EWRA

ECOLE DES MINES DE PARIS

6th International Conference / 6ème Conférence internationale

Sharing a common vision of our water resources

Partager une vision communautaire de la gestion des ressources en eau

Menton, 7-10 September / Septembre 2005

Conference Proceedings

Actes de la Conférence

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FOREWORD

Constituted since 1992, the European Water Resources Association (EWRA) is a leading European non-profit organization aiming at enhancing cooperation and exchanges in application and research on all aspects of water resources. Activities range from conference organization to publication of journals and news, organisation of training courses and expert knowledge sharing through networking with other organizations.

The 6th International Conference, organized by the Ecole Nationale Supérieure des Mines de Paris, the UMR-CNRS Sisyphe, the Office International de l'Eau and UNESCO, is held in Menton from 7th to 10th of September 2005. Professional organizations supporting this event are : IAHR, IAHS, GISIG, INBO, SHF, TECHWARE and UNESCO-IHP.

It is the occasion to bring together the professionals of the water of approximately 40 countries presenting more than 200 interventions giving a progress report on the state of the art in the field of the water resources. At the inaugural sitting, EWRA2005 treats of the whole subject of the "Urgencies of water" that it is on the national or international level. This conference allows also a profitable exchange of information and know-how between French and foreign specialists.

Countries of Europe have recently embraced a common strategy for the management of their water resources through the adoption of the EU Water Framework Directive roadmap. It brings a unique opportunity for building a common vision of sustainable usage of water and aquatic ecosystems. This effort is generating a vast set of expertise in river basin management policies, new economic transparency for water use and innovative approaches in public collaboration.

It is the aim of the conference to identify and promote best practices in good water status and demand management, realistic scenarios building, reliable economic analysis of water uses and efficient stakeholders and/or public involvement in decision making.

Préface

L'European Water Resources Association (EWRA) est l'une des plus importantes organisations européennes dont l'objectif est de faciliter les échanges et le partage des connaissances dans l'application et la recherche ayant trait aux ressources en eau. Ses activités couvrent l'organisation de conférences, la publication de journaux spécialisés, la conduite de formations et la mise en réseau d'expertises en liaison avec d'autres organisations professionnelles du domaine.

La 6ème conférence annuelle de l'EWRA, organisée par l'Ecole Nationale Supérieure des Mines de Paris, l'UMR-CNRS Sisyphe, l'Office International de l'Eau et l'UNESCO, se tient à Menton du 7 au 10 Septembre 2005. Les organisations AIRH (IAHR), AISH (IAHS), GISIG, RIOB (INBO), SHF, TECHWARE et UNESCO-IHP participent à l'évènement.

En séance inaugurale, EWRA2005 traite de l'ensemble des « Urgences de l'eau » que ce soit sur le plan national ou international. Cette conférence permet aussi un échange fructueux de connaissances et de savoir-faire entre spécialistes français et étrangers.

Les pays d'Europe ont adopté une stratégie commune pour la gestion de leurs ressources en eau en acceptant le programme défini par la Directive Cadre Européenne de l'Eau (DCE). Ceci offre l'occasion unique de construire une vision communautaire de la gestion durable de ces ressources et des environnements aquatiques associés. Cet effort génère un vaste champ d'expertises dans les domaines de la gestion de bassin, de la transparence économique des usages de l'eau et de la participation du public aux décisions de gestion.

Le vaste champ des sujets abordés dans les conférences, sessions poster et l'exposition doit contribuer au succès des échanges entre participants et professionnels de l'eau au niveau européen et international sur le plan des méthodes, critères et procédures portant sur la gestion des ressources en eau. L'objectif de cette manifestation est de promouvoir les meilleures pratiques dans le maintien du " bon état " des ressources, la conception réaliste de scénarios, la fiabilité de l'analyse économique des usages de l'eau et la participation efficace du public dans l'élaboration des décisions.

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EWRA 178 Issues & responses in hydrology, environment, life, and policy in the São Francisco Verdadeiro river basin (Brazil)

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The São Francisco Verdadeiro river basin, with an area of 2,200 km2, is strategically located in Brazil, bordering the Itaipu reservoir (which supplies ¼ of the Brazilian electric demand) and the Iguassu Falls National Park (Unesco's world monument). Recently, due to its unique character, the S.F. Verdadeiro watershed was selected as an operational HELP/UNESCO basin. However, since the 1970's, the basin has experienced some hydrologic, environmental, life and policy problems, arising from the land use/management model used. In terms of Hydrology, although there are no apparent water quantity conflicts, there are some water quality problems, which threaten the sustainability of water supply in the basin. Among the causes is the discharge of non-treated sewage in the basin rivers, as well as sedimentation generated in rural areas. With regards to the Environment, the most important issues are the clearing of native forests and the loss of biodiversity. Recently, there was a river infestation by an exotic mussel (Limnoperna fortunei). The most significant Life & Policy issues in the basin are the decreasing farmer income and the incomplete knowledge, by the urban & rural population, of the existing and potential water and environment-related risks. In addition, only timid actions in integrated water resources management were implemented by stakeholders and decision-makers.

These issues result in a classic "paradigm-lock", which threatens the basin's sustainability. Recently, with the involvement of two federal institutions (ANA & Itaipu Power Company), and the adoption of the HELP framework, solutions for the above issues are being sought. In addition, the local expertise (state agencies, universities, cooperatives) is being called to contribute with the environmental, land-use & water quality monitoring and reclamation in the basin, using simple and yet efficient technologies. In order to integrate the environmental, life & policy issues, as well as the existing pressures and policy responses in one quantitative and aggregated indicator, a "Watershed Sustainability Index-WSI", which uses a pressure-state-response function, was developed and applied to the SF Verdadeiro basin. The basin WSI was 0.65, which represents an intermediate level of sustainability.

Keywords: hydrology, environment, life, policy, watershed sustainability index, S.F. Verdadeiro, HELP basin.

EWRA 180 Implementing equitable water allocation in transboundary catchments: the case of river Nestos/Mesta

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Border areas comprise inevitably problematic fields especially when the countries are bound to share common water resources. The conflict potential is rather high and quite often countries are directed to the negotiation table in order to form tranboundary agreements. These agreements aim at the settlement of tensions and conflicts originating from the management of shared water resources. Often a starting point of the conflict resolution is the water allocation scheme between the interested parties. The definition of entitlements over shared water resources in not an easy task and it requires the use of specific decision tools in order to reach the maximum level of objectivity.

According to the Water Framework Directive (WFD) 2000/60, management of transboundary catchments shall be based on existing structures set by international agreements, such as the UN Convention on the Protection and Use of Transboundary Watercourses and International Lakes. The main aim of this paper is the implementation of a water allocation tool based on representative indices characterizing the involved parties while placing emphasis on environmental protection. The variables used are proposed by the UN Convention on the Law of the Non-navigational Uses of International Watercourses incorporating both natural and socio-economic aspects. These factors are quantified for each country and a weight factor is assigned to each one depending on its importance and suitability for describing the environmental and socio-economic situation in each country. As an illustration example the transboundary river Nestos/Mesta case is presented.

Keywords: transboundary river management, water allocation, indicators, weighting factors, Nestos River

EWRA 177 Involving the community in water resource management: learning from action research in two New Zealand case studies

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This paper outlines the work carried out by a research team within the Institute of Environmental Science and Research (ESR) - a Crown Research Institute in New Zealand - in relation to community involvement in council decision-making about water allocation in the context of water scarcity. It identifies the national drivers of increasing water scarcity (and quality) such as intensified land use (farming and residential development), and changing climate patterns. The discussion of the case study research also draws on the process and findings of the government-led Water Programme of Action that focuses on issues of water quality, allocation and water bodies of national importance, and potential changes in the Resource Management Act 1991.

The paper focuses on articulating and evaluating ESR's intervention in two case study sites. The first site is Akaroa (a small Banks Peninsular town) facing drinking water shortages related to inadequate access to water, ageing water infrastructure and increasing residential development. The second is Tasman, at the top of the South Island, where development and intensification of the productive Waimea Plains is limited by a 22% over-allocation of water along with its associated environmental effects. In both areas the ESR research team, funded by the Foundation for Science, Research and Technology, used social and systems science methods and tools for actively engaging the public in articulating and exploring the range of activities and values that would need to be taken into account in decision-making. In Akaroa the intervention resulted in a water-metering programme that would feed into a long-term water strategy, and in Tasman the intervention has been incorporated into Feasibility Study into water storage options in a local catchment.

Keywords: water resource management, Resource Management Act, water allocation, infrastructure, action research, community participation

EWRA 189 Anticipating climate change: knowledge use in participatory flood management in the river Meuse

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Given the latest knowledge on climate change, the Dutch government wants to anticipate the increased risk of flooding. For the river Meuse in The Netherlands, the design discharge is estimated to increase from 3800m3/s to 4600m3/s. With the existing policy of "Room for the River", this increase is to be accommodated without raising the dikes. At the same time the floodplains are often claimed for other functions, e.g. new housing or industrial estates.

In 2001 the Ministry of Transport, Public Works and Water Management started the study "Integrated assessment of the river Meuse (IVM)" with the objectives of making an inventory of the probable physical effects of a design flood, assuming climate change, on the river Meuse in 2050, investigating possible spatial and technical measures to mitigate these effects, and finally combining various measures to create an integral strategy for flood protection, while at the same time increasing spatial quality. This paper presents the results of research into the decision making process that took place in order to achieve these objectives.

Special attention was given to the role of scientific and technical knowledge in the decision making process, e.g. by investigating the effect of the quality of input data on acceptance by stakeholders, and the interactive use of a decision support system to visualise hydraulic effects.

Conclusions on successes and pitfalls are drawn from observation and interviews with participants. It demonstrates how it is possible to integrate the necessary, technically complex knowledge in a political debate with stakeholders on how to deal with flood risk. Furthermore, the experience indicates in what area improvements could be made.

Keywords: Flood management, spatial quality, participatory decision making, knowledge use, hydraulic model, climate change

E1 - Integrated Water Management

EWRA 048 Land use and aquatic ecosystem protection within an English lowland catchment: The Eye Brook

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The Eye Brook is a 6750 ha sub-catchment of the River Welland (UK) with land use comprising mainly grazed pasture and arable cropping. Transport of soil and nutrients from arable land to water is an increasing concern for the quality of water, stream substrates, and associated ecology. The Allerton Project addresses this issue through its research and demonstration farm in the centre of the catchment, through catchment scale research and through building social capital at the catchment scale. A stakeholder workshop applied a social learning approach to understanding local catchment issues, values and concerns of local people, identifying an implicit identity with the Eye Brook as natural capital, but limited understanding of the ecological or physical processes. A subsequent survey of Brown Trout, a species valued by some local stakeholders, revealed low recruitment because of sedimentation of spawning substrate. Research projects in the Eye Brook catchment investigate the influence of cultivation methods on soil erosion, and the impact of this on the aquatic ecosystem. Further research, combining ecological science with a Participatory Learning Research approach with farmers, investigates the potential of newly created 'Paired Ponds' associated with arable ditches to mitigate transport of soil and nutrients to water. This catchment-based project therefore combines practical farming with sound science and local knowledge to provide a focus for better understanding of catchment issues more widely.

