the transboundary water basin. Lake Peipsi belongs to the Republic of Estonia and the Russian Federation. By now Estonia has adapted its laws and the administrative system to the requirements of the EU. As a part of this work the Estonian Water Act was revised to harmonize with the EU Water Framework Directive that defines river basins as the basic unit for all water planning and management actions. Estonian Ministry of the Environment with an additional financial support from the EU LIFE Programme develops a plan of water protection measures in a line with the EU and Estonian national legislation.

The other half of Lake Peipsi/Chudskoe is located in the Russian Federation. The Water Framework Directive (WFD) of the European Union does not have mandatory character for Russia as far as the EU WFD is compulsory only for the members of the EU and recommended for accession-countries. Nevertheless, it could be used for transboundary water basins located on the territory of the Russian Federation because it is dealing with the questions of joint water management in the case of EU and third-countries transboundary waters. In the Russian Federation waters are managed according to the Russian Federation Water Code. Russian authorities, responsible for the water management, have accepted that principles of the EU Water Framework Directive would be applied also on the Russian side of the Lake Peipsi/Chudskoe basin (Budarin, pers. comm.). EU TACIS project with an amount of 2 million EUR have supported this work on implementation of the EU WFD principles and Russian water legislation and preparation of the water basin management plan for the Russian side of the lake basin.

At the same time preparation of these measures are coordinated across the border in an interactive way through developing an umbrella Lake Peipsi/Chudskoe Basin Management Program for the whole transboundary water basin. The program will address issues of importance to the whole transboundary water basin and will include practical recommendations for the Lake Peipsi/Chudskoe nutrient load reduction and prevention, and the sustainable conservation of habitats and eco-systems in the cross-border regional context.

Organisation of the coordination of national activities on water protection is organised through the development of detailed joint plans of work between the relevant authorities who coordinate their work within the Estonian – Russian transboundary water commission; this takes place through work of the Commission's four working groups that include experts from both countries from the government, research organisations, local authorities and NGOs.

Activities of the mentioned international projects are lined up with the working plan of the Transboundary Water Commission. Coordination of works within the projects is organised by the projects' implementation units by the means of regular consultations between the project managers and establishment of projects' steering committees that include the same representatives from the Estonian and Russian relevant authorities. A transboundary Lake Peipsi/Chudskoe Basin Communication and Public Involvement Plan is being elaborated jointly by Estonian, Russian and other international experts that will help to ensure timely consultations with multiple stakeholder groups as a part of preparation of the transboundary water basin management program.

Recommendations for integrated management of transbundary waters

In planning and implementation of transboundary water policies, it is important to keep a balance between working on transboundary/international, national and local scales. All these scales of management are important and different from each other in terms of water management issues and stakeholders involved.

To ensure integrated management of the transboundary waters, it is of great importance to provide support to transboundary networks of the local authorities and stakeholders that develop the shared on the international basin scale vision of the future in the water basin. Involvement of stakeholders on different levels ensures sustainable use of water resources in a long run.

The experience of preparation of the transboundary Lake Peipsi/Chudskoe water management program demonstrated that in the transboundary context water management projects should have much more focus on communication, information exchange, and developing trust between all the partners – between the relevant authorities, experts and stakeholders; the communication and cooperation across the borders as well as between different levels of governance, including the international water basin, national and local levels. As usually budgets of relevant authorities are limited, it is necessary that tailor-made information dissemination and communication approaches are elaborated and used to deliver relevant and understandable information to the stakeholders' groups involved in implementation of water policies and receive their feedback. Besides, using more efficiently funding for working with stakeholders and public, this will facilitate and promote more effective implementation of the water policy.

Developing special communication and participation plans for transboundary water basins aimed to communicate expert based and scientific information to stakeholders and to promote a three-way political dialogue between decision-makers, experts and local stakeholders are very important.

Finally, in the planning process interaction processes in transboundary water basins should be addressed taking into account policies at various levels and established forms of co-operation practices on different sides of the borders, conditioned by the perceptions of various public and private actors

Acknowledgement

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Reference:

Andersen, D. H. 2002. Public participation in environmental decision making in a transboundary context. Working paper. Peipsi CTC, Tartu, Estonia.

Budarin, V. 2003. Presentation at the open seminar "Transboundary Water Management", Tartu, 27 May 2003.

Council of Europe. 2000. Strengthening good-neighbourly relations in Central and Eastern Europe in preparation for EU Enlargement. Background paper for a "brainstorming seminar". December 2000, Lublin (Poland).

Estonian Ministry of the Envrionment website at www.envir.ee.

Gooch, G.D. 2003. Scenarios for environmental policy-making on the Estonian-Russian border. MANTRA-East working paper, January 2003. Linköping University, Linköping, Sweden.

Gooch, Geoffrey D.; Höglund, Pär; Roll, Gulnara; Lopman, Evelin; Alekseyeva, Natalia. 2002. Review of existing stuctures, models and practices for transboundary water management. MANTRA East project working paper, February 2002.

Grey D., Sadoff, C. 2002. Beyond the river: the benefits of cooperation on international rivers. In Water Science and Technology: Balancing competing water uses – present status and new prospects. IWA Publishing.

Kangur, K. 2003. Use of Water Resources and Associated Problems in Rural Municipalities at Lake Peipsi. Report on the sociological survey. Working paper. Peipsi CTC, Tartu, Estonia.

Mourad, D.S.J, Van der Perk, M, Gooch, G.D., Loigu, E., Piirimäe, K. and Stålnacke, P. 2003. GIS-based quantification of future nutrient loads into Lake Peipsi / Chudskoe using qualitative regional development scenarios. In proceeding from the 7th International Conference on Diffuse Pollution and Basin Management, Dublin, Ireland August 17–22, 2003

Minutes of the Estonian – Russian Transboundary Water Commission (Narva – Jõesuu, December 2002) at www.envir.ee/jc.

Stålnacke, P and Roll G 2002 Lake Peipsi A transboundary lake on the future border of the European Union In Hedegaard, L and Lindström (Eds), The NEBI Yearbook 20021/2002 Springer-Verlag Berlin Heidelberg pp 159-176

Timmerman, J.G., K. Kipper, A. Meiner, S. Mol, D. Nieuwenhuis, G. Roll, M. Säre, Ü. Sults, and P. Unt, 2002. The use and valuing of environmental information in the decision making process: An experimental study. Workshop report. RIZA report no. 2002.069X. RIZA, Lelystad, The Netherlands.

Uus, P.; Unt, P.; Rehema, A. Raadom, K. 2001. Sociological study in the local municipalities by Lake Peipsi in Estonia. Working paper. Peipsi CTC, Tartu, Estonia.

INTERNATIONAL PROJECTS

"National policy on SCALDIT, a project embedded in the International Scheldt Commission with the financial support of Interreg IIIB NWO : 2003-2005"

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Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy or shorter, the European Water Framework Directive (WFD), has been published on 22 December 2000 in the Official Journal of the European Commission and entered into force on that day.
Starting from the idea that water in the Community is under increasing pressure from the continuous growth in demand for sufficient quantities of good quality water for all purposes, the WFD introduces a river basin approach with relation to integrated water management on a European level. Because the WFD is a FRAMEWORK directive, a lot of provisions of the WFD still need to be concretised. Therefore, the European Commission (DG Environment), the EU Member States, Norway and the Candidate Countries agreed on a Common Implementation Strategy (CIS) for the implementation of the Water Framework Directive (WFD). Within this common implementation strategy, a number of guidance documents are developed in 2001 & 2002. Before putting these guidance documents into practice, the European Commission and

Member States want to test them on their practicability in a selected number of pilot river basins.
The riparian regions of the Scheldt river basin district introduced the Scheldt as a pilot for integrated testing of the guidance documents. The CIS Scheldt pilot project proposal is the only proposal in which an entire international River Basin District is involved. The purpose of this integrated testing is to perform the testing and the preparation of the characterisations in a shorter timeframe as provided by the WFD so that other member states and candidate countries can benefit from experiences gained in the Scheldt river basin district.
The international character of the Scheldt river basin district, which inevitably complicates the management and implementation of the tasks to be delivered, urges the partners to apply for financial support to deliver the results in due time so that all other NWE and European river basins can benefit from the results of this project to implement the WFD in their river basin districts within the timeframe of the WFD. This financial support is given bij Interreg IIIB NWE, a EU programme for stronger transnational co-operation in the fields of urban development, transport, cultural heritage, and territorial integration across seas.

The overall objective of the project is to establish a transnational analysis of the characteristics of the Scheldt river basin district, a review of the impact of human activities on the status of surface water and groundwater and an economic analysis of water use in the international river basin district of the Scheldt as a basis for an international river basin management plan that will lead to a good water status in the international river basin district of the Scheldt. The project will make an essential contribution to the implementation of the WFD in the Scheldt river basin district. Secondly it will figure as a pilot for all international river basin districts within the NWE Area, the EU and the Candidate Countries through the structure of the Common Implementation Strategy.

In the partnership all relevant competent authorities for the implementation of the WFD in France, the three Belgian regions and the Netherlands are represented. The creation of this partnership is the basis for a transnational co-operation for the implementation of the WFD within the Scheldt river basin district.

By embedding the link of the project in the International Scheldt Commission, the documents that will define these aspects are subject to a transnational political decision making process. These documents will be submitted to the political decision making bodies in the five riparian regions of the Scheldt river basin districts. This formal approval by the political authorities of the International Scheldt Commission will give the documents the status of terms of reference for all future actions related to integrated water management in the Scheldt river basin district. These documents will constitute a common base for the preparation of the programme of measures and the river basin management plan that need to ensure a good surface water and groundwater status in the international river basin district of the Scheldt

The action program is divided into 5 themes:

1. Characterisations of the river basin district

The project partners engage themselves in an integrated water management of the Scheldt river basin district. The first step in this process is to develop a transnational characterisation of the Scheldt river basin district. This will start with the development of a common understanding, based on a harmonisation of the monitoring and assessment of data. Based on this common understanding a harmonised transnational characterisation of the river basin district, an assessment of the environmental impact of human activities on the status of surface water and groundwater and an economic analysis of the water use in the river basin district will be performed.

