OPERATIONAL SYSTEMS FOR WATER MANAGEMENT UNDER EXTREME CLIMATIC CONDITIONS

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ABSTRACT

The storms, extreme heavy rain falls and floods of the last time require water management more than ever for extreme conditions and long-term climatic changes. Hence new strategies are needed to secure requirements of society and environment. On an international level comparable results and intergovernmental water management is required which means to learn from each other experience. To ensure sustainable water management strategies a holistic approach is emphasized. The bases of a modern water management system are computer based Decision Support Systems (DSS) including computer simulation tools with active graphical user interface. By using of modern mathematical solutions (e.g. Fuzzy-systems, GIS, Neuronal Networks) the prognosis of water level and flood prevention and control is possible. A DSS requires a coupled analysis of all kinds of data to describe the long-term scenario of global and local changes. To get measurable results benchmarks are defined to evaluate performance of the developed simulation tool. Water management needs will be set into a socio-economic context.

INTRODUCTION

A deficit of water resources, unfavorable distributions of water in time and space, increasing water use, polluted water resources, variability and instability of climate and change of socio-economic activities demand rational ways of water management.

The goal of the DSS OSMOW computer program system is to develop a methodology for effective operational water management under normal and extreme conditions of the water cycle.

On December 22nd 2000 the General European Guidelines for Water was enforced. This guideline forms the basement for an inter-European cooperation for water protection, water management and catastrophe prevention and ensures a controlled management of surface and ground water. The General Guideline for Water requests harmonization of actions for water protection and contributes to the further decrease of water pollution. But much needs to be done to fulfill this goal. The General European Guidelines can be used not only inside the European Union, but also she is valid worldwide.

Consequent installation of a circumspect classification of watercourses especially under hydrological, economical and ecological aspects is an excellent chance to improve water management in Europe. This does not neglect the unique aspects of single river or lake system. Both must be enabled through:

- a consequent, aerial and river-specific approach
- a specific approaches for every water course
- the monitoring of sufficient data and its compilation in data bases,
- a combined consideration of pollutants (emission and imission) and
- a single pollutant or complex pollutant cocktail specific approach.

Paragraph 3 of the guidelines is a central theme of the guideline and every national water management authority will have to cope with its demands. Until now the water management is under supervision of national or even local authorities with no interaction to each other. Water management was enabled within political or geographical borders. But 50% of the residential areas are situated aside international water course systems and all of the water authorities responsible for the supply of water and waste water management have one common interest: to nationalize the advantages of water and to internationalize the disadvantages of water.

Due to the introduction of the New guideline water authorities will have to co-ordinate their actions on a broader and international scale. Along international river courses international river water management and construction plans must be introduced. International river catchment areas must be handled adequately. In order to establish such water management and construction plans a huge amount of data for the evaluation, determination of management goals as well as action plans must be compiled. The interaction of climatic, social, agricultural, industrial, environmental and economical aspects have to be considered and controlled. An interactive decision for an action must be taken according to all that information. Water pollution and the measures for water protection will have to be revised continually. The management plan therefore must be revised every 6 years (prescribed by paragraph 4 of the guideline) and ef-

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fects caused by previous actions, improvements and damages have to be evaluated. The status of the necessity of exceptional regulations has to be evaluated every time and, if the status has expired, the regulation must be withdrawn. All information must be stored and forms input data for an interactive decision support system for European water management.

The co-ordination of information exchange and decision consulting is in the first place a management task, which challenges experts and is the only way to ensure stable supply of water and to protect the environment. The living standard, agricultural production and modern industry depend on a stable supply of water and wastewater treatment.

Catastrophes caused due to absence or strong presence of water occurs with the highest probabilities. Natural catastrophes due to flooding or catastrophes caused by water such as slope sliding, dam failure or even the failure of concrete reservoir constructions due to flood impact as well as hygienic impacts, which come in the course of such events, are strongly burned into our mind. But also sneaking quiet catastrophes have a terrible and ugly face such as dry seasons. The more extreme a catastrophic event becomes the less probable becomes its occurrence. But this actually forms the danger of natural disasters. The danger that comes along with these events is difficult to predict and measures against such events are difficult to master. Prediction of such events, measures against floods and the planning of residential areas and industrial areas away from areas prone to floods is one effective measure. The construction of reservoirs for both flood protection and dry-out prevention becomes an international and inter-cultural task especially on river courses, which are situated in several countries. Water management for prevention of natural catastrophes must deal with

- the protection against catastrophes of high probability, but under economically considerations and with a calculable remaining risk,
- the remaining risk must be at a scale that the national economy is able to carry the damage and is not turned into long-term disaster.