Keywords: Catchment, natural resource management, Water Framework Directive, erosion, sediment, phosphorus, non-inversion tillage, fish, inter-disciplinary research, paired pond

E2 - Water Quality Challenges

EWRA 031B A procedure to define the good chemical status of groundwater bodies in Germany

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Commissioned by Germany's Working Group of the Federal States on Water Problems (LAWA) the authors developed a procedure to define natural groundwater conditions from groundwater monitoring data. The distribution pattern of a specific groundwater parameter observed by a number of groundwater monitoring stations within a petrographical comparable groundwater typology is reproduced by two statistical distribution functions, representing the "natural" and "influenced" component. The range of natural groundwater concentrations is characterized by confidence intervals of the distribution function of the natural component.

The applicability of the approach was established for 17 hydro chemical different groundwater typologies occurring throughout Germany. Based on groundwater monitoring data from ca. 26000 groundwater-monitoring stations, 40 different hydro chemical parameters were evaluated for each groundwater typology. For all investigated parameters the range of natural groundwater concentrations have been identified. According to the requirements of the EC Water Framework Directive (article 17) (WFD) this study is a basis for the German position to propose criteria for assessing a reference state for a "good groundwater chemical status".

Keywords: Good groundwater chemical status, background values, groundwater typologies, EC Water Framework Directive.

EWRA 126 Calculation of diffuse seepage loads of nitrogen in the Upper Rhine valley using the STOFFBILANZ model

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From March 2004 to April 2005 we modelled diffuse seepage loads of nitrogen in the catchment of the upper Rhine between Basel and Karlsruhe. Three separate time periods reflecting the situation between 1979 and 2000 were computed at the Landscape Ecology Dept. of the Institute of Geography of Dresden University of Technology. The project is part of the Interreg III-project "modelling of the groundwater load of nitrate in the Upper Rhine Valley - MONIT" (State Institute for Environmental Protection Baden-Wuerttemberg). The model results are an important component in elucidating the past and present situation of nitrate transport into ground water as well as its future development. Calculations were performed by means of the STOFFBILANZ model, originally developed for Saxony, but adjusted to the project area in cooperation with the orderer, the State Institute for Environmental Protection, the State Agricultural Testing and Research Station Augustenberg and the ARAA (Association pour la Relance Agronomique en Alsace, Schiltigheim / France). This contribution describes these adjustments.

Due to climatic favour, rural structures in the Upper Rhine Valley are dominated by maize. Furthermore, there is specialised cultivation especially of tobacco, asparagus, vegetables and wine. Concluding analysis of the origins of nitrate in the substantially loaded ground waters of the area under study is possible only, if this typical land use is considered in the model. This requires a realistic description of management practices (fertilizing, yields), of processes of mobilization and immobilization as induced by the respective types of fruit and of local conditions. To achieve these demands, we extended the model by including the mineralisation rates from soil matrix during the entire year as well as the fruit-specific release of nitrogen from harvesting and root residues in winter. Yields and fertilizing rates were estimated by the State Agricultural Testing and Research Station Augustenberg and the ARAA taking the known agrarian practices in the region into account. First tests of the modified model lead to convincing results.

Keywords: seepage, nitrogen, nitrate, modelling, diffuse pollution, mineralization

EWRA 138B Safe drinking water in Rodrigues

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The island of Rodrigues in the Indian Ocean has a population of around 5,000 on an area of 108 km2. A Master Plan study was carried out in 2000 to assess the present and future water requirement of the island up to the year 2020 for different uses (domestic, touristic, industrial and irrigation) region wise, assess the potential of presently available water sources, both surface water and groundwater (whether in use or not), analyse the present transmission and distribution network and submit proposals for rationalisation of same to make optimum use of the existing water sources, and make proposals concerning the rehabilitation, upgrading, and extension of the existing network.

In the long term, a sizeable water requirement for Rodrigues is to be expected (of the order of 20,000 m3/day). Present surface water sources and boreholes tests indicate that this order of yield is not obtainable on an annual basis. A development programme separated into three stages was prepared:- Short Term Action (0-5 years), Medium Term Action (5 -10 years) and Long Term Action (10 -20 years).

It can be reported that less than 4 years after the Master Plan was approved, many of the proposals, such as the laying of pipelines, meters, etc. have been or are in the process of being implemented. Investigations for two dams (Baie Pistache, Cascade Pigeon) are under way while a third one (Grenade) is being constructed and a fourth one (Anse Raffin) is being rehabilitated.

Keywords: water resources requirements, planning, Master plan, Rodrigues

EWRA 151 Integration of a detailed nitrogen balance model into a mesoscale water balance model for river water quality predictions

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Land use change throughout Europe leads to both an intensification of farming in areas offering better prerequisites for cost-effective production and an increase of fallow land in peripheral regions. These changes can have an impact on various eco-hydrological key values such as groundwater recharge, low-flow frequencies as well as river water quality. Each of these key values is emphasized for consideration within an integrated catchment management plan by the EU Water Framework Directive.

We implemented algorithms from the detailed biogeochemical model DNDC (Denitrification-Decomposition-Model) in the Soil and Water Assessment Tool (SWAT). The coupled SWAT-DNDC model is a time continuous semi-distributed eco-hydrological model. Apart from calculating all relevant hydrological fluxes, it simulates decomposition, nitrification and denitrification on a process level and a daily time basis. The model distinguishes 3 organic litter pools; each pool is characterized by both a specific C-N ratio and a rate coefficient. The coupled model is tested on the point scale (lysimeter data) and the meso-scale (Dill River 693 km², Germany). The model is further used to predict the influence of land use changes and agricultural practices in the Dill catchment on the above mentioned eco-hydrological key values. Therefore, spatially explicit land use predictions by the agro-economic model ProLand based on various EU agricultural policies are investigated.

Keywords: nitrate, point and non-point source pollution, landscape scenarios, nitrogen modeling

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EWRA 144A Evaluation of sampling strategies for estimating nutrient fluxes at the outlets of agricultural watersheds

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Developed countries around the world are experiencing more and more serious environmental problems. Recognising the threat of excess nutrient emissions to receiving water bodies, western countries have engaged into vast programs of nutrient control on land. Best Management Practices have been proposed to reduce nutrient emissions at the field and the watershed scale in many regions of the world. In many cases, BMP implementations have been coupled with nutrient flux monitoring programmes for effectiveness assessment purposes..

Nutrient fluxes are usually estimated from continuous flow measurements and discontinuous concentration values obtained after laboratory analysis from discrete water samples. Because of the discontinuity on the concentration information, there is an error made in flux estimations compared to the actual fluxes. This error may be, in some cases, within the same range as the expected water quality improvements. Actual improvements may thus very well remain undetected because of unsuited sampling strategies. To our knowledge, there are no existing references to 1) estimate those errors and 2) propose sampling guidelines for minimizing those errors. In this paper, we propose to evaluate nitrate and total phosphorus flux estimation errors induced by common water sampling strategies. Sampling strategies evaluated include: set frequency using discrete bottles, and flow-weighted frequency using discrete bottles.

Keywords: Best Management Practices, sampling strategies, sampling errors, nutrient fluxes, water quality, watersheds, diffuse pollution, nitrates, total phosphorus

EWRA 170A The World Hydrological Cycle Observing System (WHYCOS)

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Adequate information is essential for wise management of water resources. Sadly, at the global scale our ability to provide information about the status and trend of water resources is declining. To counter this trend, the World Meteorological Organization uses such means as technology transfer and training, collaboration among meteorological and hydrological services, and international exchange of data and information.

The World Hydrological Cycle Observing System (WHYCOS) is Composed of regional systems (HYCOSs) implemented by cooperating nations. WHYCOS will complement national efforts to provide the information required for wise water resource management. Based on WMO's World Weather Watch (WWW) it will provide a vehicle not only for disseminating high quality information, but also for promoting international collaboration and provide means for the international community to monitor more accurately water resources at the global level, and to understand the global hydrological cycle.

In 1993 WMO, in association with the World Bank, launched WHYCOS. Its objectives are to: establish a global network of national hydrological observatories which provide information of a consistent quality; strengthen the technical and institutional capacities of hydrological services to capture and process hydrological data, and meet the needs of their end users for information on the status and trend of water resources; and promote and facilitate the dissemination and use of water-related information, using modern information technologies such as the World Wide Web and CD-ROMs.

WHYCOS has two components: a support component, which strengthens cooperative links among participating countries; an operational component, which achieves "on the ground" implementation at regional and international river basin levels. It is also a programme for training facilitation.

Keywords: water resources assessment, hydrological network, databases, data processing, data dissemination, information system, training.

EWRA 170B HYDROMET software

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The Research Institute for Development (IRD) and the National Company for the Rhone (CNR) have combined their expertise in managing networks for measuring and processing hydro-meteorological data. The result is a new software program called HYDROMET. It has been designed to provide the following functions: hydro-meteorological data acquisition and collection: stage, discharges, gauging, rating curves, water quality parameters, rainfall, temperatures, hygrometry, wind speed, etc; information storage in an ORACLE data base ensuring full integrity; automatic data processing in real time or in deferred time for data stored in the data base; varied means of disseminating stored data.

HYDROMET is an open system, designed to solve the problems of data management in contemporary hydro meteorology. The main functions are: setting parameters: totally open and scalable, the HYDROMET software allows the data administrator to create his own hydro meteorological measurements network: stations, measurements, rating curves, warnings, current-meters, etc. and to also manage access rights with a password for each user: data acquisition; data storage; automatic and deferred data processing; consulting the data; alarm warnings; availability and dissemination of information; computer system architecture

HYDROMET (French, English, and Spanish) is available: in a multi-station version: a server and several client PCs: (for example, up to a hundred client PCs can be connected at the CNR, some of which are off-site, connected to the server with through a high-speed data link and have the same conditions of access as the users of the central site and the same access time as those using the internal network); mono-station version : the server and the client are on the same PC.

Keywords: database management, water resources, hydro meteorology

EWRA 159 Management of regional aquifers using a combined procedure based on geostatistical and GIS tools (Haouz groundwater of Marrakech ...)