The characterisations and analysis will be based on the guidance documents prepared within the Common Implementation Strategy (CIS).

This means that different issues and their connection will be addressed such as: groundwater, surface water, coastal and transitional water, heavily modified waterbodies, reference conditions, economics, description of the river basin district in terms of the WFD, pressures and its impacts on the water ecosystem, monitoring.

The common developed characterisation will be used to elaborate scenarios. Based on these scenarios the likelihood that surface water bodies within the river basin district will (fail to) meet the environmental quality objectives will be assessed.

Although a lot of information is available on the Scheldt river basin district, very little of this information is in line with the prescriptions of the WFD and even less is comparable throughout the entire river basin district. Therefore, a common understanding with regard to the harmonisation of the monitoring and assessment of data will be developed. This will be based on the prescriptions of the WFD and the information in the EU CIS guidance documents. Knowledge gaps will be stopped by carrying out the necessary research projects and organising workshops with experts of the different project partners. Based on the common understanding and the knowledge acquired by the research projects and the workshops, the partners will carry out the characterisations within their region. The information on the regional characterisations gathered by the partners will be used to draw up the transnational characterisations of the river basin district. These transnational characterisations based on a common understanding and knowledge of the river basin district are a condition sine qua non for the preparation of a transnational programme of measures and the international river basin management plan for the Scheldt river basin district which will contain the required measures to reach a good surface water status and a good groundwater status in the Scheldt river basin district.

2. Data and information management

Data management is an important aspect in integrated water management of the Scheldt river basin district. Without access to real data an efficient implementation of de WFD is impossible as it constitutes the basis for reporting, the development of scenarios, cartography, and eventually the development of appropriate measures. Information management is dealing with exchange and compatibility of

data, reports, etc. All preparatory steps with relation to data management will be carried out while preparing the characterisations.
Based on these experiences data management tools in order to facilitate the testing activities will be developed.

Data management is also related to cartographic data. The different partners within the project use different co-ordinate systems. This makes the accessibility and comparability of cartographic data among the different partners very difficult as well as the drawing up of maps.
As a generic activity a sustainable solution for cartographic related data/information exchange between the different partners will be developed. An atlas with maps on the characterisations for the Scheldt river basin district will be produced.

3. Water management and spatial planning

The scope of the project is to draw up the transnational characterisation (water bodies, typology, reference conditions and intercalibration) of the river basin district, perform the transnational review of the impact of human activities on the status of surface water and groundwater as well as a transnational economic analysis related to water uses by testing the EU CIS guidance documents.
The Scheldt river basin district is a highly urbanised and industrialised river basin district. These human activities are not strictly limited to emissions, discharges and losses of polluting substances. Human activities also cause pressures with relation to spatial impacts. In periods of high rainfall e.g.,

watercourses do not dispose of sufficient storing capacity to drain away the water which may eventually lead to a higher risk of accidental flooding.
Flooding can not always be avoided. An early warning system between the parties will progressively be developed. To overcome too big damage in the future, it is recommended to give water space where possible. In this regard, guidelines to establish a shared vision between water managers and spatial planners will be developed and workshops will be organised to bring together water managers and spatial planners.

4. Communication and raising awareness

Scaldit also focusses strongly on communication. First of all we will ensure that the project and its products are recognisable. To make the project more visible, a logo and a common style will be developed and used in the publications of the project, the writing paper, the web site, etc. In this way, all communication actions will show a direct link with the Scaldit project.
In the beginning of 2003, a seminar will be organised to officially present the project and the national, regional and local water managers, the spatial planners, the stakeholders, NGO's and the press of the Scheldt River Basin District will be invited.
During the project we will publish newsletters and brochures to inform the national, regional and local water managers, the spatial planners, the stakeholders and NGOs about the progress and the results of the project. Every newsletter will be written in Dutch and French, the two languages of the Scheldt river basin district. By means of regular press releases, the press will

be informed about the existence and the main results of the Scaldit project.
A Scaldit web site will be developed and linked to the web site of the International Scheldt Commission, to the NWE web site and the web sites of the partners. The web site will provide the national, regional and local water managers, spatial planners, stakeholders and NGOs with all the relevant information of the project. Therefore, the web site will be regularly updated with the latest news and developments. In a special section, the Scaldit partners will be able to download documents and reports. The general public will also have access to the Scaldit web site.
At the end of the project a closing event will be organised to present the results of the project to the target groups by a number of boat excursions on the Scheldt from source to estuary.

5. Up to the international river basin management plan

Scaldit provides the first step in the implementation of the WFD in the international river basin district of the Scheldt by carrying out the characterisation of the Scheldt river basin district, the review on pressures and impacts and the economic analysis based on common understanding and agreement. The experience gained in this process will be used to inform the other river basin districts in the NWE Area, the other EU Member States and the Candidate Countries.
The characterisation of the Scheldt river basin district, the review on pressures and impacts and the economic analysis will be submitted to the political decision making bodies. After political approval, these documents will act as terms of

reference for the further steps that need to be taken to implement the WFD.
Based on the information gathered in the characterisation and the scenario-analysis, the work programme for the development of the international river basin management plan for the Scheldt river basin district will be drawn up as a recommendation for the execution of the next phase of the transnational co-operation for the implementation of the Water Framework Directive

Description of the Scheldt river basin district

The river Scheldt rises in France, in the north of Saint Quentin, and flows then through the Walloon Region, the Flemish Region and the Netherlands before running into the North Sea. The length of the river is 350 kilometre. The Scheldt and its affluents, which constitute the Scheldt river basin, are lowland watercourses with low rates of flow and discharge. An important part of the river is canalised. More than 250 weirs and sluices constitute the artificial connections between parts of the river and between the river and its affluents and canals. Upstream of Ghent, the Scheldt is canalised for 138 kilometre.

The part of the Scheldt between Ghent and Vlissingen is a unique area, as it is considerably influenced by the tide. The estuary contains zones with freshwater, brackish water and saline water comprising channels, shallow water areas, tidal flats, salt pastures and their biotopes.

The scope of the Scaldit project is the entire Scheldt river basin district.

The Scheldt river basin has a surface of 21.863 km^2 and a population of 10 million inhabitants. The entire Scheldt river basin district with all its joined small river basins has a surface of 37.170 km^2 and a population of 12.686.000 inhabitants.
The population density varies strongly in the different parts of the river basin district: from less than 100 inhabitants/km^2 in rural areas like in the upstream part of the Leie or in some villages of Zeeland, to more than 2.000 inhabitants/km^2 in urban parts like Antwerp, the Brussels Capital Region and Lille.

The river basin district of the Scheldt has a very dense network of waterways and motor ways. This has encouraged the creation of a considerable industrial and urban structure. The inland navigation network is strongly developed and is for the most part adapted to the European dimension of 1300 tons.

The land use of the Scheldt river basin district is varied. The river basin district is highly urbanised. It contains several industrial areas. The areas destined for agricultural purposes, are quite consistently spread over the whole territory. Woodlands take up only a restricted part of the total surface and are mostly situated in the north-east of the river basin district (Kempen), in the neighbourhood of some major cities (the Brussels Capital Region, Leuven and Valenciennes) and in the sub-basin of the Haine. Important wetland areas are situated along the Scheldt between Ghent and Vlissingen, like the largest brackish water pasture of Western Europe: the Verdronken land van Saeftinge.

"Overview of CCMS Pilot Study on Environmental Decision-Making for Sustainable Development in Central Asia"

John E. Moerlins
IICER, Florida State University

An overview of the recently established CCMS pilot study on environmental decision-making in Central Asia will be presented. The presentation will consist of historical information concerning establishment of the pilot study, participating countries, objectives of the pilot study and overall approach focused on capacity building based on a declared Central Asian need for:

- Education;
- Training; and
- Technical Assistance (involving tools such as cost-benefit analysis, risk assessment, landscape science tools, decision support software, structural/functional analysis, etc.)

A summary of priority environmental problems in the following countries will be presented:

- Kazakhstan;
- Kyrgyzstan;
- Tajikistan;
- Turkmenistan; and
- Uzbekistan.

A consensus list of regional environmental problems (for these five Central Asian Countries) will also be presented, involving water resources, waste management, public health and other problems. Almost every problem listed by the Central Asian environmental scientists and ministerial representatives who compiled this list relate to water scarcity, degraded water quality, water mismanagement and related issues.

Summary data taken from the World Health Organization (WHO-Rome Office) will be presented related to life expectancy, infant mortality and general economic conditions in Central Asia, as well as to water supply/sanitation issues.

Finally, a "path forward" for the Central Asian pilot study will be presented along with a request for suggested possible areas of collaboration between the IWM pilot study and the Central Asian pilot study.

IWM RELATED PROJECT REPORTS

"Decision Support Systems for Integrated Water Management"

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Introduction

Modern development and population growth has greatly increased water demands. As a water crisis is forecasted in the near future, the welfare of the world's population is closely tied to a sustainable exploitation of groundwater, surface and coastal water resources in order to prevent their depletion and contamination.

The need to manage a water system in an integrated way comes from the fact that our water supplies are limited both in quantity and quality. In addition, water has multiple and competing uses, so that a water system is interrelated with many other realities, such as for example physical and socio-economic systems. Specifically, the ecosystem and the anthropic action can effectively modify the behaviour of a water system.