Concerning the General European Guideline for Water much research demand exists for a variety of topics. The research proposed deals with the classification of water courses using a circumspect approach, deals with compilation and evaluation of ecological aspects and in the end prepares a tools for fast and efficient water management for both flood prevention, dry-out prevention and pollutant impact under economical, ecological and sustainable aspects.

The main problems to be interpreted in the proposal are delineated in connection with: Water Resources, Water Users and Operational Water Management. The scientific/ technological objectives and the solution of these problems are outlined in general objectives and measurable targets are described in the specific problems, respectively.
The current research proposal deals with the adaptation of models and the development of management scenarios for catastrophe protection.

The addressed general objectives of the to developed project include:

1. evaluate the danger of catastrophes,
2. evaluate the vulnerability for disasters of an area,
3. manage the catastrophe prevention and catastrophe protection,
4. improve the model output of interpolation and prognosis for managing tasks for water management based on circumspect data and its handling in an interactive data base.
5. consider hydrological, meteorological, biological, biochemical and ecological influences for decision-making.
6. Furthermore the need for water supply and protection against dry seasons must be handled. Water resources therefore must be qualified regarding quantity and quality of the water reservoir. Decision support systems will be needed and therefore the development deals with:
   a. coupled analysis of water supply safety and the safety of food supply. This involves the use of information and an integrated analysis method of water availability, water usage, food demand, and economical aspects for agriculture, and
   b. improvement of respective development for decision support for the management of catchment areas with help of input data describing the long-term scenario of global climatic changes.
   c. The decision support system must supply tools to help to improve the co-operation and communication of involved parties.
7. The decision support system also must help the governments and the private industries to decide and take action.
8. The decision support systems developed within the presented approach will help by the economical controlling and steering of water supply systems, waste water treatment plants and help to evaluate the environmental impact of actions taken.

STATE OF ART

The motivation to submit the program system OSMOW is the necessity to develop tools - methods, programs, techniques, etc. - which will enable a decision support system for water management in Europe as requested by previously published guidelines. Present practices of many European countries may need considerable alterations. Water economy systems ensuring in general needs of different water users, are methodically and technically unfit in particular cases and cannot be operated in synchrony with user requirements, for example - during unexpected droughts and floods. The operation of systems managing groundwater flow for instance is in particular exposed to retardation. The response to user needs in large open channel systems and an inter-European approach is retarded as well.
The aim of the to developed OSMOW is to develop a methodology, contributing Decision Support System for the sustainable water resources management. The methodology for water management under normal and extreme condi-

tions of water cycle builds up on management of water resources for normal cases.
The approach to the solution of considered management problems combines the best available scientific knowledge and methodologies. On basis of existing and own-developed numerical and balance models of surface and ground water flows and other dynamic processes, a new simulation and controlling system on a regional scale is constructed. The controlling system is based on a hierarchical online closed-loop concept with two simulation levels. Water needs of different water users are reflected in the management methodology, thus achieving an integrated water management. Under a user-friendly interface a decision support system is formed that allows to control and predict possible actions for water management regarding environmental, agricultural, hydrological and socio-economic aspects.
The management process is realized by an integrated information system, performing cyclic processing and analysis of the information and transferring the commands for the next time step.
The selection of several water systems/subsystems is envisaged to be the starting point and the criterion for the development of different problems included in the DSS - OSMOW. These territories (catchments) will be equipped with information devices and monitoring will be organized for the detailed observation of water flow processes, as well as for other processes in the course of experiments with the developed methods.
The introduction of strategic methods for sustainable water resources management in the practice of European countries will be in direct connection with the recently adopted European Water Framework Directive. The introduction of management methods leads to a decrease of water losses, thus affecting favorably economic efficiency. The regulation of the water/air regime in the unsaturated soil zone influences environmental conditions. Vadose zone is functioning as buffer system for the mitigation of extreme conditions.
Water resources management methods are a technological progress for the population living and working in the corresponding territory. In this way significant social effects are achieved.