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Evaluation and management of groundwater resources in regional aquifers require preliminary knowledge of various parameters such as hydrogeological parameters (transmissivity, storage); exploitation parameters (production rates of the wells and their productivity), quality and vulnerability of the groundwater, etc… The acquisition of all these data at the system scale can prove however long and very expensive. The use of geostatistical tools can to this end be of a great utility. Geostatistics enables to carry out a reliable and economic estimate of these parameters at the aquifer scale, and to obtain sufficiently precise maps. The integration of these spatialized data in a GIS (geographical information system), jointly with other information (topographic, geological, water-table, water-depth, water quality, groundwater vulnerability maps, water requirements map, populations map, etc…) ultimately allows to place at the disposal of water authorities and decision makers, a genuine tool of assistance to decision-making.

The example of the alluvial groundwater of the Haouz of Marrakech is developed here. This groundwater extends on approximately 6000 km² and represents the main water resource of this first tourist area of Morocco. It plays consequently a major part in the social and economic development of this area. Due to this fact, the Haouz groundwater was the subject of a great number of studies and works since the Forties. All the data available were spatialized and integrated in a GIS. These data were subdivided in two categories: quantitative and qualitative information. It is shown that such a GIS, through a permanent interaction between these two types of data, actually constitutes a water resources management and a decision-making tool for the managers.

Keywords: water resources, regional groundwater, geostatistics, Haouz of Marrakech, Geographical Information System, decision aiding tool.

EWRA 125A Italian hydrologic GIS: the hydrografic network

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The Hydrological Service of the Italian Agency for Environmental Protection and Technical Services (APAT) is carrying out a hydrological GIS for the information mapping of the hydrological features of the national territory aiming at supporting its monitoring task and its management of Italy's water resources. This function is also performed in the frame of the implementation activities concerning EC 2000/60 Directive requiring the realization of geographical information layers for the production of an information system referred to water resources at European level. The basic layers forming the hydrological GIS are created at national scale 1:250.000. These are the hydrographic network, the catchment boundaries, the layer of meteo-hydro stations and the layer of hydrogeology.

The "national Hydrographic network" is a vectorial cartography of the Italian watercourses correlated with a database with the hydrological features of each reach and of each node of the hydrographic network. The "Catchment boundaries" layer with the catchment draining into the sea and the first order subbasin with an area greater or equal to 200 km2.

The layer of ""meteo-hydro stations" is a relational database containing all information concerning the monitoring stations managed by the Hydrographical and Tidal Service and by those regional structures giving their contribution to the national integrated hydro-meteo-pluviometric monitoring system. The project has already been carried out in a pilot area. In order to achieve a deep knowledge of groundwater, an information layer, "hydrogeology", has been realized with the aim of marking and describing the main hydro-geological ensembles and identifying the preferential directions of groundwater flow. The database linked to the vector cartography concerning the southern Italy has been completed and it will be extended to central and northern Italy.

EWRA 078 Assessing the impact of land-use changes on surface runoff through remote sensing

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The Seybousse catchment located in eastern Algeria has undergone rapid urbanization and tremendous economic growth during the past few years. Most of the economic development activities are focused in and around the city of Annaba. The growing urbanization in the outer periphery of Annaba city has created pressure for the changes in the land use pattern. Infrastructure development has further enhanced the land use change process in the area. Bad land use management practices are thought to be the cause of increased flooding. It is thus very important to assess the runoff changes due to land-use changes. This paper deals with the effects of land use changes on runoff evolution and flood risks. Within the framework, a physically based hydrological model coupled with the SCS curve number method is presented to assess the runoff changes due to land-use changes. In order to approach a reasonable result in hydrologic modelling satellite based remote technologies are used to extract land surface parameters. Future changes in land use can also be incorporated in the model once digital database is available and the change in runoff production can be found out. Thus land-use planning and management can be done efficiently. The relationships developed between changes in runoff with respect to a change in CN are very useful to quantify the effect of land-use change. The change in peak runoff values can be estimated for a basin having known changes in land-use for known rainfall. The study clearly demonstrated that the integration of spatial data and the application of a physically based model in a remote sensing environment provide a powerful tool for the assessment of an effect due to land-use change.

Keywords: Surface runoff, Urbanization, Remote sensing, Hydrological model, SCS curve number.

EWRA 022 Groundwater resource assessment in hard rock terrain using conventional, remote sensing and GIS approach: a case ... in Ethiopia

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Integrated studies were implemented for studying the groundwater resource in the drought prone peripheral part of Ethiopia, Negelle Borena. Analysis of hydrometeorological components shows that mean precipitation for the catchment is about 647mm per annum. Actual evapotranspiration is evaluated using the simple "book keeping" Thornwait and Mather method and is found to be about 93.6% of the annual input from the precipitation. The mean annual recharge to the catchment is 31.4mm and about 9.2mm of water leaves the catchment as surface runoff. Five hydrostratigraphic units have been characterized based on porosity, permeability and storage capacity. Recharge area in the catchment is mainly confined to the Phanerozoic cover and the discharge areas are in the basement terrain.

Application of the GIS and remote sensing shows that movement of groundwater in the study area is mainly controlled by structures. A series of water types was identified in the study area; hydrochemical studies reveal that the hand dug wells mainly on the basement show variety of water types: calcium-bicarbonate, calcium-chloride-bicarbonate and calcium-sodium-chloride-bicarbonate attributed to the arid condition of the area. The intersection on other lineament orientations and the NE-SW structures are considered to be the potential sources due to the effect of double porosity, the NE-SW structures existing at topographically depressed (south western) parts of the study area are also considered to be potential sites, which is in agreement with the available ground data.

Keywords: Lineament, GIS, Groundwater, Hydrogeology, Remote sensing

EWRA 057 Integrated water cycle management - "An Australian perspective"

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Integrated Management of Water Resources including stormwater and waterways is potentially one of the most influential factors in shaping our urban centres and our standards of liveability, now and in the future. Australia has a high water usage coupled with low and uncertain rainfall . Local governments in Australia are under enormous pressure to manage the significant future population growth in a sustainable manner. In order to be a sustainable and liveable region, local governments and the development industry need to work cooperatively to manage water resources and to protect natural assets.

The traditional approach to managing water, at a government level, involves a number of departments looking after different water components. For example, at a Queensland State level, the Environmental Protection Authority (EPA) regulates water quality, while the Department of Natural Resources & Mines (DNRM) regulates water quantity. At a local government level the water authority provides supply and sewerage, while stormwater is managed by a different department and water sensitive urban design by another. Emerging ideology in the management of water supply is towards demand management. Demand management involves looking at efficient use of water through reducing losses, improving water usage efficiencies and source substitution. An holistic approach to demand management is through Integrated Water Cycle Management (IWCM). IWCM requires an integrated institutional approach to implement effectively. Water supply, sewerage and stormwater are the three key elements of IWCM, but are traditionally designed independently. In IWCM the three elements work together to derive sustainable water outcomes. As numerous disciplines are involved, a trans-disciplinary management approach is required to effectively implement IWCM. Urban stormwater and waterways health issues are generally managed separately by Local Governments through Total Management Planning (TMP) for Catchments and Waterways. This approach will serve to integrate water quality, catchment health, flood management and waterway corridor planning into a coordinated activity.

EWRA 093 Towards a new leader of local water policy in France?

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The administrative organisation of water management in France is very complex: the lack of territorial coherence in public interventions is obvious. There is no satisfactory regulation in this field. The law of March 1995 introduced the concept of "chef de file" (leader) in order to clarify both the role and responsibilities of each actor and his fields of intervention. On the one hand the concept of "chef de file" is an alternative to the tangle of competencies between actors, which harms the effectiveness of water policy. On the other hand the concept of "chef de file" deals with the need for a referee in charge of animation, coordination and decision-making if necessary.

The concept of "chef de file" seems appropriate for tackling the problems of competent distribution and unravelling the tangles of the actors frequently observed in the field of water management. However, the legislator has hardly recognised this concept. The actors concerned do not agree on the significance and even the relevance of this concept. Some of them fear that its implementation will be in conflict with the principle of free administration of the communities ("libre administration des collectivités"). And even when they consider that it is relevant, they agree neither on the attributions related to this role nor on the best actor for the job.

Our purpose is to describe the actors' relationships by this exploratory study. We have based our thoughts on interviews of various actors involved in water management and on the analysis of the legal debate in the area of sharing competencies. We have been interested by the question of the legitimacy of actors to become "chef de file". We could identify four types of "chef de file" by crossing the two following dimensions : the degree of specialisation of the actor (transversal practitioner vs. specialist) and the entrance point in water policy/ the base of legitimacy (installations – equipment vs. sustainable management of resources). In conclusion we will point out advantages and drawbacks of each identified type of "chef de file".

Keywords: sustainable management, water policy, water management, leader, communities, France, intermunicipal bodies

EWRA 060A Sustainable water resources management in Pinios river and lake Karla basins, Thessaly, Greece

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This study investigates the water balance of Pinios River and Lake Karla basins under various water management scenarios. The two basins are located in the Thessaly Region of central Greece. Thessaly is an intensely cultivated agricultural region, the second largest plain of Greece and is traversed by Pinios River. The intense and extensive agriculture of water demanding crops, such as cotton, has lead to a remarkable water demand increase, which is usually fulfilled by the over-exploitation of groundwater resources. This unsustainable practice has deteriorated the already disturbed water balance and accelerated water resources degradation.

The Pinios river basin extends to about 9500 km2, and it was divided into sub-basins. The lake Karla basin has an area of about 1200 km2. The whole hydrological system of Thessaly was discretized into five control nodes. A modeling system was developed to evaluate the sustainability of the various water resources management scenarios. The monthly and annual surface water and groundwater potential of each sub-basin of the system was estimated through hydrological modeling for the period 1960-2002. The water demand was calculated for each sub-basin and water sector in monthly and annual basis for the same period. Water balance analyses were performed for each sub-basin and each control node of the system for a number of water management scenarios. Four scenarios of hydro-technical project development were coupled with two scenarios of groundwater withdrawal and three water demand scenarios. In total, twenty four water management scenarios were evaluated.

The results showed that, under the existing water resources management, the water deficit of the Pinios River and Lake Karla basins is very large. However, the development of proposed hydro-technical projects in the Pinios river basin coupled with water demand management measures, like improvement of the existing water distribution systems, change of irrigation methods, and changes of crop cultivation could alleviate the problem and lead to sustainable and ecological use of water resources in the study area

Keywords: sustainable management, water resources, hydrological modeling, hydrotechnical projects, reservoir modeling, Pinios River, Lake Karla.