As a solution to the problem of the continuously widening gap between water needs and the availability of useful water in many locations, Hall [1] suggested an approach which includes: 1) management across political boundaries, 2) the collective management of atmospheric water, surface waters and groundwater, and 3) the combined management of water quality and water quantity.

Finding an integrated water management (IWM) strategy minimizing the water demand dissatisfaction, satisfying water quality standards and respecting the ecosystem, minimizing the overall water treatment costs, taking into account specific local problems, regulations and special agreements is a very complex task. According to Mitchell [2] there are at least three main decision aspects in IWM: 1) the systematic consideration of the various dimensions of water: surface and groundwater, quality and quantity; 2) the implication that while water is a system it is also a component which interacts with other systems; and 3) the interrelationships between water and social and economic development.

In this context, an integrated approach that considers the different conflicting objectives of the decision problem is necessary and Decision Support Systems (DSS) aim to play a fundamental role.

Architecture of an IWM DSS

Water has been one of the most important fields of DSS application. Some chief references can be found in [3-17]. According to [18], in the water domain, a DSS architecture should consist of three main components: 1) state representation in the form of databases and geographic information systems, 2) state transition obtained through modelling and simulation approaches, and 3) plan evaluation, consisting of evaluation tools such as multi criteria evaluation, visualization and status checking. This DSS architecture is shown in Figure 1.

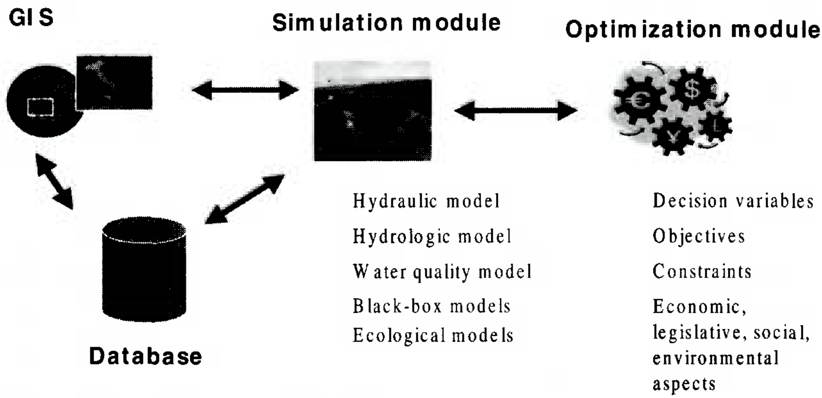

Figure1: the architecture of the DSS

In an IWM DSS, the plan evaluation, which may be implemented as an optimisation model, can be used to define long term and short/medium term decisions (such as infrastructure and resource planning, resource allocation and reservoir management), while the necessity to quantify water demand in time (highlighting seasonal variation) for every kind of activity (agriculture, industry, public use, drinking water, etc.) can be satisfied using of GIS tools. In this respect, a great amount of data must be collected, stored and analyzed to characterize the whole system: concentrations, withdrawal, confluences, farming land use, urban and industrial settlements, geological information, hydrological data, ecosystems, treatment plants. Further information is also needed as regards the economical evaluation of the effects of the dissatisfaction of water demand.

The main task of the simulation module is to represent the physical reality integrating different levels of knowledge (from hydraulic to ecological issues). While the hydrologic model is necessary to predict and monitor the flow in the various parts of the river basin, the hydraulic model can determine the velocities and the water behaviour in every reach. The hydraulic model is strictly connected with the water quality model that is necessary to assess the degree of pollution of the various rivers. In general, water quality models consider the behaviour (in time and space) of various kinds of pollutants (including toxic materials). Its integration with ecological aspects allows modelling more complex phenomena dealing with the ecosystem. In order to simulate water quality it is possible or to build a program for the specific case study or to use existing simulation softwares, like Qual2e, Mike 11, Desert to integrate with the optimisation module. In fact, the assessment of water quality using ecological knowledge requires a particular attention and often the definition of a model for the specific case study.

The optimisation module requires the formalization of the different objectives and of the constraints of the problem on the basis of specific decision variables. These are the entities from which all the system depends and, generally speaking, they correspond to the practical decisions that have to be taken (for example water flow extracted).

Moreover, conflicting objectives should be taken into account: minimization of water treatment costs, achievement of water quality standard, minimization of water demand dissatisfaction. Specifically, the decisions regarding the technologies are to be taken with respect to number, size, location, and management strategies of the treatment plants, while the constraints to be formalized concern hydrological aspects, treatment plants technologies and costs, environmental constraints, regulations, etc.

A case study example

A DSS has been applied to Stura di Lanzo River Basin, where an iterative solution is adopted to integrate the water quality simulation [19]. Specifically, a decisional procedure, which consists of two phases, is formalized. In the first phase, the water resources sharing problem is dealt with, taking into account the demands of the various water users and the requirement of a minimum flow in any section of the river. In the second phase, the problem of fulfilling water quality standards is considered. This may require reformulating the water resources sharing problem in order to increase the water flow in the river. Figure 2 reports the schematic representation of the physical model.

Other recent ongoing experiences on IWM DSS applications in our group deal with the groundwater management problems (where water extraction from wells must take into account the pollution derived from agriculture facilities) and to coastal aquifer management (where the pumping pattern of coastal wells must minimize both the salinity arise and the costs in order to satisfy the water demand and to preserve the water resource).

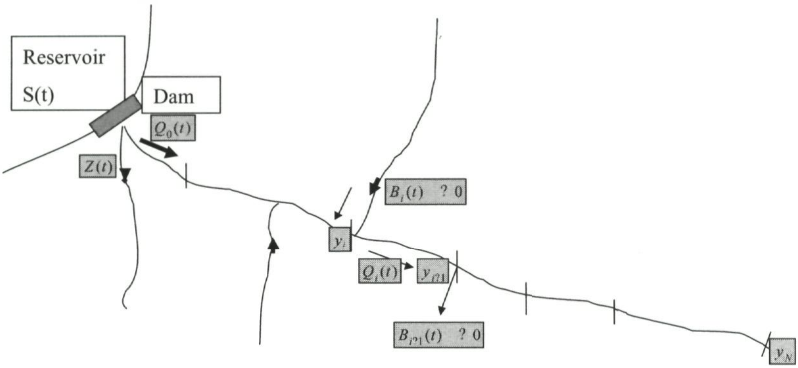

Figure 2: The physical representation of the system

Conclusions and future directions

Schultz [20] identified the factors that have to be satisfied in IWM: 1) economic benefits; 2) technical efficiency; and 3) performance reliability. The approach which seems to become more and more dominant includes: the principle of sustainable development; ecological quality; consideration of macroscale systems and effects; and planning in view of changes in natural and socioeconomic system [20]. These ideas are directly linked to the new concept of ecohydrology [21-22], which suggests that the sustainable development of water resources is dependent on the ability to maintain evolutionary established processes of water and nutrients circulation and energy flow in the basin scale.

In this respect, one of the main difficulties in an effective application of an IWM DSS is to limit the problem to the aspects in which a decision maker is interested, while taking into account the effects that a decision can have on other systems.

References

[1] Hall, M W Extending the Resources Integrating Water Quality Considerations into Water Resources Management, *Water Resources Update*, Issue No 111, (1998), Universities Council on Water Resources, Carbondale, Illinois

[2] Mitchell, B Integrated Water Management International Experiences and Perspectives, Belhaven Press, London (1998, ed).

[3] Ejeta, M Z and Mays, L W "Computer models for integrated hydrosystems management", available at http //www public asu edu/~lwmays/comp_mod htm

[4] Somlyody, L "Use of optimization models in river basin water quality planning", *Wat Sci Tech* , vol 36, 1997, no 5, pp 209-218

[5] Reda, A L L and Beck M B Simulation model for real-time decision support in controlling the impacts of storm sewage discharges, *Water Science and Technology*, Volume 39, Issue 9, 1999, Pages 225-233

[6] Jolma, A , De Marchi, C , Smith, M , Perera, B J C, Somlyody,L StreamPlan a support system for water quality management on a river basin scale, *Environmental Modelling and Software*, Volume 12, Issue 4, 1997, Pages 275-284

[7] Makowski, M , Somlyody, L , Watkins, D Multiple criteria analysis for water quality management in the Nitra Basin, *Water Resources Bulletin*, Volume 32, Issue 5, October 1996, Pages 937-951

[8] Jamieson, D G and Fedra, K The WaterWare' decision-support system for river-basin planning 1 Conceptual design, *Journal of Hydrology*, Volume 177, Issues 3-4, 1 April 1996, Pages 163-175

[9] Jamieson, D G and Fedra, K The WaterWare' decision-support system for river-basin planning 2 Planning capability, *Journal of Hydrology*, Volume 177, Issues 3-4, 1 April 1996, Pages 177-198

[10] Jamieson, D G and Fedra, K The WaterWare' decision-support system for river-basin planning 3 Example applications, *Journal of Hydrology*, Volume 177, Issues 3-4, 1 April 1996, Pages 199-211

[11] de Jong, J , van Buuren, J T, Luiten, J P A Systematic approaches in water management Aquatic outlook and decision support systems combining monitoring,

research, policy analysis and information technology, *Water Science and Technology*, Volume 34, Issue 12, 1996, Pages 9-16

[12] Chen, H. W. and Chang N.B. Water pollution control in the river basin by fuzzy genetic algorithm-based multiobjective programming modeling, *Water Science and Technology*, Volume 37, Issue 8, 1998, Pages 55-63

[13] Abbott, M.B., Havnø, K., Lindberg, S. The fourth generation of numerical modeling in hydraulics, *J. Hydraul. Res.*, 29(5), 1991. 20pp.