NEW ASPECTS OF WATER MANAGEMENT SYSTEMS

Traditionally water resources management till now has been practically performed for surface water flows. It has been realized mainly by reservoir operation for both ordinary water use and flood prevention. The management task is expressed in an optimized hierarchical distribution of water volumes between different water users for an annual or seasonal time interval. The operative management of an open channel system is connected with substantial problems concerning the water distribution in single nodes of the system. The solution of these problems leads to accurate supply of water volumes to end points of the system.
During the last two decades the problem of integrated water management has reached a certain level of development. Groundwater management for instance is very important because of observed trends of water supply deficiencies and of possibilities to use water for irrigation purposes more economically. Regulating groundwater table contributes to the solution of diverse ecological problems. The general concept of groundwater management is based on controlled drainage according to available water resources in the region. The classical drainage facilities are ditches, open channels, drainage pipes, mole drainage and vertical drainage wells, providing mainly subsurface drainage. Water management systems are set up in various configurations. The drainage facilities should be operated alternately for the management purposes.
Investigations on water management systems useable for subsurface irrigation have been carried out in different countries: Slovakia, Russia, the Netherlands, Poland, Bulgaria, Germany, the USA, the Ukraine and elsewhere. In most cases the attention has been focused on drainage equipment operation and on possibilities of maintaining a certain groundwater level, or on determining the drainage water amount under constant operation conditions. The results of investigations and practical applications clearly confirm the possibility of regulating the groundwater level by means of drainage equipment. These results are only the basis for new research work on a complex of problems depending on requirements for control systems operating under dynamically changing conditions and still meeting the needs of water users.

The computer program system OSMOW comprises new investigations in following research topics:
1. harmonized modeling for strategic planning
2. hydraulic processes connected with the structures for regulation of surface and groundwater flows under changing conditions,
3. regional and inter-regional performance of management systems under the effect of natural conditions and the needs of different competitive water users,
4. influence of groundwater table management on mitigation of extreme environmental conditions (floods and droughts) by water retention or water release in the aquifer and in the vadose zone as well
5. technical-economic, social, hydrological, meteorological, biological, chemical and other problems related to development and operation of systems for water regime management.
6. evaluate the vulnerability of an area regarding disasters.
7. prevent or if it fails manage a catastrophic event
8. coupled analysis of water supply, safety, food supply and environmental impact
9. possible pollutant impact is involved for decision making

The strategy under consideration (item 1) is set into a holistic approach, including definition of tasks and needs (visions, guidelines), water controlling (transformation of strategy into practice), use of selected or developed tools (workmanship) and interpretation of results. The loop is completed through the feedback of results with respect to the defined tasks (Fig. 1).

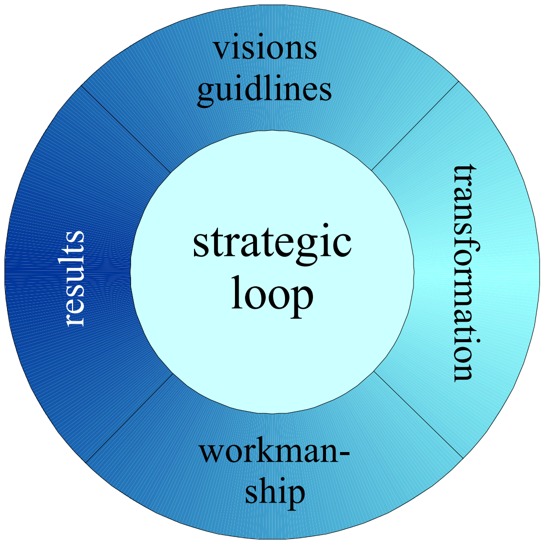

Figure 1: Strategic water resources planning approach

Investigations of item 2 are designated to formulate direct relationships between two types of parameters, describing the processes: “controlling” and “controlled” ones. These relationships are necessary for the quantitative process modeling for both surface and groundwater flows. The experience of the partners of the project consortium shows that it is possible to obtain these relationships by means of numerical modeling.