EWRA 107 Transboundary water management & cooperation in Greece. The Axios river basin

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Transboundary water resources management is in the heart of the international agenda due to the great importance sharing water resources are gaining lately. The intensive need for international cooperation and macro-engineering schemes among neighboring countries sharing common water resources is widely recognized. Systematic approach and cooperation between the border countries based on new technologies and practices could assist the efficient, effective and equitable management of sharing transboundary water resources.

The paper examines the case of transboundary Axios/Vardar river basin between Greece and FYROM, lighlights the major problems and forms a framework for the integrated water resources management of the river basin. Meeting the increased water demands mainly for agricultural purposes downstream, preserving the quality of the Thermaicos Gulf and maintaining the delta of the river, a wetland protected by the Ramsar treatment, are among the first priorities of a new potential agreement.

Keywords: Transboundary water resources management, Axios river, cooperation, Greece, SWOT analysis

EWRA 163

Water systems management - Lifesaving interventions evaluation

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The present study deals with the evaluation of the lifesaving interventions project that the Water & Sewage Utility of the city of Thessaloniki (E.Y.A.TH. S.A.) implemented in the urban water distribution network. The measures involved (installation of PRVs and Public Awareness Campaign) aimed at decelerating the brake rates of the various types of pipes met in the network by dividing the whole system into pressure zones and by decreasing the Urban water consumption. The basic factor used to evaluate the measures, is their impact on the optimum replacement time of the pipes. The optimum replacement time of the pipes is determined by an appropriate method based on the Present Value of all the various types of costs related to a pipe break (repair and replacement costs). Additionally, break rate forecasting models are developed, using the Water & Sewage Utility's records. The results of this study are compared to the results of similar projects implemented in other networks with more or less the same characteristics (variety of pipes' materials, size, types, etc.). In the case of Thessaloniki, actually, the implementation of the project significantly reduced the pipes' brake rates. The interventions involved (mainly installation of PRVs) are being analytically presented and their consequences regarding the water savings (conservation) are being evaluated in economical terms, using a cost-benefit analysis. Finally, suggestions for the specific network management that can be widely used also to water delivery networks of other metropolitan cities, are being stated.

Keywords: water systems, technical and economical analysis

EWRA 020A

Distribution of organic micro-pollutants, suspended sediments and phosphates in the Speke gulf (lake Victoria), Tanzania

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Field measurements campaigns were carried out in the Speke gulf (Lake Victoria), in 2002 and 2003 to measure the water quality. Surface water samples were collected and analyzed for pesticides, phosphorous, organic carbon and suspended sediments from eight locations in the gulf. Three organochlorine pesticide chemicals (DDT, HCH and Endosulfan) were detected in the water samples, with total concentration ranging between zero and about 2000 ?g/m3. Total phosphorous concentrations ranged between 200 and 700 mg/m3 and total organic carbon from 3 to 100 g/m3. Total suspended sediment concentrations ranged from 2 g/m3 to about 500 g/m3. Generally, higher concentrations appeared during the rainy season in April 2003 suggesting that high contaminant loads are caused by the Simiyu river discharge to the Speke gulf. Also, a significant decline in concentration especially for phosphorous, organic carbon and suspended sediment concentrations is observed at stations located further away from the river mouth, but this trend is not noticed for pesticides for reasons that remain unknown.

Keywords: field measurements, Speke gulf, pesticides, phosphorous, organic carbon, suspended sediments

EWRA 054 Soil and plant pollution in floodplains after the extreme Elbe flood 2002 in Germany

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Floodplains including low marshlands take up 10.4% of the land mass of Germany. Of these, however, only a small part are regularly flooded areas today. Large parts of the floodplains are used more or less intensively. Greenland usage and agriculture on these fertile soils have relevant economic importance. Due to the more and more frequent occurence of extreme floods in recent times provisions and after-care have become the focus of societal discussion and scientific investigation. Pollutants are remobilized and shifted by floods. In extreme events, like at the Elbe River in August 2002, partial areas, which, as a rule, do not show any connection to the channels and streams, become subject to clearance and accumulation. Numerous old sites, hazardous waste deposits, companies and sewage works were flooded.

Aside from their function concerning water retention, the floodplains also have a function concerning anorganic and organic materials. Questions regarding the pollutant contamination of the Elbe and the Mulde arose among users and customers alike after the flood catastrophy in 2002. In the framework of the investigations by the authorities and the research projects supported by the ministry, the German Elbe system including important tributaries like the Mulde were analyzed extensively after the flood in 2002. Waters, sediments, muds, soils and the vegetation are assumed to be strongly enriched with nutrients and pollutants in catchment areas influenced by industrial and mining activities. As a rule, floodplains, which were flooded for the first time in 2002, are seen as not very or only moderately polluted. Altogether, however, there was no immediate danger to human health on account of the pollutant situation during and after the flood.

The pollutant concentrations measured do not justify a general ban on agricultural usage of the flood-endangered floodplains. Nevertheless, the contamination of soils and plants at the Elbe and Mulde is such that the problems will have to be given further attention.

Keywords: flood, floodplain, plant, pollution, risk evaluation, Elbe River, sediment, soil

EWRA 168 Total dissolved nitrogen and phosphorus in lake Qarun, a closed Egyptian basin ... with contaminated agricultural drainage waters

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Lake Qarun, a closed elongated salty basin lying in the western Egyptian desert, has two peninsulas dividing it into eastern and western basins. It receives continuously agricultural drainage waters, controlling its area and volume. The vertical and horizontal distribution of total dissolved nitrogen (TDN) and phosphorus (TDP) in the lake was studied to illustrate their levels and sources. Lake Qarun showed enrichment in TDN. Dissolved organic nitrogen (DON) constituted the major fraction (98 %), whereas dissolved inorganic nitrogen (DIN) exhibited the rest 2 %. Accordingly, the vertical and horizontal TDN distribution followed that of DON, giving higher bottom values and a gradual decrease northward. The eastern TDN averages were slightly lower than the western averages. The minimum and maximum monthly TDN averages in July and November were accompanied with the lowest and very high TDN content in the drainage waters, confirming their direct influence. The increase in TDN in cold months and its decrease in warm months are confirmed by the significant negative correlation between temperature and TDN ($r=-0.53$, $p?0.001$). The high surface total dissolved phosphorus (TDP) concentrations mainly reflect the effect of phosphorus enriched drainage water discharges. The high bottom TDP values coincided with phosphate regeneration in bottom water and sediments. Similar to TDN, the horizontal distribution of TDP followed that of dissolved organic phosphorus (DOP), showing a gradual decrease northward. The eastern lake region harboured higher TDP concentrations than the western part. The minimum and maximum monthly TDP averages in December and August were accompanied with the lowest and highest averages of its main constituents; dissolved inorganic phosphorus (DIP) and DOP, as confirmed from the high significant positive associations with DIP ($r=0.93$, $p<0.001$) and DOP ($r=0.95$, $p<0.001$).

Keywords: dissolved nitrogen compounds, dissolved phosphorus compounds, saline lake, Egypt, agricultural drainage waters

EWRA 014 Water quality of the Aliakmon river at Kozani, Greece: results of a monitoring program

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This report is the first contribution directly related to variations of the physical-chemical parameters over a period of nine months of Aliaknon river in West Macedonia Greece. In order to evaluate the water quality the Water Quality Index was used. The real time control data collected from environmental management studies of the Aliakmon River require presented important information in the calculation of the water quality index. By considering its physical-chemical and bacteriological composition at this point in time, it is possible to make important political decisions related to environmental legislation, by using the water quality index and to evaluate actions relevant to the regulation of human activities.

Information is presented on water quality variations of the Aliakmon for temperature, turbidity, pH, BOD, PO4, TP, NO3, at three monitoring points in Kozani Greece.

Keywords: water quality, water quality index, Aliakmon river, Western Macedonia Greece.

EWRA 218 Modeling the impact of river morphology on nitrogen retention - Uncertainty and scenario analyses

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The goal of this study is the investigation of the impact of river morphology on water quality - especially nitrogen cycle – in a 4th order river using the river water quality model WASP5. Uncertainty and scenario analyses were carried out to investigate nitrogen retention processes. It was shown that different morphological factors influences nitrogen retention. Nevertheless the potential of management measures to reduce nitrogen loads seems to be low because of the restrictions for reaching a natural state of river morphology.

Keywords: river water quality model, river morphology, nitrogen retention, uncertainty analysis

EWRA 208A — Biomonitoring of freshwater quality in Scottish lochs using their aquatic flora composition

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In this paper is studied the possibility of using the aquatic flora composition in some lakes in order to monitor their water quality. During June and July of 2004, 18 lochs in Scotland were investigated in situ in order to record the presence of aquatic plant species. The purpose of this study was to classify the lakes in groups according to their flora composition and afterwards to see whether these groups coincided with the four primary groups of lochs that were found according to West's (1904, 1910) data.

Multivariate ordination procedures and in fact the Canonical Correspondence Analysis (CCA) was used for the ordination of the macrophyte data and the creation of the lochs' groups.
Additionally the Trophic Ranking System (TRS) of Palmer et al. (1992) was used for the assignation of the waterbody trophic status based on the macrophyte assemblage and thus relating the trophic alterations between the lochs nowadays and 100 years before.

Indeed, the results implied that the primary loch types, representing four distinct sets of trophic conditions in the early 20th century, can be still identified today, and recommended that these loch vegetation types can potentially provide representative baseline reference conditions, for use in assessing environmental change, as required by the EC Framework Directive (EC, 2000).

Keywords: Scotland, bioindicators, macrophytes, trophic requirements, freshwater lakes, environmental change, physical and chemical parameters.

EWRA 132 — Regional models for the evaluation of streamflow series in ungauged basins

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The assessment of water resources in a region usually must cope with a general lack of data, both in time (short observed series) as well as in space (ungauged basins). Therefore regionalization techniques have to be adopted in order to transfer information to sites without or with short available observed series.

The present paper aims to analyze applicability and limitations of two regionalization procedures respectively based on a "two-steps" and on a "one-step" approach, for the evaluation of monthly streamflow series in ungauged basins.

In particular, a "two-steps" and a "one-step" approaches based on multiple regression equations and a "one-step" approach based on neural networks are presented. The "two-steps" approach requires as a first step the estimation of the model parameters for each gauged basin, and as a second step the determination of regional relations between the parameters and the geomorphological characteristics of the basins. On the other hand, according to the "one-step" approach, hydrological and geomorphological characteristics of the sub-basins are directly considered as model inputs to derive streamflow series.
An application of the proposed regional models to a Sicilian river basin is reported. For the investigated region, results indicate that models based on the "one-step" approach appear to be robust and adequate for evaluating the streamflows in ungauged basins.