[14] Andreu, J., Caprilla, J., Sanchis, E. Aquatool, a generalized decision-support system for water resources planning and management. *Journal of Hydrology* 177, 1996, p269-291

[15] Arnold, U., Orlob, G.T. Decision support system for estuarine water quality management, *Journal of Water Resources Planning and Management*, ASCE Vol 115(6),1989), p 775-792

[16] Orlob,TG.T. Water-quality modeling for decision making, *Journal of Water Resources Planning and Management*, ASCE, Vol. 118, 1992, p 295-305

[17] Reitsma, R.F. Structure and support of water resources management and decision making. *Journal of Hydrology* 177, 1996, p 253-268

[18] Reitsma , R. F., et al. Decision Support Systems (DSS) for Water Resources Management in L. W. Mays (editor-in-chief), *Water Resources Handbook*, McGraw-Hill, Inc., New York (1996).

[19] Avogadro, E., Minciardi, R., Paolucci, M. A decisional procedure for water resources planning taking into account water quality constraints, *European Journal of Operational Research*, 102 (1997) 320-334

[20] Schultz, G. A. A Change of Paradigm in Water Sciences at the Turn of the Century?, *Journal of the International Water Resources Association* 23(1) ,1998, pp. 37 – 44.

[21] Zalewski, M. "Ecohydrology - new conceptual tool for restoration and sustainable use of fisheries resources in rivers " available at http://www.lars2.org/unedited_papers/unedited_paper/Zalewski.pdf

[22] Zalewski, M. et al., "Guidelines for the Integrated Management of the Watershed -Phytotechnology and Ecohydrology", Dec, 2002 available at http://www.unep.or.jp/ietc/Publications/Freshwater/FMS5/index.asp

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"Decision support tool for flash flood warning in the Mediterranean area"

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Introduction

The orography of the Northern Mediterranean coastline is very rough. The hydrologic time scale of most watersheds is in the order of a few hours. Flash floods develop rapidly during the rainy season and inundate suddenly the terminal flood plains. Historical cities developed on such flood plains in the past. Therefore town centres are, nowadays, exposed to a high risk of inundation. Civil protection procedures require that population undertake precautionary measures when a flood warning is issued. However the time scale of the social system to put efficient measures into action is in the order of the day.

Traditional warning systems based on rainfall observations and rainfall-runoff modelling do not provide timely predictions in order to implement the required precautionary civil protection measures (Siccardi 1996). Social safety demands that hydrologists reliably predict ground effects twenty-four hours in advance. In order to accomplish this task they have to use rainfall predictions as input to rainfall-runoff models.

Flash Flood forecasting chain design

Two major sources of uncertainty are present in coupling meteorological with hydrologic models: the uncertainty at the meteorological scale per se and the uncertainty at the interface between meteorology and hydrology (Castelli 1995).

The uncertainty issue has been extensively debated in literature, but usually the meteorological domain (Buizza et al. 1999; Toth et al. 1998; Toth et al. 2001) and the hydrologic domain have been treated separately. In hydrology the discussion about the uncertainty dates back to a few decades ago, but traditionally it was based on a given rainfall field (Beven 1993). The uncertainty was not addressed quantitatively with respect to the whole operational chain (Ferraris et al. 2000).

The meteorological uncertainty has a larger scale when compared with the space and time scale of the concerned watersheds. Hydrologists refer to it as to an "external scale" uncertainty, meaning that it cannot be reduced by improving the observational network at the basin scale. This uncertainty increases as the forecast focuses on smaller scales typical of hydrology. About a decade ago Limited Area Models (LAMs) were developed in order to downscale Global Circulation Models (GCMs) outputs, using a better representation of the mesoscale processes (Mesinger et al. 1988), e.g. atmosphere-ground interactions. Nesting a LAM into the GCM deterministic boundary conditions, however, did not – and still does not - improve the forecasts as required by hydrologists, because the "external scale" uncertainty is not addressed. A technique was introduced by Molteni et al. (2001), in which the Ensemble Prediction System (EPS), which gives a measure of the "external scale" uncertainty, was downscaled through the use of a LAM.

The second source of uncertainty is due to the lack of coherence among the space and time scales of meteorological and hydrologic models. Even in the event when the external uncertainty is negligible, the meteorologically predicted rainfall intensities are not enough to produce saturation excess in the time intervals in which floods develop because of the scales' inconsistency. In order to make rainfall fields coherent with hydrologic scales, hydrologists have to disaggregate the large scale meteorological predictions by preserving the expected value of the field at the large scale and by introducing appropriate second and upper order moments of the probability distribution (Deidda et al. 1999).

In order to bridge the space and time gap between the meteorological models' outputs and the inputs consistent with the distributed hydrologic model (in this work) a multifractal disaggregation model, as proposed in Deidda (2000), is utilized. This is basically a probabilistic tool that contributes information about the internal scale uncertainty of the hydrologic processes involved.

Two approaches have been used to address statistical modelling of precipitation fields within meso-scale areas: cluster-based models and fractal/multifractal models. Rainfall processes in cluster-based models are commonly organized in a preferred hierarchy of scales in space and time. This hierarchy of scales describes the process of rainband arrival, the cluster organization of cells within a rainband and the life-cycle of cells belonging to each cluster. A hierarchical description was first designed by LeCam (1961), while a large diffusion of cluster–based models was determined after Waymire, Gupta and Rodriguez Iturbe proposed the well-known WGR model (Waymire et al. 1984). A disadvantage of this kind of models is certainly the large number of parameters that need tuning (Marsan et al. 1996; Ferraris et al. 2002). A more parsimonious approach uses multifractal models based on random cascades (Gupta and Waymire 1993; Kumar and Foufoula-Georgiou 1993; Deidda 2000).

The same parsimonious criterion guided the choice of the hydrologic model. The state of the art procedure uses distributed models (Beven 1989), which results in a better description of the heterogeneity of the physics of the soil response and of the rainfall input. However, these models are over-parameterized and it is difficult to use them in an operational context, especially in multi-catchment systems. In the present work we use a semi-distributed model, synthetically described in chapter 4, which exploits the advantages of distributed modelling in a more efficient framework for peak discharge evaluation (Giannoni et al. 2000; Giannoni et al., 2003).

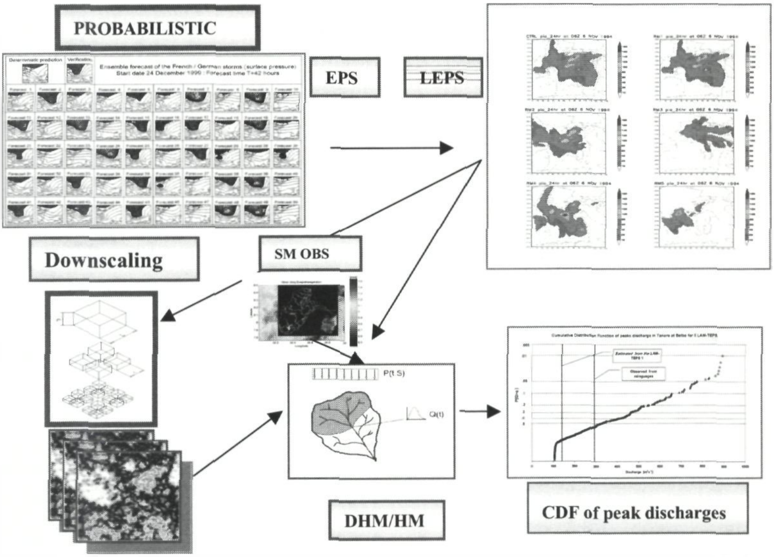

Figure 1: schematization of the probabilistic Flash Flood Forecasting system

The three previously described components are linked into an operational flood forecasting procedure, able to give results usable in terms of probability (Figure 1).

A case study example

The event chosen in this work as a case study took place in the Northwestern part of Italy from 4 to 6 November 1994 and it is considered one of the major floods observed in the Mediterranean area.

The meteorological conditions were determined by an intense meridional flow advecting humid and unstable air mainly from the South.

The ground effects considered in this work mainly concerned the Tanaro River basin near the town of Alessandria and its major sub-catchments.

Figure 2: site of the Tanaro River basin (NW Italy) with rain gauges (dots) and select hydrometric sections (stars)

We are presenting the results for two chosen hydrometric sections, representative of the small and large scale catchments of the Tanaro River basin. The first is the Belbo River basin in the Castelnuovo area, with a drained area of 410 km^2, and the second one is the Tanaro River basin in the Montecastello area with a drained area of about 8000 km^2. The results are summarised, for both hydrometric sections, as the exceedence probability curves of the peak discharge, conditioned to the precipitation volume in the target area derived from the LAM-TEPS (Targeted Ensamble Prediction System) outputs.

The CDFs (Cumulative Distribution Functions) for the peak flow of the Tanaro River (a) and of the Belbo River (b) are plotted on Gumbel chart in figure 3. The two vertical lines in each plot respectively denote: the value of the peak flow obtained by simulation using as input the non-disaggregated rainfall fields of the most probable LAM-TEPS member, which happens to coincide, in this case, with the "deterministic" run of the LAM used for the meteorological forecasting; the value of the peak flow obtained by simulation using as input the recorded rainfalls over the catchment.

From the results summarized in figure 3 we can observe how the peak flow obtained with the meteorological deterministic run without disaggregation shows a probability of being exceeded $Pr[Q_p > Q_{md}] \sim 0.8$ in the case of the Belbo River at Castelnuovo and even more so for the Tanaro River at Montecastello.