A new simulation and controlling system to achieve the transformation of strategies for the regional water-resources management will be developed in connection with the investigations in item 3. This system will be based on a hierarchical online closed-loop controlling system with two simulation levels, a detailed complex simulation tool and reduced block-models. The interaction between different processes in soil and groundwater zone is described by coupling different models to one detailed complex simulation package. Non-steady-state simulations can be performed. Substantial error reduction is achieved by introducing fine-mesh discretisation models. Detailed simulation requires the use of high-performance Computation (HPC) technique and parallel computers. The to developed project OSMOW emphasizes on the application of recently developed HPC tools in parallel codes for groundwater flow simulation to the Danube lowland and other groundwater dominated areas. On-line closed-loop control tools must be created for practical field application. These reduced models, the so-called block-models, are calibrated by the complex model. New methods will be used for calibration and sensitive analyses. In this way a hierarchical controlling system will be created. Elements of knowledge based system and mathematical methods for computation with inaccurate measurement values will be also incorporated in the block-models.

Research on groundwater pollution is included in the sphere of the regional management problems considered in this project OSMOW. In particular, the "pure zones" in the region will be defined by solving the so-called "inverse problems", as well as places for discharge and disposal of polluted water will be determined.

Investigations in test fields related to item 4 would contribute to the proof or adaptation of theoretical concepts. Data for all observed water, soil and plant parameters with respect to the regulated groundwater regime will be analyzed.

There are no data available for holistic investigations related to item 5 on technical-economic and social problems of water systems with controlled operation. Such an analysis will be performed on basis of quantitative characteristics both existing and new planned water systems.

OSMOW will advance the present situation by a holistic methodology for water resource planning under dynamic changing conditions.

Results of investigations envisaged in the DSS - OSMOW would represent a sound basis for further development and practical application of methods for water-resources management.

As a final conclusion the performance of these investigations will represent a stage in the acknowledgement of the general trend for rational use of water resources.

The OSMOW includes the development of a new method of modeling the diffuse pollution. The basis of the new method is the solution of "inverse problems". In this way the possibility is created to determine (manage) the flow path of disposed pollutant without aggravation of water quality in the rest part of the catchment.

THE CONCEPT OF OSMOW

The work planned is following the red line conception phase → implementation → application.

The conception phase comprises the harmonization of the modeling concepts within the consortium to achieve comparable results and data process identification for extreme conditions. All partners need to be actively involved in this part, because it is essential for the success of the proposal to establish a common starting point and a mutual understanding of problems each partner contributes to the research investigations. The consortium is formed by partners comprising knowledge in water resources management, groundwater flow simulations, drainage and irrigation, unsaturated flow, data base establishment as well as socio-economic and environmental issues. In this way most synergy effects of the different expertises may be gained for the project. The research work will be performed with a strong link to endusers. Members of the consortium include research institutes and water management institutions.

The implementation is a key action of the project. Hence first the selection, adaptation and when needed the development of new mathematical/numerical concepts will be performed. The participating partners have experiences with all kind of models related to all parts of the hydrological cycle. With these models a pool of mathematical concepts is formed and cross models are established. The pool of models includes in particular:

- Regional models for description of surface water flow: HBV and HBV-light (rainfall-runoff model), NLC, NONLIN, MODI (river water quantity and quality)
- Models for water balance in cross-sections of a main river
- Regional models for description of groundwater flows: MODFLOW, MOC, THEIS

- Local models for description of drainage system operation:
  DRAINMOD (simulation of shallow groundwater table), SEEP-CANAL (operation of an open drainage channel), SEEP-DRAIN (operation of pipe drainage), SEEP-WELL (drainage wells)
- Solute transport models:
  MODFLOW-MT3D, SWMS-3D, RPMOD (3D-model for reverse filtration problems), HYDRUS, COMBESICK, GLOBAL (1D-, 2D- and 3D-models for unsaturated flow in rigid soils), MACRO (2D- water and solute transport in macro porous soils), FLOCR (water flow in shrinking and swelling soils)
- Models for determining the relationships between "controlling" and "controlled" parameters
- Algorithms for inverse problems:
  MINPACK (LEVENBERG-MARQUARDT-Code), NL2SOL (Secant method for nonlinear least squares)
- Block models for simplification of the detailed models
- Models for water-economy balance in a catchment

The pool is not defined to be final during this phase; it may be extended with other models whenever needed.