Keywords: regional models, regression equations, neural networks, streamflows

EWRA 042 Comparative analysis of the hydrologic impact of land use change and subsidence in an urban environment

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The present research demonstrates how distributed hydrologic modeling can be successfully used to evaluate the relative effect of various hydrologic factors influencing the magnitude of flooding and the associated losses in an urban watershed. The study area is Whiteoak watershed, located northwest of downtown Houston, TX. Whiteoak experienced rapid urban growth during the last thirty years, complemented by continuing subsidence due to excessive groundwater pumping. This study examines whether subsidence contributes to the increased flooding occurrences of the last few decades in the area, amplifying the impact of moderate and extreme rainfall events. The objectives of the analysis require spatially accurate representation of critical topographic and hydrologic parameters such as slope, rainfall, and roughness along the Whiteoak basin. The lumped hydrologic models commonly used to simulate rainfall-runoff are not capable of preserving detailed spatial information. The present study addresses the effect of spatial variability in hydrologic response with the use of a physics-based, fully distributed hydrologic software, VfloTM. Vflo is based on finite element analysis, thus, it is computationally efficient and equally capable of simulating historical rainfall-runoff events and operating in real time, at any location of the study domain. Detailed digital elevation data acquired from a 2001 Light Detection and Ranging (LIDAR) survey of Harris County, NEXRAD radar rainfall data, and satellite data land cover provide the main topographic and hydrologic parameters of the study. Historical aerial photos of Whiteoak are geo-referenced to offer information about the land use change in the area over the last thirty years. Subsidence contours for the periods 1978-1987, 1987-1995, and 1995-2000 were provided by the Houston-Galveston Subsidence District. All data sets were compiled in a GIS environment, analyzed, and transformed into grid format prior their input in Vflo. Quantitative results indicate that continuing subsidence since 1978 should be considered at least as important a hydrologic factor affecting upper Whiteoak as land use change and channel modifications.

Keywords: Urban flooding, GIS, Distributed hydrologic modeling, LIDAR digital elevation model, NEXRAD rainfall data

EWRA 003 Contribution to the evaluation of some theoretical models, calculating hydraulic conductivity in unsaturated soils

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The steady state profile method, under constant rainfall flux surface conditions was used to obtain the K(Th), K(H) and H(Th) relationships for a range of Th values, for a porous medium that is a mixture of sand (where K is the hydraulic conductivity, Th the volumetric water content and H the water pressure head). This mixture was packed in a 1.2-meter long polyethelene column. A number of tensiometers were installed in order to secure pressure head uniformity throughout the length of the column. By using a number of analytical models and the experimental moisture retention curve of the porous medium, theoretical K*(Th) and K*(H) relationships were obtained. The comparison of the experimental data to those derived from the computational approaches seems satisfactory.

Keywords: Unsaturated hydraulic conductivity, moisture retention curve and models.

EWRA 111 Rainfall – runoff process simulation using the Watershed Modeling System (WMS) software

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The subject of the present paper is the hydrological modeling, using the software of the Watershed Modeling System (WMS). The program WMS is a Geographic Information System (G.I.S.) with hydrological application, therefore it combines the G.I.S.'s spatial data with hydrological models. The study area is the Portaicos river watershed, located in the Thessaly hydrological department of Greece. The hydrological data for the watershed are two separated events of rainfall – runoff. The structured G.I.S. furnishes the Digital Terrain Model, the hydrological and the geomorphological features. The HEC–1 hydrological model was used in this paper. The choice was based on three criteria. The first and most important is that the input data are known values, measured or estimated, secondly that it provides completeness, concerning the Loss Method and the Unit Hydrograph (U. H.) Method and finally, the system equations of the model are known. The hydrological model HEC–1, as it is supported by WMS, doesn't provide the possibility of automatic calibration, that's way the initial simulation was realized, where the input data are values of the hydrological parameters, as they derived from the research of the separated rainfall –runoff events or from G.I.S. Based on the conclusions of the initial simulation, the procedure of calibration was orientated towards the search of the optimum simulation methods and parameters values.

Summarizing the conclusions, it is noted that the calibrated runoff hydrograph, on the Portaicos river watershed, is best given with the SCS dimensionless unit hydrograph method. Supplementary, the software WMS provides reliability in the computation and design of the G.I.S. components. Also, the hydrological model is updated directly and calculates simultaneous from the structured G.I.S. the set of attributes concerning the hydrological modeling.

Keywords: watershed, rainfall, runoff, simulation, water resources, surface water model, Portaicos river, Water Modeling System (WMS)

EWRA 059 Validation of a simple water balance model in Pinios river basin (Peloponnese, Greece)

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In this paper, a three parameters Simple Water Balance Model was tested,. Monthly runoff data from the Pinios river basin (dam site) were used. During calibration, data of two out of three consecutive hydrologic years were compared with the output of the model. The parameters of the model have been determined using the trial and error method. The R2 criterion was selected as a measure of the suitability of the model to the data. Moreover, the model validation was carried out using data of the subsequent hydrologic year. It was shown that, for the values of the parameters determined, R2 remained unchanged. It was also proved that one of the parameters of the model can be estimated from the S.C.S. analytical formula, using a weighted CN coefficient for the river basin studied (i.e. the calibrated value of this parameter was found close to the one derived from the S.C.S. formula). Moreover, it was shown that the model is not sensitive to the above mentioned parameter and thus, either the calibrated value or the estimated one from the S.C.S. formula can be used.

Keywords: Simple water balance model, Pinios river

EWRA 148

Groundwater pollution policy design – Unique needs and challenges

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Until three decades ago it was generally believed that the soil, on which the pollutants are discharged, would filter out the contaminants, and prevent them from penetrating down to the groundwater reservoirs, lying beneath it. It was only in the late seventies that this notion was proven to be wrong, urging hydrologists, water managers, and government officials to pay closer attention to groundwater quality. Today, Countries all over the world are dealing with groundwater pollution of different severity. For some, pollution may well be a life threatening crisis, due to the high levels of usage of their aquifers for the supply of drinking water.

In the last few decades, environmental law has evolved to include regulation promoting the protection of groundwater and the treatment of contaminated aquifers. In some cases countries have adopted a policy, based on their existing anti-water pollution policy. However, most nations have found that the protection of groundwater is a challenging mission, requiring specific measures and multifaceted cooperation among a variety of sectors and institutions. This is because other than the medium that is being polluted, groundwater contamination is fundamentally different from surface water pollution. As such, traditional water protection and pollution prevention policies,mainly focused on surface water contamination, cannot adequately and efficiently protect the aquifers, and their application on groundwater results in a flawed and unbalanced policy.

This paper examines four main characteristics of groundwater seeking to determine the effects these unique traits have with regard to the required design of a successful policy protecting aquifers. First we will identify the main characteristics of the polluters, and the effects these qualities have on the policy design. The second factor is the methods through which the contamination will be discovered emphasizing both timeframes and costs. The third aspect is the remediation process's costs and timeframes and the consequences of these on the design of an efficient policy. Lastly, we will refer to the need for soil clean-up and the effects these ties have on the regulation of groundwater remediation.

Keywords: groundwater pollution, surface water, contamination, policy, design, prevention, remediation, clean-up

EWRA 086

Small irrigation and sustainability of water resources (Andalusia – Spain)

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In order to discuss about water management in Mediterranean areas, we put under study the case of a colony of little farmers in West Andalusia. After heavy problems of salinization during the 80', these farmers obtained to be connected to a pipe of water, proceeding from another basin. Unfortunately, technical and economical problems force them to mix this superficial water with local subterranean and saline water, inducing a degradation of water resource. Such situation show how the lack of fair decision making can recreate environmental problems.

Keywords: irrigation, water quality, Mediterranean areas

EWRA 137 Combining state-of-the-art techniques for developing integrated water management scenarios in a lake catchment

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Integrated Management of the Water Resources is nowadays a prerequisite for environmental preservation and economic growth. The EU Water Framework Directive provides the guidelines to develop strategies and institutions to protect and restore the water resources in both qualitative and quantitative basis. However, the implementation of the proposed measures incorporates significant difficulties arising from the lack of necessary data, the fragmented approach often followed in water management and the incomprehension of the interactions between hydrologic systems and ecological components. Nevertheless, the Integrated Water Resources Management demands multidisciplinary approaches, use of sophisticated scientific techniques and establishment of a broad and reliable monitoring network. In the particular study, a combination of remote sensing data, hydrologic models, ecological assessment techniques, GIS software and isotopic surveys have been adopted to extensively study the water resources of Trichonis lake catchment, in Western Greece, in order to develop management alternatives aiming in protecting ecologically significant wetlands and meeting the local irrigation demands. For this purpose, the available water resources have been quantified in high accuracy, monthly and annual water budgets for the lake catchment have been estimated, the hydrologic interactions between different water bodies have been identified and both environmental and anthropogenic water needs have been calculated. The main threat from the current water management scheme for the important wetlands surrounding Trichonis lake, is the high monthly and annual fluctuations of the lake's water level. The management alternatives have been developed with the contribution of local authorities by redistributing the monthly water outflows from the lake according to the ecological and anthropogenic demands and comprise five (5) plans that attempt to minimize the environmental impacts from the regional water use while maintain the economic activities unaffected. The proposed water management plan has been implemented for a year and the result indicated a 25% decrease in the annual water level fluctuation of the lake.

Keywords: Water resources management, wetlands, hydrologic modeling, lake catchment

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EWRA 138A Water resources management in Mauritius

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Water resources management consists in the initial planning and matching of water availabilities and demand.

Water is a basic ingredient in economic and social development, and should be one of the main components of national and regional planning. Planning of water resources is usually carried out at three levels: (i) long term overall planning on national level, with time horizons of about 50-100 years. (ii) medium term planning with time-horizons of 15 to 25 years (iii) short term project planning with varying time-horizons (usually 5 to 10 years) according to each specific project.

It is important to be able to assess availabilities and demand, and to define proper criteria for this assessment so that the conclusions may be trustworthy. This assessment must cover water availabilities, include both surface waters and groundwater, consider the aspects of quantity and quality and refer to both present and future situations. This paper explains how on the one hand the water resources were evaluated through a simulation of reservoir performance, while water demand was estimated using several scenarios for consumption.

The results from these two basic objectives helped in formulating a Master Plan for the development of water resources in Mauritius. Implementation is presently being carried out, which gives the opportunity to discuss a post analysis of the simulation carried out.