It is also interesting to note that the peak flow of the recorded rainfall hydrograph, in fact, largely exceeds in both sites the meteorological deterministic prediction, and that, again in both sites, it is very near to the expected value of the probability distribution. We can at this point evaluate the benefits of the complete forecasting chain within a decision-making framework. The civil protection issues a warning as long as the forecast peak discharge exceeds a predetermined threshold in the analyzed hydrometric section. The threshold peak flow for the Belbo River is of about 200 $m^3 s^{-1}$, while for the Tanaro River at Montecastello is of about 4000 $m^3 s^{-1}$. If the decision whether or not to issue a warning at 6.00 UTC of 5 November 1994 had to be made only on the basis of the information provided by the "deterministic" LAM run, no warning would have been issued as no peak flow exceeds the threshold discharges in the hydrometric sections analyzed. Using the additional information, provided by the LAM-TEPS outputs, gives the same result. On the other hand, the results of the disaggregation procedure would have suggested issuing a warning both for the Belbo River and the Tanaro River as the probability of exceedence of the threshold peak flow is in both cases more than 0.7.

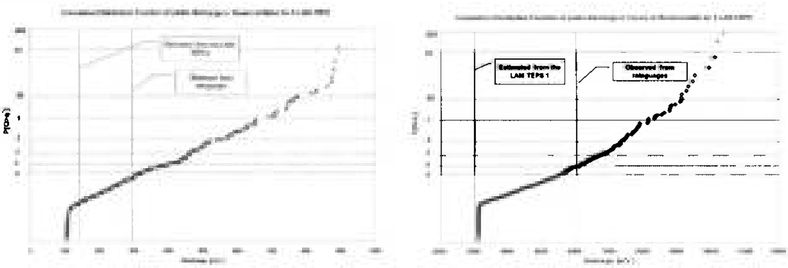

Figure 3: peak discharge exceedence probability plotted on Gumbel chart for the Belbo River and for the Tanaro River. The first vertical line shows the value of the peak flow obtained by the non-disaggregated rainfall fields of the meteorological deterministic LAM-TEPS member; the second line shows the value of the peak flow obtained by simulation using as input the recorded rainfalls over the catchment, i.e. the "Rainfall hydrograph".

Conclusions

This work describes a procedure that uses LAM-TEPS predictions combined with a multifractal disaggregation scheme of the large scale predicted rainfall volume on the area of interest: the procedure allows to formally transfer the information about uncertainty to the predicted hydrographs.

The results show how tackling the flash flood forecasting problem within a deterministic approach, at least in the analyzed environments, is not to be considered particularly useful. It is, therefore, necessary to use a probabilistic forecasting system able to address the uncertainty at the different scales involved.

The results dealt with show the approach that civil protection procedures should now consider, when dealing with inundation risks in most of the Mediterranean environments. Future peak flow values have to be conveyed to the decision makers as well as an associated probability in order to allow the authority to evaluate the issue of a warning in a cost-benefit framework.

Many improvements are still required in order to reach a reliable application of this forecasting chain in the normal operational practice.

All these outlooks are based on our direct operative experience as summarized by the presented case study. The value of this forecasting chain has been based so far on the study of the evidence of single cases. A non-biased forecasting skill is, in fact, obtainable as long as it is tested on a larger sample of events and for a continuous period. We are confident that such an approach will deeply improve the early warning issue procedure.

Acknowledgements

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References

[1]Beven, K.J., 1989: Changing ideas in hydrology. The case of physically based models, *J. Hydrol.*, **105**, 157-172.

[2]Beven, K.J., 1993: Prophecy, reality and uncertainty in distributed hydrologic modelling, *Adv. Wat. Resour.*, **16**, 41-45.

[3]Buizza, R., M. Miller, and T. N. Palmer, 1999: Stochastic simulation of model uncertainty in the ECMWF ensemble prediction system. *Q. J. R. Meteorol. Soc.*, **125**, 2887-2908.

[4]Castelli, F., 1995: Atmosphere modelling and hydrology prediction uncertainty, *Proc. Workshop on hydrometeorology: impacts and management of extreme floods*, La Colombella, Perugia, Italia, 13 – 17.

[5]Deidda, R., R. Benzi, and F. Siccardi, 1999: Multifractal modelling of anomalous scaling laws in rainfall, *Water Resour. Res.*, **35(6)**, 1853 – 1867.

[6]Deidda, R., 2000: Rainfall downscaling in a space-time multifractal framework, *Water Resour. Res.*, **36(7)**, 1779 – 1794.

[7]Ferraris, L., 2000: Sulle proprieta di scala dei campi di precipitazione ("On the scale properties of precipitation fields"), *tesi di dottorato ("Ph.D. Thesis")*, Universita degli studi di Genova.

[8]Ferraris, L., S. Gabellani, R. Rebora, and A. Provenzale, 2002: A comparison of rainfall dowscaling models, submitted to *Water Resour. Res.*

[9]Giannoni, F., G. Roth, and R. Rudari, 2000: A semi-distributed rainfall-runoff model based on a geomorphologic approach, *Physics and Chemistry of the Earth*, **25/7-8**, 665 - 671.

[10]Giannoni, F., Roth G., and R. Rudari, Can the behaviour of different basins be described by the same model's parameter set? A geomorphologic framework, *Physics and Chemistry of the Earth*, **28/6-7** pp. 289-295, 2003

[11]Gupta, V. K., and E. C. Waymire, 1993: A statistical analysis of mesoscale rainfall as a random cascade, *J. Appl. Meteor.*, **32**, 251 – 267.

[12]Kumar, P., and E. Foufoula-Georgiou, 1993: A multicomponent decomposition of spatial rainfall fields. Part. 1: Segregation of large and small scale feature using wavelet transform. Part. 2: Self-similarity in fluctuations, *Water Resour. Res.*, **29(8)**, 2515 – 2532, 2533 – 2544.

[13]LeCam, L., 1961: A stochastic description of precipitation., *Proc. 4th Berkeley Symposium on Mathematical Statistics and Probability*, **Vol 3**, , University of California, Berkeley, 165-186.

[14]Marsan, D., D. Schertzer, and S. Lovejoy, 1996: Causal space-time multifractal processes: Predictability and forecasting of rain fields, *Journal of Geophysical Research*, **101(D21)**, 26,333 – 26,346, 1996.

[15]Mesinger, F., Z. I. Janjic, S. Ničkovic, D. Garvilov, and D. G. Deaven, 1988: The step mountain coordinate: Model description and performance for cases of lee Alpine cyclogenesis and for a case of Appalachian redevelopment. *Mon. Wea. Rev.*, **116**, 1493-1518.

[16]Molteni F., R. Buizza, C. Marsigli, A. Montani, F. Nerozzi, and T. Paccagnella, 2001: A strategy for high resolution ensemble prediction. Part I: definition of representative members and global model experiments. In print on *Quart. J. Royal Met. Soc.*

[17]Siccardi, F., 1996: Rainstorm Hazards and related disasters in the western Mediterranean region, *Remote Sensing Rewiews*, **14**, 5-21.

[18]Toth, Z., Y. Zhu, T. Marchock, M. Tracton, and E. Kalnay, 1998: Verification of the NCEP global ensemble forecast, *Proceedings of 12th AMS conference on numerical weather predictions*, Boston.

[19]Toth, Z., Y. Zhu, and T. Marchock, 2001: The use of ensembles to distinguish between forecasts with small and large uncertainty, *Wea. Forecasting*, **16(4)**, 463-477.

[20]Waymire, E., V. K Gupta, and Rodriguez-Iturbe, I., 1984: A spectral theory for rainfall intensity at meso-beta scale, *Water Resour. Res.*, **20(10)**, 1453-1465.

"Management Optimisation of Hydraulic Resources in Water Distribution Systems"

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The objective of a Water Distribution Systems (WDS) is to convey treated water to consumers through a system of interconnected pipes. To achieve this aim in a safe manner, that is to say, without service interruptions and optimising the natural and scarce resource that is water, the system must be monitored. The monitoring is carried out by taking continually certain measures that are sent by a telemetry system to the control and operation centre of the Company. Using these typically limited number of measures together with demand predictions, called pseudomeasures, the state of the system must be assessed. This task is carried out by using state estimators, which are mechanisms of combination of the available information interrelating it within a mathematical model of the system. Correct state estimation is of paramount importance to diagnose leaks and other operation problems within the network. It would be nonsense to invest efforts and resources to improve water management (WM) from more global perspectives, in terms of whole catchment areas, global ecological considerations, sophisticated quality criteria and/or trying to follow the best of the directives if, eventually, the more expensive water, that that has been treated for human consumption, is lost without control. Since many WDS are old and politicians are reluctant to invest in buried assets, the risk of accidents and leaks may represent the worst contribution of WDS to Integrated Water Management (IWM). In this paper we describe a research project[1] aiming to develop a system based on Artificial Intelligence (AI) that allows, through suitable pattern recognition, on-line diagnosis and classification of problems in the system.

Most Water Companies, especially those supplying water to big cities, use telecontrol systems for operation. By considering the data provided by this system the engineer on duty makes operation decisions trying to optimise the system utilisation. Nevertheless, the system complexity does not allow but to take a few real- time measures, which slightly represents the network state. They give indicators for only certain aspects of the system, leaving out more specific or "less relevant" aspects. Thus, suitable techniques that allow more accurate network health estimations are necessary so that anomalies can be detected more rapidly and light anomalies, which develop progressively and insidiously, can be identified. This will enable to control their consequences in earlier stages, thus avoiding, among other things, losses, which can be of great importance, of this scarce resource called water. In addition, in the case of water for human consumption, it is an expensive one since additional investments in terms of quality have been already made. In Spain, for example, surveys carried out in different water distribution systems reveal an alarming rate for the water lost through leakage or unaccounted consumption, rising to 30% or even 40% in certain water supply systems [1].