The mathematical/numerical concepts are made useable by developing simulation models. The simulation tools are structured in two levels. Out of a detailed complex simulation model so-called block models are generated (Fig. 2). These models are related to a given task.

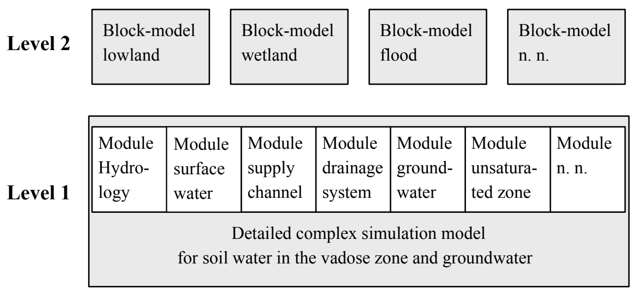

Figure 2: Hierarchical controlling system

Block models are:

- simplifications of a detailed model. There are different methods to achieve simplifications, e.g. condition viewer or transfer functions
- designed for special regions and users
- designed for different hydrological conditions, that means for a region more than one block model is required, e.g. for spring or summer conditions, flood or low discharge
- calibrated by the complex model
- integrating a part of knowledge based rules. In this case a lot of expert experience exists

The block-model level is a simplification, but enables the user to overcome the disadvantage that not all influences of the groundwater level can be described by mathematical equations. Block-models run not only on mainframes, but also on control computers, e.g. on a PC. Another aspect is inaccurate measurement values. In the state of art simulation tools take for granted accurate values, which are not available for practical working conditions. The innovative idea is the combination of mathematics of inaccurate values (e.g. Fuzzy set manipulation) with the block-models to achieve knowledge based Fuzzy controlled system.
The following figure shows the online closed-loop control system for a part of the regional water balance: surface water – vadose zone - groundwater.

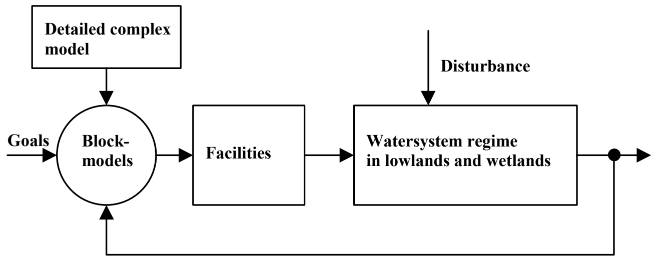

Figure 3: Loop for controlling components of water balance:
surface water, vadose zone and groundwater

The block model is online coupled with the control-loop comparing results with actual values. The goal function will be created in the computer or put in by the operator. Actual measurement values are made available online or with datalogger systems. The block-model calculates the input of regulation units. The transmission from the computer to regulation units is online. In this way a feedback between actual values and the regulation unit will be guaranteed. For the improvement of controlling effects multi-stage control loops will be used (Fig. 4). Such control loops take into consideration e.g. disturbance values (disturbance feed forward) and early warning condition values (controller feedback).