Keywords: water resources, requirements, planning, Master plan, Mauritius

EWRA 176 A hydrogeotechnical integrated system for water resources management of Attica – Greece

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In this paper an information management system used in Attica Greece that combines modeling with the integrated management of water, sewerage and storm water infrastructure is presented. From this information management system there are proposed certain public works that are grouped in two categories, i.e. works that are needed for the entire Attica district and have a general character for the whole region (1st category works) and then, works that are specifically needed for every particular and individual municipality (2nd category works).

The first category consists of: Collection and Treatment of the Used Water Works, and Reuse of at least a portion of the Treated Wastewater Works, and the second category consists of: Flood Protection through Stormwater Storage Works, Artificial Recharge of Groundwater Aquifers Works, Municipal Boreholes & Wells Construction Works, Works of Water Conservation & Recycling for use for Industrial Purposes, Spring Development & Exploitation Works, and Desalination of Groundwater Resources Works. Alternative scenarios and proposals are evaluated using G.I.S. technology, and finally the greater usage of the integrated modeling and the management as well as the technical results in terms of proposed public infrastructure works for each municipality in Attica district are presented.

Keywords: surface and groundwater modeling, sustainable management, integrated management, water conservation and recycling, decision support systems, G.I.S.

EWRA 056 A new approach for risk assessment of soil salinisation: a case study in Songnen Plain, Northeast China

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Soil salinisation is a major problem in resource and eco-environment management in Songnen Plain, Northeast China, and constraining sustainable agriculture development. Hydrogeological condition significantly contributes to the formation and development of soil salinisation, especially depth to water, water quality and runoff condition. This paper focuses on impact of the evolution of groundwater environmental space on the formation and development of soil salinisation and applies a new approach - Hydrological Response Units (HRUs) to assess the risk of soil salinisation. Thereby, based on three principal parameters as weight index of hydrological zones (HZ), depth to water in 2001 (DTW) and rate of rise from 1992 to 2001 (RR), the constructed hydrological response units (HRUs) map in 2001 was created in the Tao'er river basin of Songnen Plain. This was achieved by the algebraic multiplication of three classified grids, HRUs = DTWxRRxHZ. The HRUs map indicates that the risk degree is not high in the whole area; comparatively, the higher risk zones occur in Momoge wetland, Zhenlai County, Laifu and Chagan Town, which is mainly attributed to the poor discharge of groundwater, recharge of surface water bodies and irrational irrigation by raising the shallow groundwater table. These results can provide scientific guidance for mitigating and controlling soil salinisation.

Keywords: hydrological response units (HRUs), risk assessment, soil salinisation, groundwater, hydrological zone, Songnen plain

EWRA 031A — A procedure to define the good chemical status of groundwater bodies in Germany

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Commissioned by Germany's Working Group of the Federal States on Water Problems (LAWA) the authors developed a procedure to define natural groundwater conditions from groundwater monito ring data. The distribution pattern of a specific groundwater parameter observed by a number of groundwater monitoring stations within a petrographical comparable groundwater typology is reproduced by two statistical distribution functions, representing the "natural" and "influenced" component. The range of natural groundwater concentrations is characterized by confidence intervals of the distribution function of the natural component. The applicability of the approach was established for 17 hydro chemical different groundwater typologies occurring throughout Germany. Based on groundwater monitoring data from ca. 26000 groundwater-monitoring stations, 40 different hydro chemical parameters were evaluated for each groundwater typology. For all investigated parameters the range of natural groundwater concentrations has been identified. According to the requirements of the EC Water Framework Directive (article 17) (WFD) this study is a basis for the German position to propose criteria for assessing a reference state for a "good groundwater chemical status".

Keywords: Good groundwater chemical status, background values, groundwater typologies, EC Water Framework Directive (WFD)

EWRA 201 — Presentation of the BRIDGE project - Background criteria for the identification of groundwater thresholds

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The BRIDGE project is a contribution to the global European effort which focuses on the sharing of a community approach of Water Management. Its overall objective is to develop background criteria for the establishment of threshold values in groundwater. In this way it supports sustainable groundwater management.

Article 17 of the Water Framework Directive 2000/60/EC (WFD) stipulates that criteria for establishing the groundwater chemical status should be developed in a proposal made by the European Commission, i.e. a "Groundwater Daughter Directive", which is currently under negotiation at European Parliament and Council. The Commission proposal of Groundwater Directive COM(2003)550 specifies that the "good chemical status" of groundwater shall be partly defined by Member States themselves. Indeed, the chemical status of groundwater will be based on existing Community quality standards (nitrates, pesticides and biocides) and on the requirement for Member States to identify pollutants and related threshold values (i.e. environmental quality standards) that are representative of groundwater bodies found as being at risk, in accordance with the analysis of pressures and impacts carried out under the WFD.

The BRIDGE project intends to develop a common methodology on "how to derive groundwater thresholds" that could be used by Member States. In that way, it will contribute to the WFD Common Implementation Strategy (CIS). The project is carried out at European level, involving a range of stakeholders and efficiently linking the scientific and policy-making communities. The different activities within BRIDGE are: to set out criteria for the assessment of the chemical status of groundwater; to derive a plausible general approach on how to structure relevant criteria appropriately to set representative groundwater threshold values scientifically sound and defined at national river basin district or groundwater body level; to check the applicability and validity of this approach by means of case studies at the European scale; and to carry out an environmental impact assessment taking into account the economic and social impacts.

Keywords: E.C. Water Framework Directive (WFD), Groundwater protection, environmental thresholds, water quality, characterisation, groundwater bodies, impact assessment, socio-economic impacts.

EWRA 191B

Geochemical baseline of French groundwaters : state of the art and methodology

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One of the basic requirements of the European Water Framework Directive (2000/60/EC Directive) is the evaluation of the patrimonial state of groundwater quality. This task implies knowledge of the natural geochemical background of groundwater in order to detect chemical variations due to human activities and to predict both short and long-term water quality evolutions. Aware of this problem, the French Ministry of Environment (Water direction) and the French Water Agencies entrusted the BRGM with the development of a methodology, applicable to the French geological context, able to characterise the natural baseline of water chemistry.

A large range of factors controlling the chemical composition of groundwater do overlap, making impossible a deterministic approach that could be applied to all types of aquifers. The proposed methodology therefore adopts a step-by-step strategy that takes into account the definition of groundwater bodies, the need to identify human pressure on the groundwater resources as well as the long-term quality objectives, fixed by the Water Framework Directive for groundwater bodies. To make sure that the methodology is practicable, it has been tested on four different case studies.

All these results (state of the art, methodology and application to case studies) are compiled in a guidance document to be published soon (BRGM, 2005). This document aims to give to water managers a practical methodology in order to assess the geochemical background of one given aquifer. It will particularly be useful for the River Basin Districts to meet the Water Framework Directive requirements. As the future Groundwater Daughter Directive will ask Member States to define threshold values for the definition of good chemical status, this guidance document offers key elements to distinguish anthropic inputs from naturally occurring substances.

Keywords: water geochemistry, groundwater, geochemical baseline, Water Framework Directive (WFD)

EWRA 072A

Groundwater quality in Slovenia assessed upon the results of national groundwater monitoring

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In Slovenia groundwater is predominant drinking water source. More than 97% of drinking water is abstracted from shallow, unconfined alluvial aquifers and fractured or karstic porosity aquifers. The protection of groundwater quality is therefore of upmost importance for Slovenia. According to the landuse on the recharge areas of shallow alluvial aquifers and their natural vulnerability pollution of groundwater is to be expected. In Slovenia groundwater quality monitoring of 19 alluvial aquifers important for drinking water supply started in 1987 while groundwater quality monitoring of karstic springs has been carried out since 1990. Monitoring network on alluvial aquifers contains 100 observation wells (among them 2 automatic monitoring stations) and 23 springs and wells on fractured- or karstic-porosity aquifers. Two- to four times a year about 160 different chemical parameters are analysed, among them 100 different pesticides and their metabolites. Groundwater is polluted mostly by nitrates, pesticides and volatile chlorinated aliphatic hydrocarbons therefore these parameters are most important for groundwater quality assessment. Monitoring results from the year 2004 are statistically treated to represent groundwater quality on individual sampling site. Some characteristic trends are shown.

Keywords: aquifers, drinking water, groundwater, pollution, monitoring, groundwater quality assessment, chemical status, trends

EWRA 197 Uranium and radon in groundwater. An overview of the problem

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Radioactive elements occur naturally in our environment. A long-term exposure to the radioactive gas radon (222Rn) can lead to lung cancer. In Sweden, 500 cases of lung cancer are registered every year, due to inhalation of radon gas. The parent element of 222Rn is uranium (238U), which is found in soils and bedrocks in varying concentrations. 238U is also radioactive but causes more harm due to its toxicity; kidney problems arise when uranium is ingested. In areas where municipal water is not available, wells are drilled in bedrocks to extract water for drinking purposes and other uses. Groundwater from wells drilled in rocks rich in uranium (e.g. granite rocks) have shown tendency to have both high radon and uranium concentrations. However, the opposite is not always true; In Stockholm, concentrations of radon exceeding the Swedish regulatory limit of 1000 Bq/l have been observed in bedrocks containing low concentrations of uranium (0-2 ppm). The uranium concentration in water is usually not routinely measured as an indicator of water quality despite its toxicity. A uranium concentration as high as 445 microg/l (WHO limit is 15 microg/l) was observed in one private well in Stockholm, The heterogeneous conditions in the subsurface (geochemistry, groundwater flow, geology and fracture system) make the development of a risk prediction model, that can be applied at large scale, complex. This paper presents an overview of the problem of natural radioactivity in our drinking water.

Keywords: Radon, Uranium, Groundwater, Risk prediction.

EWRA 091 Impact of the industrial rejections on surface and groundwater on Annaba aquifer (Algeria)

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The characterization of a hydrologically complex contaminated site bordering the Meboudja river (Annaba, Algeria) was undertaken by investigating surface water and groundwater affected by Number of industrial rejections have been established during 1999-2005 in the El-Hadjar Industrial Development Area in the Annaba region, North-East of Algeria. The treated and untreated effluents from the industries are being discharged in Meboudja wadi. Groundwater level and water quality monitoring was carried out during 1999 and 2005 in El-Hadjar and it environs. Surface water samples were also analyzed for the water quality. The groundwater shows a high electric conductivity (more than 560 cm-1 with a maximum exceeding 20000 µScm-1), a high chloride content (with a maximum exceeding 6000 mgl-1), and a high sodium concentration (mean = 420 mgl-1) are observed for the wells located down gradient and near the industrial rejections. Also, high metallic concentrations (0.02-1.25 mgl-1 in chromium) are observed in these wells. The Meboudja is acting as a diffuse source of contaminations all along its course. Aquifer parameters were estimated by carrying out pumpings test at a number of wells. Groundwater flow and mass transport models were prepared using visual MODFLOW software. The extent of migration of contaminants from the Meboudja and other streams has been assessed for 6 yr (1999-2005). The stream-aquifer interaction was found to be responsible for faster migration of contaminants in the over-exploited area east of the Seybouse.