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When the objective is sustainable development, synergy appears to be unavoidable and, without doubt, more efficient management and suitable water audits are completely necessary in water distribution systems in order to get a better IWM.

The state of a WDS is obtained by interrelating different measures within a mathematical model of the network with as much accuracy as possible, [2]. In the GMMF (Multidisciplinary Group of Fluid Modelling) a tool to analyse water networks, SARA [3], has been developed, which is based on EPANET, developed in the EPA (Environmental Protection Agency) of USA [4]. It makes use of the conjugate gradient method, [5], which has shown to be the more efficient, reliable and of better convergence among the existing methods for analysing pressurised water networks.

But state estimation cannot be accurately performed if there are missing or uncertain data. Thus, system operators must not only be provided with data but also with some measure of their reliability. That is to say, they need a set of feasible states corresponding to the level of measure uncertainty. Equivalently, they need error limits of the state variables. But data are abundant since they are permanently received. Thus, the operators can evaluate errors neither easily nor in real time.

It is expected that suitable techniques borrowed from AI could encapsulate the necessary knowledge to assess the network state, [6], [7]. Different approaches would consist, for example, on artificial neural networks, or expert systems obtained form statistical or fuzzy techniques or based in Data Knowledge

Discovery, Data Mining or Machine Learning Methods. Whatever the approach, the model should be able to identify the real system state, detecting anomalies, what will be used in decision making processes, necessary to optimise the water use.

There are a number of proposals in the literature to detect and identify anomalies and topological errors; yet, this still represents an important challenge to water supply managers.

State estimation makes use of a mathematical model of the network. The non-linear relations among heads and flows describing the network elements allow obtaining mass balances in the system junctions and, thus, representing the specific measures that are taken. These relations can be expressed compactly by the vector equation

$$y = f(x_r) + \sigma$$

where y is a vector of m measures contaminated by noise; $f(.)$ is the non-linear function describing the system; x_r is the n-dimensional state vector and σ is an unknown vector taking into account the model errors. It is an overdetermined problem since, in general, $m > n$. By considering that σ is unknown and non-negligible, the state estimation may expressed as a minimisation problem of the discrepancies between the real measures and the values calculated by the mathematical model with objective function

$$F(x) = \frac{1}{2}(y - f(x))^t P(y - f(x))$$

where x is a n-dimensional vector estimating the real state x_r, and P is a diagonal matrix of order m that weights the measures. A linearizing technique together with a recursive process is used to obtain the solution (out of the scope of this paper), given the problem non-linearity and dimensionality.

One possibility for the diagnosis and decision making process would consist on a neural network for clustering and pattern classification. Input patterns could be either deterministic or fuzzy (in terms of lower and upper bounds for the individual variables). During training each input should consist of an ordered pair, $\{P_l, e_l\}$, where P_l is the l-th input pattern made out of vectors of lower and upper limits for each variable, and e_l is and index corresponding to a label describing the state of the system.

Given the huge size of the modern WDS it is not feasible to predict and cover all the possible combinations or demand patterns, inflows, load conditions and anomalies that are likely to occur during daily operation. This means that the neural network should be able to evolve to cover problem requirements and incorporate new information without requiring to train from scratch every time new information is received.

The anomalies in a WDS can be identified from values of the state variables which differ from the expected values (corresponding to normal operation), that represent discrepancies of the real measures from the calculated values by the state estimator. Theoretically, for a perfectly calibrated and accurate model working at normal operation, and using exact measures all those discrepancies should vanish. This property gives such discrepancies an important role in efficiently detecting problems in the network, which will be detected by monitoring discrepancies or patterns of them. To embody these ideas, it is necessary to have training data and a suitable device for recognition.

This is a general principle for processes in which physical interference is not recommended or is dangerous, to use computer simulations to reproduce abnormal situations. Thus, simulations on a certain network have been performed for a complete period of 24 hours and for different abnormal situations. All the obtained data have been collected in a database with a specific organisation.

The learning device (e.g., the neural network) should work on two levels. The first should be a system of load state classification according to certain input data (essentially those which are independent of the anomaly, like head at fixed head nodes). Once the load condition has been identified a subsystem specialised in this load state will determine the anomaly, taking into account all the other variables that may or may not be affected by the anomaly. The output of this specialised subsystem will be the classification of the network state.

In WDS, leakage detection and rapid location of problems involving water loss, such as accidental breaks o malfunctioning of system components, are major concerns in order to achieve higher efficiency and, as a consequence, better water management. Data used in decision making are abundant, since they are permanently received, and uncertain, since they are affected by errors. Humans operators can process all this amount of fuzzy information neither easily nor in real time. We have described a research project aiming to develop a system based on Artificial Intelligence (AI) that allows on-line diagnosis and classification of problems in the system. This clearly represents a positive and necessary contribution of WDS to IWM.

[1] Asociación Española de Abastecimientos de Agua y Saneamiento AEAS. *Suministro de agua potable y saneamiento en España (2000). VII Encuesta nacional de abastecimiento, saneamiento y depuración.* Edited by AEAS (Spain), (2001).

[2] F. Martínez, R. Pérez and J. Izquierdo. Optimum Design and Reliability in Water Distribution Systems, in *Improving efficiency and reliability in water distribution systems*. Kluwer Academic Pub. Dordrecht, Boston, London (1995).

[3] Grupo Mecánica de Fluidos. SARA, *Software de Análisis de Redes de Agua, Manual de Usuario*. Ed. Grupo Mecánica de Fluidos, UPV, 1998.

[4] L. A. Rossman. *Manual de usuario de EPANET. Drinking Water Research Group*. Risk Reduction Engineering Laboratory. US EPA. Traducido por Grupo Mecánica de Fluidos, UPV, 1997.

[5] E. Todini and S. Pilati. A gradient algorithm for the analysis of pipe networks. *Proceedings International Conference on Computer Applications for Water Supply and Distribution*. Leucester, Polytechnic, 8-10 September,

1987.

[6] M. B. Abbot. The electronic encapsulation of knowledge in hydraulics, hidrology and water resources. *Advances in water resources*, Vol. 16, pp 21-39, 1993.

[7] Y. B. Dibike, D. Solomatine and M. B. Abbot. On the encapsulation of numerical-hydraulic models in artificial neural networks. *Journal of Hydraulic Research*, Vol 37, 1999, No 2.

"Flood hazard management and its integration in spatial planning policies"

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As a resource, water has favoured the close location of population, infrastructures and human activities to water body margins. Pressures on the resource derive from agriculture irrigation, drinking water, energy production, or transportation.
Parallel, water cycle has a seasonal and, partly, random component, that causes a disturbing interaction with the resource, that in the form of abundance may put lives and goods into risk.
The Mediterranean region particularly experiences seasonality, weakening risk perception of authorities and population, producing a progressive invasion of flooding areas of water courses. Irregularity as a hazard component derives from heavy in situ precipitation and floods. These may be caused by heavy/long-time precipitation upstream, dam failure, or flow disturbance by landslide or earthquake.
Vulnerability is a parameter to measure the level of exposition of the subjects to an event and the potential damage they may experience. The integration of hazard and vulnerability analysis results in a flood risk analysis, measuring the costs associated to events of a certain magnitude, location and probability. The planned and systematic adoption of actions to reduce the potential impact of events, assemble a policy of risk management based on previous analysis. The implementation of the policies has spatial implications as regards to their

location, relationships with territorial components, and the social and economic structure. Spatial planning deals with managing space as a resource and the organization of land use for its optimization as a resource. Risk management, as a policy, has to take into consideration the implementation of other policies, particularly spatial planning which structures territories and integrated water management organizing water use as a resource, being the three horizontal or transverse policies. Flood hazard management involves the adoption of structural and non-structural measures, some take place in the territory and use land, where stakeholders should participate in their implementation.

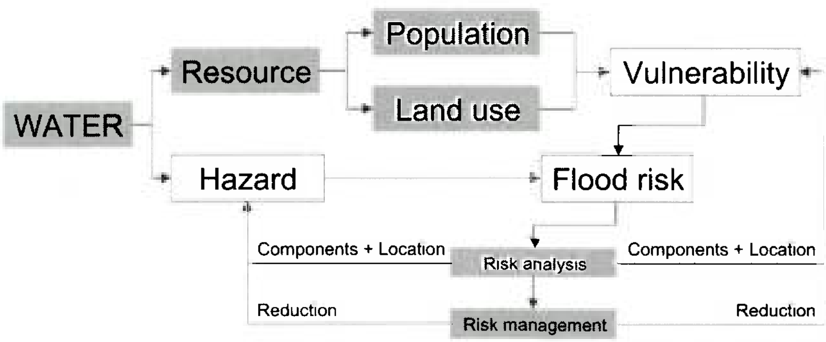

Figure 1. Flood risk and management

Also, policy implementation assumes a proactive or a reactive perspective, prevention or mitigation, or both. They are not contradictory but differing and paired strategies. The first stresses hazard and vulnerability reduction, while the latter stresses efficient reaction before an event. Spatial planning

contributes to the former, assigning land uses, imposing restrictions, through the implementation of plans.
The planning scale imposes the degree of definition of the territorial components taken into consideration alongside the administrative domain involved. We may define the scales of study related to the objectives of the risk analysis.