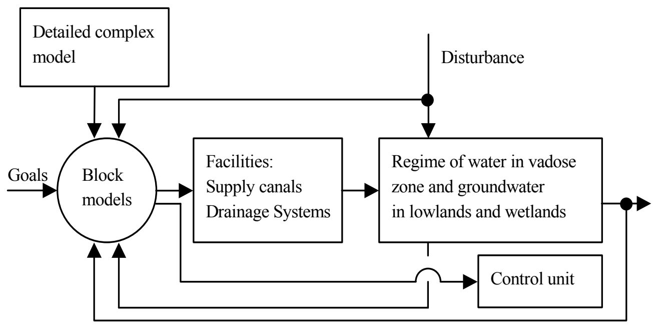

Figure 4: Multi-stage control system

The best mathematical concepts will not be used if they are not set into a user-friendly simulation environment. Therefore it is intended to embed the simulation tools into a graphical user-interface.
The application phase starts with the establishment of benchmarks. Test regions are selected to cover most foreseen extreme conditions in Europe. Simulations in test regions serve to proof the applicability of the proposed simulation tool and to perform a feasibility study with the established benchmarks.
A diversity of European test sites, covering the extreme conditions as previously described before, including

the East Slovakia Lowland

- Estimation of the characteristics of:
  - Water-level regime in a river network and channels,
  - Water-level regime of groundwater,
  - Water-content regime of the unsaturated zone of soil

  and their both spatial and temporal interaction.
- Estimation of the components of water balance in the system of atmosphere –plant canopy – unsaturated zone of soil - groundwater
- Comparison of the characteristics monitored in the test region with the results from the harmonised model

test field in Poland

- the catchment of the Gasawka river with drainage-subirrigation systems as main users of water, with other users as fish ponds, sugar plants, small towns and villages, environment (biological flows), wetlands, recreation and tourism
- the polder area in the north Poland with flood risk and mainly agriculture activity

test field in Bulgaria

- With subirrigation as characteristic component of water balance
- description of Iskar river basin up to Novi Iskar town, detail description of water resources system structure
- methodology for short-term operation of water resources system

Upper Tisza Region, Hungary

- Especially with respect to social, economic and environmental effects of integrated water resource management

Marchfeld region in Lower Austria

- This region is supplied with water from Danube for irrigation purposes. The main channel serves also as recipient for some small wastewater treatment plants.

should be representative for Europe.

After the establishment of the harmonized modeling concepts the following workpackages are embedded into a socio-economic context. Environmental issues, when not already included in water related topics, are attributed accordingly.

INTERNATIONAL ASPECTS

The European dimension of dynamic changes of the water cycle is reflected in the European Water Framework Directive. Global change effects are investigated in various research programs. The changing of climate is not only a European problem, but also more a worldwide challenge. OSMOW will take advantage of these results and is aimed to develop strategies to react to extreme conditions, like floods and water shortages. Water as a transboundary resource needs common attention of neighboring countries or of those who share river catchments. A harmonized modeling concept for strategic water resource planning will contribute to improvements of guidelines, standardization and regulations. It also ensures that the guidelines are applied accordingly.

Declining availability of water is a profound problem, which is not only a result of reduced water supply, but also exaggerated by the continuing increase of water use for agriculture, industry, municipal demand, nature conservation, etc. These problems become evermore significant in many regions of Europe and worldwide, especially in CEE countries (Central and Eastern Europe).

On the other side of the spectrum extreme conditions related to an excess of water due to an increase of annual return periods are observed in the western part of Europe. Most practices are related to surface water. An important aspect of the proposed research project is to investigate the controlling possibilities of groundwater and the storage capacities of the unsaturated zone.

Due to human activities water quality (pollution) became a key topic for water provision and environmental conservation.

The problems stated above (floods - draughts - pollution) occur in different regions and under different hydrological and environmental conditions, but to cope with the effects for all an efficient management strategy is needed. Hence exchange of information and expertise between the regions in Europe has to be enforced. In particular this will emphasize the role of integrated water measurements and efficient water use strategies.

- By developing a harmonized modeling tool results are comparable and synergy effects are easily passed on.
- The establishment of benchmarks should contribute to unbiased analyses of the performance of the proposed strategies.
- The proposed strategies are set into operation by simulation for test regions, which are representative for Europe.

The project will utilize existing experience whenever available and will establish a knowledge resource that will be continuing beneficial after the present research program is completed. For the dissemination of results CD-ROM and other electronic means are utilized. The information collected in the created knowledge base will be accessible through Internet.

The scale of the project impact is potentially very large. Regional development in water scarce areas is highly dependent on available water resources. The efficient allocation of water is important as it maximizes the potential returns on water use economically and environmentally.