Keywords: Pollution, Chromium, Industrial rejections, Numerical modelling, Annaba (Algeria)

EWRA 035 Salt removing species – An environmentally safe and clean technique to control salinity

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Conventional techniques used to control soil salinization process - soil leaching or fertilization enhancing – contribute highly to soil and aquifers contamination; on the other hand, the use of salt tolerant species will be very useful, but does not solve the problem of soil or groundwater contamination. Hence, the only way to control the salinization process and to maintain the sustainability of landscape and agricultural fields is to combat the salinization problems by environmentally safe and clean techniques. One of these new techniques is the use of salt removing species. In order to study the potential capacity to remove soil salts, five wild species Beta maritima, Limoniastrum monopetalum, Portulaca oleracea, Tetragonia tetragonioides, and Lotus creticus were evaluated for their efficiency to remove salts from a sandy soil. Plants were analysed relatively to total growth and mineral composition of the leaves. According to the results of plant growth and leaf analysis, it was seen that Tetragonia tetragonioides is the best salt removing species and, complementary, it has other interests, as follows: 1) high biomass production potential; 2) several harvests during the year (summer and winter); 3) high content of minerals; 4) horticultural importance, as a leaf vegetable crop; 6) easy multiplication (seed propagation) and easy crop management; 7) tolerance to drought and hot conditions; 8) soil erosion control due to its excellent soil covering. As concluding remarks, it was shown that this new technique to control salinity is a powerful and environmental clean tool to maintain the sustainability of the landscape and of the irrigated areas.

Keywords: salinization process, salt removing species, clean techniques, Tetragonia tetragonioides, drought conditions, salt tolerance.

EWRA 069A Water resources exploitation-valorization in the context of environmental policies: the case of Smokovo dam in Thessaly, Greece

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The completion of works of "head" in one dam as the "Dam of Smokovo" in Thessaly, Greece (dam, tunnels, water reservoir, etc.) and the beginning of projects for exploitation - valorization of waters, created a reflection in regard to the type and the way of irrigation, the more general development and the valorization of level areas. This is possible to become with underground irrigation network and complete exploitation of rural areas, as in the technical studies is proposed, or with the construction of surface irrigation networks. The choice between the two solutions, except the closely "economic effects", will be supposed that includes the parameter "environment" and it approaches the question of exploitation - valorization of water resources in a context of effectiveness and "conservation" of resources. Then these is discussion of the general European policies of management-protection and the technical proposals in Thessaly, with the subsequent competition of uses, the technical proposals of management and the contribution of the Working Team "Natural environment" (WTNE) to the matter of consciousness-raising. The fundamental problem, that this research examines: is if the sustainable confrontation or approach can be better improved via means the effectiveness and the short term "valorization / utilization" of natural resources or if solutions should be found or proposed via means of long-term "conservation" of resources.

Keywords: environmental policies, sustainable development, water resources exploitation, valorization, regions of controlled activities

EWRA 119 Cyanobacteria in aquatic ecosystem: effects of microcystins on the aquatic plant *lemna gibbaSaqrane*

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The occurrence of toxic cyanobacterial blooms in natural and artificial water bodies has been reported frequently in region throughout the world. Toxicity from cyanobacterial blooms is also a very common problem in Morocco. This toxicity is connected with the eutrophication process in freshwaters. The cyanotoxines are secondary metabolites, which can be produced by strains of cyanobacteria as Microcystis, Anabaena, and Oscillatoria. Excessive blooms of toxic cyanobacteria have been usually associated with animal death and human health problems, although information about the effect of microcystins on terrestrial and aquatic plant. In aquatic ecosystems, macrophytes can play a major ecological role as primary producers. The aim of this study was to evaluate the influence of cyanobacterial toxins extract on the growth, chlorophyll (a + b) concentration, enzymatic activity (peroxidase), and basal metabolism (proteins) of the aquatic plant Lemna gibba.

The tested plant was exposed to various concentrations of the microcystins extract during 12 days. The growth of plant was carried out during the time exposure. In order to confirm and evaluate the oxidative stress caused by the cyanotoxins on tested plant, peroxidase activity was determined.
After 12 days of exposure to microcystins, result shows a decrease of the plant growth with a reduction of 50 % of fronds number in comparison with the control plant. Cyanotoxins seems to affect also the plant chlorophyll (a + b) concentrations. Briefly, the exposition to microcystins affected all the plant metabolisme like the proteins synthesis and the peroxidase activity of the aquatic plant Lemna gibba.

The sensitivity of this aquatic plant and the results obtained prove that the occurrence of the toxic cyanobacteria in the aquatic environments constitutes a serious risk for the ecological balance and the functioning of the aquatic ecosystem. These problems must be taken into account by the programs of the monitoring and of the management of water resources.

Keywords: Cyanobacteria, Microcystins, Aquatic ecosystem, Lemna gibba, Growth, Metabolism, Enzymatic activity.

EWRA 198 Multi-reservoir system optimization using chlorophyll-a trophic indexes

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The problem of managing water scarcity resorting to complex interconnected multi-source (conventional and marginal) water systems determined the need to utilize management optimization techniques that analyze quantity and quality aspects in a common strategy. Particularly when the most part of water resources for supply systems are derived from artificial reservoirs, as frequently in the regions of south Mediterranean Europe, a simplified approach to the need of inserting water quality aspects in the mathematical optimization model can be achieved considering the trophic state of reservoirs, strictly related to their artificial nature. Modelling trophic conditions of water bodies needs to take in respect complex phenomena that are notably related to human activities in the basins. Experimental studies in lakes under different conditions have demonstrated that nutrients (nitrogen and phosphorus) play an important role as factors influencing phytoplankton biomass and a measure of this can be represented by Chlorophyll-*a* concentration. Chlorophyll-*a* is a simpler and more useful estimator than cell number o cell volume. In recent years, Trophic State Indexes (TSI) based on Carlson (1977) classification have obtained general acceptance as a reasonable manner to classify stored water in reservoirs. TSI can be used as an attempt to provide a single quantitative index for the purpose of classifying and ranking lakes in complex multi-reservoir systems. Using TSI obtained from Chlorophyll-*a* data, reservoirs water quality aspects can be easily considered in an optimization model specifically devoted for large systems management optimization. The TSI index gives us the possibility to insert quality constraints in the water management optimization model also considering large dimension multi-reservoir and multi-user systems. The model formalization and implementation in the optimization toolkit WARGI (Water Resource system optimization aided by Graphical Interface) will be illustrate in the paper. The usefulness of the mixed quantity-quality optimization approach has been confirmed in the WARGI application to a real multi-reservoirs water resource system in south Sardinia (Italy).

Keywords: sustainable reservoir management, complex water resource systems optimization, WARGI-QUAL software, quality indices, reservoir trophic state

EWRA 072B

Chemical status assessment of groundwater bodies in Slovenia

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The Directive 2000/60/EC of the European Parliament, demands to report about groundwater chemical and quantity status on the member states' territories. Since there is no uniform methodology prescribed, the first step was to determine the method for chemical status assessment in individual groundwater bodies. Several methodological approaches were tested and finally a methodology was accepted, which is in our opinion most adapted to the diversity of hydrogeological conditions in Slovenia. According to the proposed methodology, which will shortly be enacted with government decree, the quality status in monitoring points of state monitoring network is checked first. If the maximum allowed concentration of a pollutant is exceeded in one monitoring point, aggregated concentrations in other monitoring points are used to make the final assessment whether the entire water body is in a good or bad chemical condition. The same principle is used in monitoring long-term trends of pollutant concentrations. Long-term trends and changes in concentrations are monitored in individual monitoring points and in the case of decreasing water quality. They are compared with aggregated trends obtained from chemical status data in other monitoring points, situated in the area of observed groundwater body.

Keywords: Water Framework Directive (WFD), groundwater, groundwater quality assessment, chemical status, quantity status, trends, methodology, pollutant, groundwater body, monitoring point

EWRA 077

Effect of natural remediation of river, private sewage system and sewage disposal plant on water quality of Yamato river, Central Japan

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The BOD value of the Yamato River is the highest of all the Japanese first class rivers. Water chemistries along the Yamato River were investigated intensively to improve water quality. As a result, seasonal concentrations of BOD and $NH4^{+}$-N derived from domestic sewage were high in winter and low in summer. The concentrations decreased with an increase in water temperature.

The general finding was that river water contains organic compounds and Cl- derived from domestic sewage, and Cl^{-} was quite stable in rivers. As the ratios of BOD/Cl^{-} decreased down the river and changed seasonally, organic compounds were thought to be decomposed during flow. $NO3^{-}$, which organic compounds were finally decomposed into, also decreased further down the river, and were high in winter and low in summer. $NO3^{-}$-N is thought to be used for photosynthesis because pH, DO, d15N values and chlorophyll concentration of the Yamato River increased with temperature and decrease of $NO3^{-}$-N concentration. Therefore, organic compounds are decomposed into $NO3^{-}$ intensively in summer and plants along the Yamato River absorb $NO3^{-}$ and then the BOD value in summer becomes low. Hence, natural remediation for the Yamato River reduces BOD value in summer. Organic compounds in sewage are decomposed in private sewage systems and naturally in rivers in the Yamato River catchment.

As both decomposition systems depend on temperature, the BOD value in winter is thought to be high. As sewage disposal plants are large scale, the system can keep high temperature and the quality of the final effluent can be controlled. Therefore, the BOD value of Yamato River decreases annually as some new sewage disposal plants are built in the branches of the Yamato River, although the BOD value of Yamato River is the highest of any Japanese first class river. It is important to change private sewage systems into large scale disposal plants, to improving water quality.

Keywords: BOD value, water temperature, sewage water, Organic compounds, Yamato River, diffuse pollution, nitrates

EWRA 181 The evolution of the water sector in Europe – An institutional analysis of possible scenarios

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In this paper we present six scenarios about the possible evolution of the water supply and sanitation sector in Europe, considering both liberalised and non-liberalised environments. The scenarios were developed around three macro-storylines, namely (1) pressure for more competition and private sector participation; (2) opposition to liberalisation and pressure to return to direct public or community management; and (3) maintenance of the status quo. We then define the institutional framework of each scenario taking into account the specificities of the sector. The institutional framework aims at illustrating the relative positioning and changing power attributes of the main actor groups. We conclude this institutional analysis of the scenarios by assessing their viability based on three criteria, in particular stability, efficiency and accountability.