Table 1. Scales of analysis and modeling

Scale	Information	Purpose
<1:400000	General	Territorial (regional) survey Identify priorities
1:400000-1:50000	Semi-detailed	Define sectoral actions
1:50000-1:5000	Detailed	Hazard zone mapping Hydraulic models (1:10000-1:5000)
<1:5000-1:1000	Large scale	Local (municipal) analysis

Spatial plans, as for risk management, establish indications for determining criteria to reduce risk:

- Identifying flooding areas for certain return periods (50, 100 or 500 years), and introduce them as limiting factors in the official regional and urban plan designations.
- Developing regulations for planning in hazardous areas, technical and regulatory.
- Land use indications in the public water zones
- Precautionary regulations for cases when mapping is not available.
- Coordination with emergency planning
- Programing of infrastructures, forestry restoration and soil erosion control .

- Integration of urban, environmental and landscape values in the structural measure implementation

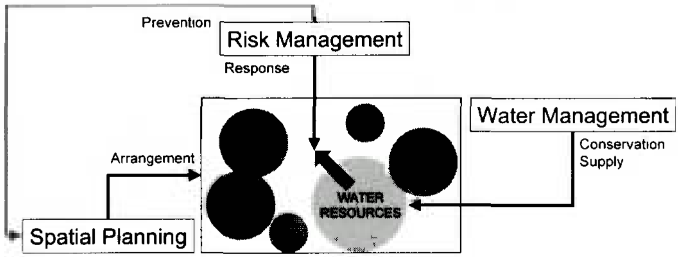

Fig. 2 Relationship between policies

Commonly, administrative divisions do not match river basins and corresponding water authorities, so that decisions taken have implications for other authorities or plans but with a different framework, and do not overlay. Plans are elaborated with two perspectives: territorial and spatial, the first focuses on the area to be planned, the location of the actions to be implemented, the components and relationships in the system; while the second focuses on a particular field. An example of the latter are special plans for different hazards. In Spain regions are responsible for their development, so that they elaborate risk management plans for inner waters, and not for inter-regional waters. The complexity of administrations involved (national, regional and local) demands the development of precise protocols for information exchange, and cooperation towards goals and objectives. Galloway (1996) understands flood risk management in a comprehensive and integrative approach where spatial planning and water management are interrelated to "...create a balance among natural and human uses of floodplains and their related watersheds to meet both social and environmental goals."

Galloway, G. E. 1996. The Mississippi basin flood of 1993. In *Reduction of Vulnerability to Floods in River Basins*. OAS, Washington, D.C.

"Rainfall runoff modelling coupled with rainfall radar estimates: enphasis on extreme floods"

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Introduction

Extreme floods represent a serious problem from the civil protection point of view, and an important challenge in the modelling context. A possible and innovative way to tackle with this problem is to utilize the simplest model representation that captures the dominant controls of extreme flood response coupled with a high resolution rainfall patterns derived from radar observations. The spatial-temporal structures of rainfall and drainage network in fact often play a key role in determining the hydrologic response. In this perspective the idea of coupling rainfall field estimated from radar (1 km horizontal scale and 5 minute time scale) through the *Z-R* relationship (see § 3) with a simple rainfall runoff GIUH-based model (see § 2) is here proposed. The case study of November 26 2002 over the Liguria region is analysed. The radar data is from the radar system recently installed at Monte Settepani (Savona, Italy) by Liguria and Piemonte regions. It is necessary to remark that this case study was performed a posteriori and not in real or near real time. Once the radar will be definitely operational the same framework used in this case study could be easily applied in real time being it a useful means to face hazardous situations.

Hydrological Model

In this work the hydrological model DRiFt (Giannoni et al., 2000) is used. DRiFt (Discharge River Forecast) is a semi-distributed event model based on a geomorphologic approach. This model is focused on the efficient description of the drainage system in its essential parts: hillslopes and channel networks are addressed with two kinematic scales, which determine the base of the geomorphologic response of the basin. The geomorphologic module is coupled with a simple distributed representation of soil infiltration properties, while the rainfall pattern is derived from radar reflectivity maps as described later in the paper.

The runoff volume is routed with a time variant TUH (T-hour Unit Hydrograph) technique, which takes into account the runoff production variability. Model parameters calibration and validation have been carried out using different intense rainfall events in different size basins. This robust and parsimonious model is able to predict consistently the main features of the hydrograph; the observed parameter invariance allows the reliable utilization for flood forecasting, also in regions where many small non-gauged basins are present. Discharge at any location along the drainage network is represented by the expression:

$$Q(t) = \int_B M\left(t - \frac{d_0(x)}{v_0} - \frac{d_1(x)}{v_1}, x\right) dx \qquad (1)$$

where:

B is the drainage basin above the specified location, $M(t,x)$ is the runoff rate (mmh^{-1}) at time t and location x, $d_o(x)$ denotes the distance from x to the closest stream channel and $d_1(x)$ denotes the distance from x to the outlet of the basin specified by the region B.

Runoff is assumed to move over hillslopes at a uniform velocity v_o and through the channel system at velocity v_l (see *Rodriguez-Iturbe and Rinaldo*, 1998 for discussion of similar models).

The Monte Settepani radar

The Settepani radar has been recently installed at Colle Melogno (Savona, Italy) by Liguria and Piemonte regions. The system is a Doppler multiparametric C-band weather radar with polarization capabilities, klystron transmitter and a full digital receiver. This system is among the most advanced monitoring systems from the meteorological point of view. It can be usefully employed in different fields from the meteorological survelliance to the facing of agronomical aspects. By the end of 2003 the installation of Settepani radar will be finished and the testing phase will be concluded. The system will be upgraded with the polarimetric variables, which will improve the attenuation correction.

Rainfall estimates from radar reflectivity maps

Volume scan radar reflectivity from the Monte Settepani radar is used to analyse the storm. Radar rainfall estiamtes are computed from radar reflectivity observation using a power law equation of the form:

$$\mathrm{R(t,x)} = BaZ(t,x)^b$$

where $R(t,x)$ is rainfall rate (mmh^{-1}) at time t and spatial location x, $Z(t,x)$ is radar reflectivity factor (mm^6m^{-3}) at time t and location x, a and b are default parameters, B is the multiplicative bias in this specific case B is 1. The default Z-R relationship (Joss and Waldvogel, 1970) is used with a = 316 and *b* = 0.5. A 55 dBZ cap is applied to reflectivity observations to mitigate the influence of hail contamination.

Case study: November 24-26, 2002

In this work all the elements described above are used to analyse the event which affected a broad area of Northern Italy and, particularly, the Ligurian region, causing intensive rainfall, floods and landslides on November 24-26 2002.

The dynamics of the event was driven by a deep baroclinic cyclones placed on the left-exit region of a strong upper level jet. It moved over the Atlantic towards the European regions and rapidly propagated southeastward, abruptly recurving northwestward over the Atlas range, defining a very sharp trough and becoming the driving force for dynamics over the Mediterranean. On November the 24th a sea level pressure minimum appeared on the leeward side of the Pyrenees and moved northeastward towards the Ligurian Sea, causing very intensive precipitation over Genoa.

In this case study two sets of hydrologic simuations are performed both on the Bisagno river at La presa (30 km^2) (Figure 1) and on the Vobbia river at Isola del Cantone (55 km^2) (Figure 2). The first simulation is obtained stressing the model with the recorded rainfall at rain gauges. The second one is obtained stressing the model with the rainfall fields derived from the reflectivity maps according to the procedure above described. These simulations are compared with the recorded hydropgraphs. In both cases the hydrograph simulated stressing the model with the rainfall derived from radar maps overperformes the one simulated using the rain-gauge recorded rainfall. It is interesting to highlight that the two examples behave in a different manner. In the case of Bisagno river the simulation performed with the recorded rainfall underestimates the recorded hydrpgraph. The simulation performed with the radar rainfall estimates corrects this behaviour and the simulated hydrograph in this case better approximates the observed one especially in the first peak and in the overall volume estimation. In the case of Vobbia the simulation performed with the recorded rainfall heavily overestimates the recorded hydrpgraph especially regarding the peak discharge value. The simulation performed with the radar rainfall estimates corrects again this behaviour towards a better approximation in this case reducing the peak discharge value.