The research partners also see particular promise for the commercial exploitation of European expertise around the World. Solving the problems of rational water use in Europe will enable European organizations to utilize or adapt the techniques for other parts of the world – particularly developing countries where water-shortage is steadily increasing and represents a profound threat to the stability of the local environment and society.

SOCIAL ASPECTS

The natural, economic and social conditions of most countries in Europe and worldwide confront the society with the challenge to solve the problem of sustainable water resources management under dynamic changing conditions. These changing conditions may be a result of global change effects or due to human impacts. Strategic water resource planning utilized by operational methods contributes to mitigate negative effects of droughts (water deficiencies) or an excess of water (floods) in other periods of the year. In general, according to quantity and quality, water is considered to be a deficient natural product.

Water resources management in modern practice represents already an instrument for solving water economic and ecological problems in a rational way. Management tasks are related to surface and groundwater. Emphasize has to be paid between both resources in a catchment. An important role plays the movement of water in the unsaturated zone. The resource water is under continuous pressure of pollutants, due to various points and diffuses sources.

Sufficient amount of water of good quality is essential for the quality of life and health.

This will only be achieved if the resource water is treated as an European concern.

In a broader sense "operational management" includes all activities leading to a sustainable water regime. More specific, operational water management has to deal with predictions of water resources use in a catchment, monitoring and data processing, analyses of water resources changes and identification of response actions.

This has to be seen in a socio/economic context and interactions with water policy statements are foreseen.

The results of OSMOW will directly effect European and worldwide international social objectives by:

- maintaining rural livelihoods. By providing mentoring advice to water and agricultural organizations, the project output will help to improve food and water availability; preserve/enhance the environment and to provide employment. Improvement of Quality of Life and Health and Safety can be expected. It has been recognized in the Fifth Environmental Action Program that the abandonment of farmlands can have negative effects on the environment.
- expansion of EU by promoting and developing links between leading organizations in the existing EU that are interested in efficient water resource management (especially in regions with water shortage) and similar organizations in Central and Eastern Europe. The network will encourage better intra-European co-operation. This will ensure that relevant results and experiences within the community can be utilized - hopefully to the advantage of the pre-accession states.
- improvements directly developed in the CEE, which will be utilizable in many regions of the EU. This is a step towards equality of information access and opportunity in all countries of EU. The compilation of all the information from the various sub-topic networks into one integrated system will provide specialized knowledge to be readily accessible by professional colleagues in partner countries, thereby adding to the EC's net overall knowledge.
- Improving agricultural production and maintaining the agricultural nature of regions in Europe. Better availability of technical information across the range of irrigation and drainage topics will help participants to better contribute to European efforts to improve yields and to limit effect of external impositions of drought and associated difficulties.

The project results will enable researchers and practitioners across Europe to share experience and skills, and then apply/adapt the benefits to their own respective countries or regions.

From an indirect point of view, the wasteful use of water has financial and economic consequences including the loss of rural livelihoods. In water scarce regions farm incomes are often very marginal and livelihoods are delicately balanced.

CONCLUSION

A deficit of water resources, unfavorable distributions of water in time and space, increasing water use, polluted water resources, variability and instability of climate and change of socio-economic activities demand rational ways of water management. The main objective is a methodology for effective operational water management under normal and extreme conditions of the water cycle. The research supplies solutions and tools to: evaluate the danger and vulnerability of an area; prevent damage; handle water supply and ensure quantity and quality of water resources; consider hydrological, meteorological, biological, biochemical and ecological influences; generate sufficient data; handle an interactive data base for interpretation and prognosis. A DSS requires a coupled analysis of all kinds of data to describe the long-term scenario of global and local changes. DSS improves co-operation and communication of involved parties in order to take action for controlling and steering.

Main milestones and expected results are: harmonized modeling concepts and data base for simulation of extreme conditions, simulation models including a graphical user interface, benchmarks to ensure comparable results and to provide a check of simulation performance, socio-economic and environmental restrictions. The result is a DSS as required by the new General European Guidelines regarding the controlling and steering of the water cycle to provide help to evaluate possible impact of actions.