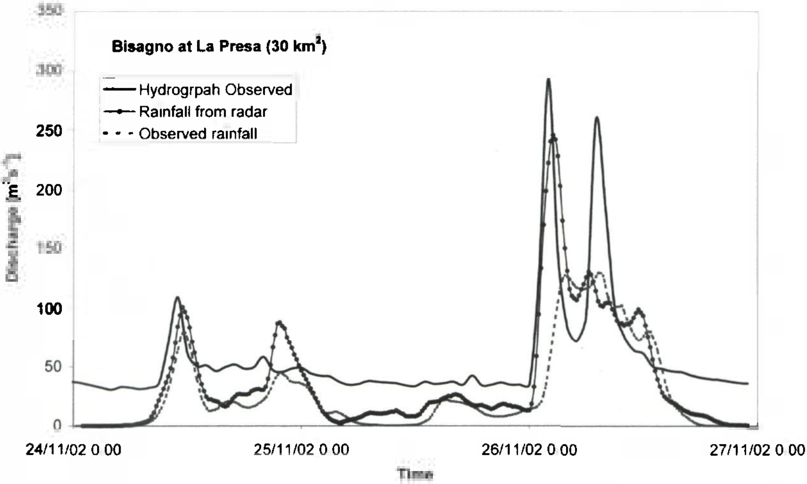

Fig.1 Hydrological simulation, Bisagno at la Presa

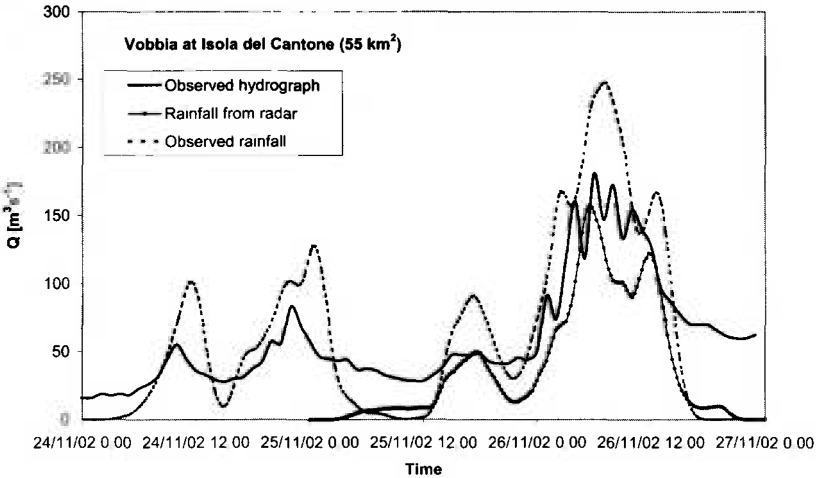

Fig. 2 Hydrological simulation, Vobbia at Isola del Cantone

Conclusions

A possible way to face hazaurdous hydrological situations linked to severe meteorological conditions is to utilize the simplest model representation that captures the dominant controls of extreme flood response coupled with a high resolution rainfall patterns. This study is the first attempt to couple the rainfall fields derived from reflectivity maps of the Monte Settepani radar with a rainfall runoff model. The work presents a case study (November 24-26, 2002) performed a posteriori considering the two catchments of Bisagno at La Presa and Vobbia at Isola del Cantone. Both the hydrographs simulated stressing the model with the rainfall derived from radar maps overperforme the ones simulated using the rain-gauge recorded rainfall. Particularly interesting is to note that the hydrological results derived from radar rainfall estimates are not sistematically biased when compared to the results obtained using rain gauges measurements.he recorded rainfall. This result, even if preliminar, is promising. The case study presented in this work, where radar rainfall estimates give such encouraging results, should be studied deeply in order to fully understand and isolate the added value provided by this tool within the flood forecating chain and in general civil protection practice.

References

[1] Giannoni F., G. Roth, and R. Rudari, A Semi – Distributed Rainfall – Runoff Model Based on a Geomorphologic Approach, *Physics and Chemistry of the Earth, 25/7-8, 2000, Pages* 665-671.

[2] Rodriguez-Iturbe I. and A. Rinaldo, FRACTAL RIVER BASINS: CHANCE AND SELF-ORGANIZATION, Cambridge University Press, 1998.

[3] Joss J., Waldvogel A., A method to improve the acccurancy of radar –measured amounts of precipitation. Prep., Radar Meteorol. Conf.,14th 237-238.

CONCLUSIONS AND FUTURE DEVELOPMENTS

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The first workshop aimed to fine-tune the overall objective of the pilot study and to develop an adequate programme. Integrated Water Management is a complex and comprehensive policy and knowledge field. Therefore the meeting agreed that working groups should be organized.

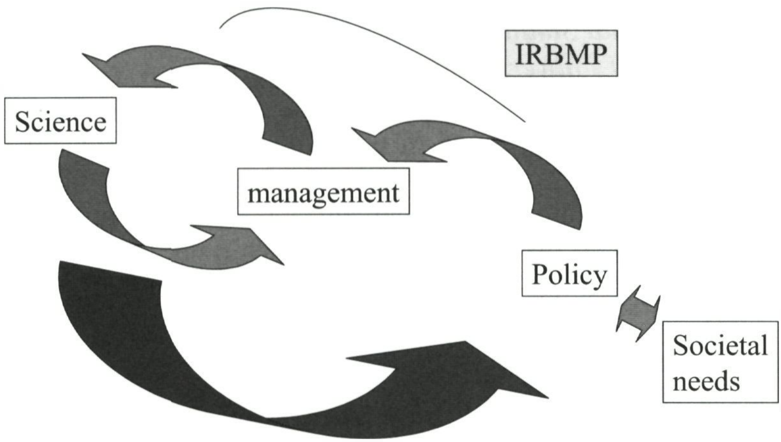
Fine-tuning the objective

Sciences, management, policy and societal needs are the main fields of interest in a river basin. Those fields are studied in depth all over the world, but essential for building (International) River Basin Management Plans (IRBMP) are the interrelations between them. Therefore this pilot study aims to contribute to the concept of Integrated Water Management by working on concepts and methodologies of those interrelations, making use of the background knowledge gathered in the different research and experience fields (Fig 1).

Final aim

The pilot study aims to learn from comparison by presenting examples to build upon, to prepare publications of scientific papers with concepts, not detailed guidelines, to establish a network for initiating new projects and to enforce capacity building in all participating countries.

A contribution to the concept of integrated water management



Work on the arrows, develop concepts, methodologies

Figure 1 Objective of the IWM pilot study

Organization

The next four workshops will include both working group sessions and a plenary session.

The working groups focus on given aspects or themes. Each working group starts with a selected number of questions to be answered. The working group members prepare a common paper on this questions based upon the contributions of the participants. To coordinate and prepare the functioning of the working groups, for each working group a working group leader (WG-leader) has been chosen. The plenary session aims to discuss and to integrate the outcomes of the working groups in order to be applicable in an IRBMP concept. Five 'pilot' basins in geographically and culturally different regions have been selected for studying specific questions related to the different working group themes (Figure 2).

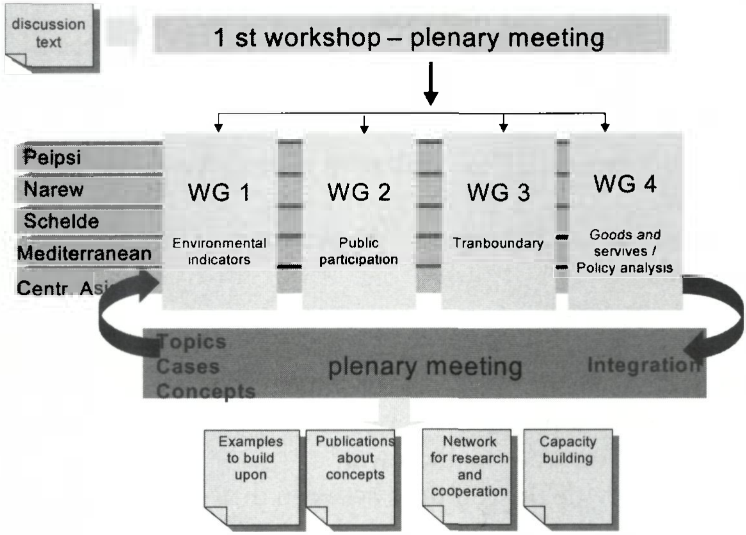


Figure 2 Organization of the workshops

Working groups and questions to be addressed

1. Environmental indicators / human health

What are the requirements to achieve health objectives? Acute disease, chronic, recoverable?

What parameters must be measured, should be measured, could be measures?

How to define carrying capacity (water use, uptake of pollutants...)?

Linked to the formulation of goals, for what do we need goals?
WG-leader: L. Lavkulich, University of British Columbia, Canada.

2. <u>Public participation</u>

How do we decide who should be involved?
How do we involve the community (the ladder)?
How do we ensure that everyone has the same information and same voice at the table?
Make a comparison of the different systems (e.g. contract de riviere…)
WG-leader: L. Santbergen, Wageningen University, the Netherlands.

3. <u>Transboundary</u>

How can we derive equitable solutions to transboundary water contamination/withdrawal, risks of inundation?
Can we develop a procedure for developing equitable user pay for contamination/water withdrawal?
How can we divide the resource between different stakeholders (e.g., agriculture – industry), impact of droughts on this division?
Comparison of basin commissions.
WG-leader: G. Roll, Peipsi Center for Transboundary Cooperation, Estonia

4. <u>Goods and services / policy analysis</u>

Valuation of ecosystem services.
Ecological services/policy analysis.
How do we ensure that the right kind of science is done to meet policy objectives?

How do policy makers ensure what the right kind of information is collected (beside allocation of money).
Role and value of floodplains.
WG-leader: M. Fisunoglu, Cukurora University, Turkey.

Basins and addressed questions and themes

<u>Peipsi</u>
How can we determine the contribution of a number of jurisdictions (land-use) on the pollution /contamination of lakes/rivers?
Can we use GIS and then modelling techniques to ascertain impacts and costs?
Public participation.
Transboundary aspects.

<u>Narew</u>
What role do natural areas have in water management? Biodiversity, ecosystem services.

<u>Schelde</u>
What are the impacts of intensive human activities on water quality/remediation?
How to create « space for the river » in an overcrowded basin?
Scaldit – WFD (2000/60/EC)

<u>Mediterranean</u>
How are transboundary effects influenced by government priorities/ strategies?
WWTP.

Central Asia: Aral Sea, Syr Daria & Amu Daria
Problem of water shortage, irrigation restoration and change in land use.A final workshop should be more comprehensive and could make use of the input of a NATO Advanced Research workshop, NATO Science for peace projects and other research projects.
The WG-leader chairs the WG-meetings and prepares the programme for the WG in cooperation with the other WG-leaders and pilot study director. The pilot study director and the WG-leaders will form a 'steering committee' for the pilot study.

Planning
The next five workshops will be organized with a frequency of two workshops a year.
The second workshop will take place in Genoa (Italy) from 28 to 31 January 2004.
The third workshop is scheduled for June 2004 in Estonia.

Up to date information concerning the pilot study and the workshops is available at the NATO/CCMS website http://www.nato.int/ccms/pilot-studies/integrated-water/welcome.html. For any further information, please contact Marleen Coenen (marleen.coenen@ua.ac.be), assistant of the pilot study director, prof. P. Meire.

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