Keywords: water sector, liberalisation, scenarios, institutional implications

EWRA 210 Scientific tools for implementation of the EU-Water Framework Directive

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The European Water Framework Directive (WFD) specifies the guidelines for the European water policy in the next decades. It is focusing the water management on ecological aspects. As river ecology depend on many different biological and non-biological conditions a complex planning approach is needed to realize the political target of a good ecological status of European rivers. The planning guidelines consider the need for public participation and the demand to integrate socio- economic aspects within planning. Obviously the complexity of these tasks demands an integrated and interdisciplinary approach. The implementation of the Directive has to be based on cooperation of ecologists, hydrologists, specialists in water management, computer scientists and sociologists. The integration of the disciplinary knowledge requires new tools for spatial information management and a new type of Decision Support Systems.

A Decision support systems (DSS) designed to support the concept of WFD should be capable to provide a platform for the public discussions of planed measures among the stakeholders. Within a pilot project, financed from the German Federal Ministry for Education and Research, basic tools for integrated river basin planning were developed for a river basin of 5.500 sq. km. Starting with an estimation of the existing ecological status and after a comparison with natural reference conditions the anthropogenic pressures were specified. Based on this knowledge of human impacts on water quantity and quality the causal relationships between economic activities and the ecological status of river reaches were estimated. Different hydrological and water quality models were applied to specify the effective measures to improve the state of environment. With regard to the stakeholder participation it was essential to consider the social aspects of these measures by a detailed analysis of the socio-economic conditions within the river basin. As a result the measures were judged with regard to their socio-economic implementations. Side-effects of the implementation of the WFD were specified and assessed. The complexity of the interdisciplinary analyses demands a common tool to visualize the planning alternatives to the stakeholders and decision makers.

Keywords: Water Framework Directive (WFD), Decision Support Systems, GIS, Planning

EWRA 127A Integrated assessment for setting up programmes of measures in pursuit of the WFD

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Programmes of Measures are one of the key instruments of river basin management pursuant the European Water Framework Directive in order to meet its binding environmental objectives for all waters. We present an assessment procedure supporting the relevant planning and decision making processes. The methodology was developed in an interdisciplinary research project for the Weiße Elster subbasin (5.200 km²) of the Elbe river basin in close cooperation with stakeholders and authorities responsible for the implementation of the WFD.

The focus is management, planning and decision-making for achieving good ecological status in terms of nutrient pressures on surface waters. The setting up of PoM is split up into successive steps of the required decision-making process. We identified (a) objective refinement, (b) option screening, (c) assessment of measure effects, (d) a combination of measures for PoM and finally, (e) implementation of PoM as the critical steps.

These steps are closely linked to further activities, like the implementation of monitoring programmes and the derogation procedures. For each step expertise, models and methods are provided, which enable decision-makers to evaluate, select and implement appropriate measures.

Keywords: Water Framework Directive (WFD), river basin management, programmes of measures, integrated modelling and assessment, decision support

EWRA 127B Institutional change in river basins induced by WFD implementation: a success story? - A case study from the Elbe river basin

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The Water Framework Directive (WFD) has induced fundamental changes in Germany's water sector, affecting the institutional arrangements as well as the kind of measures, instruments, and planning processes required. From a governance perspective two key questions are (a) how are the existing institutional regimes changing in order to adapt to WFD regulations, and (b) in how far are the emerging river basin management regimes capable to implement the activities necessary for meeting the environmental objectives for all waters.

Starting from a conceptual framework for the analysis of institutional change in river basins, the institutionalisation of RBM in the German part of the Elbe river basin is studied in more detail. Recent activities like the risk assessment of all water bodies and the initialisation of participative processes are analysed for their empirical evidence in order to evaluate the success of institutional change.

Keywords: Water Framework Directive (WFD), river basin management, governance, institutional change

EWRA 095 Rhine West: fitting a water system below sea level into the European Water Framework Directive roadmap

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In 2004 the characterisation of the river basin district Rhine West has been completed according to the schedule of the EU Water Framework Directive. Several aspects of this district are unique, in the sense that the Directive does not explicitly recognize the consequences of a water system beneath sea-level. Firstly: only the impact of groundwater on surface water is recognised, whereas in Rhine-West rivers and canals infiltrate and so greatly influence the groundwater system. Secondly, saline intrusion into a hydrogeological system results in a bad groundwater status, according to the Directive. As Rhine West is situated under sea level, intrusion of saline water is inevitable and so it is a challenge to fit this phenomenon into the EU-legislation. The chosen solution for these two challenges is using a method called 'working from coarse to fine'. In 2004 a rather rough characterisation has been done which is being refined, so it can be used for producing the river basin management plan, to be completed in 2009. Meanwhile, more insight will be gained into the meaning and consequences of the Framework Directive, making a 'EU-proof' roadmap possible.

Keywords: EU Water Framework Directive (WFD), saline intrusion, water system, groundwater

EWRA 141A New methods for adaptive water management under uncertainty – The NeWater project

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The European 'Integrated Project' (IP) NeWater is presented, an inter-disciplinary project developing new methods for integrated water resources management taking into account the complexity of the river basins to be managed and the difficulty to predict the factors influencing them (e.g. climate, socio-economic developments). The central focus of NeWater is a transition from currently prevailing regimes of river basin water management to more integrated, adaptive approaches that cope with growing uncertainty like climate change. Water management must become more flexible and responsive to change to be able to cope with increasing uncertainty. New management approaches must be tailored to the evolving institutional, societal, economic, environmental and technological setting of a basin. Therefore NeWater identifies key elements of current water management regimes and investigates their interdependence focusing on transformation processes of these elements in the transition to adaptive integrated water resources management. Investigated key elements include for instance governance in water management, sectoral integration, scales of analysis, information management, vulnerability, infrastructure, finances and risk mitigation strategies, and stakeholder participation.

The paper summarizes expected achievements and portrays how these results may contribute to the European policy on water resources management and its relations to the European Water Framework Directive and the European Water Initiative. Addressed outcomes are (a) an understanding of aspects that determine adaptive capacity and vulnerability of river basins, (b) a comprehensive methodology to develop, implement and decide between alternative management regimes, (c) support for a paradigm shift in water management in science, policy and practitioners communities at European and Global Scales, and (d) an innovative toolkit and guidance for practitioners in applying adaptive management.

Keywords: IWRM, WFD, adaptive management, uncertainty, adaptive capacity

EWRA 053 Effect of fuzzy aggregation operators in selecting best groundwater management strategy

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Various groundwater management strategies for the Savannah, Georgia area are evaluated with respect to multiple fuzzy objectives. To determine the best management strategy, a systematic approach which couples a groundwater flow model with an optimization model and utilizes a fuzzy multi-objective decision making process to select the best management strategy is used. The results of the optimization model (i.e., location of the active wells and their pumping rates) are used to calculate the overall performance of each management strategy. Each alternative management strategy satisfies each fuzzy objective to a certain degree. In order to calculate an overall performance for a specific management strategy, the satisfaction degrees of all the fuzzy objectives have to be aggregated into a single number. The aggregation process can be realized by using various aggregation operators: conjunctive, disjunctive, or averaging operators. These aggregation operators are used to calculate the overall performance of each groundwater management strategy in Savannah region and to select the best one among them. The results are compared with respect to the aggregation operators. Comparison of the results obtained by using different aggregation operators to combine individual satisfaction degrees into a single overall performance value provides important information about how different aggregators effect the final decision which leads to the best management strategy.

Keywords: multi-objective decision making, fuzzy set theory, aggregation operators, OWA

EWRA 174 Dynamic programming and nonlinear programming application in irrigation networks design

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The designating factors in the design of branched irrigation networks are the cost of pipes and the cost of pumping. They both depend directly on the hydraulic head of the pump. It is mandatory for this reason to calculate the optimal head of the pump as well as the corresponded optimal pipe diameters, in order to derive the minimal total cost of the irrigation network. The certain calculating methods in identified the above total cost of a network, that have been derived are: the linear programming optimization method, the non linear programming optimization method, the dynamic programming optimization method and the Labye's method. All above methods have grown independently and a comparative study between them has not yet been derived. In this paper, a comparative calculation of the pump optimal head as well as the corresponded economic pipe diameters, using the dynamic programming method and the nonlinear programming method is presented. Application and comparative evaluation in a particular irrigation network is, also, developed. From the study it is being held that the two optimization methods in fact conclude to the same result and therefore can be applied with no distinction in the studying of the branched hydraulic networks.

Keywords: Irrigation, network, head, pump, cost, optimization, economic diameter, nonlinear method, dynamic method.

EWRA 175 Application of internet-based support for improvement of multi-reservoir water/wastewater system operation

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A sudden toxic substance appearance in the inlet flow of an industrial wastewater treatment plant (WWTP) must be considered as a very important challenge for biological part of the plant. The parallel five-retention-reservoir system is dedicated to appropriately counteract the danger. In order to improve possibilities of operator actions, the second system of six-retention reservoirs, dedicated for storage of clear water from rainfalls (normally used as rainwater resource for industry purposes) can be considered as an additional resource of water for dilution of the poisoned wastewater. The process operator should make the appropriate decision based on distributed control system with monitoring and visualisation. A real-time simulator of a process may improve effectively the optimal operating control. In some especially complicated situations an external independent expert-based aid can be very helpful. In this case the external expert should have a possibility to use the proposed simulator through the Internet. The paper presents the proposed simulator after detailed discussion of the operating control problems. Special attention is paid to present and discuss the architecture of the Internet-based communications.

Keywords: remote Internet-based operation and management support, computer-aided operator control, SCADA, water/wastewater system management, multi-reservoir system, scaled real-time simulation.

EWRA 146 Using the Fuzzy Analytic Hierarchy Process for selecting wastewaters facilities at prefectural level

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Although decision makers involved in environmental management issues usually agree on the necessity of interventions, conflicts emerge when interventions are concretized and touch upon citizens' reality in their local societies. In this context, a rationalization of the decision-making process is clearly needed in order to deal with conflicting objectives and divergent interests. We propose a multicriteria approach based on the Analytic Hierarchy Process (AHP) for selecting wastewater facilities at prefecture level. On the one hand we take for granted that there is consensus on the structure of hierarchy, i.e. the treatment processes and the criteria used for their evaluation. Evaluation of alternative treatment processes is performed with respect to the number, size, treatment method, and facilities location, and the evaluation criteria are based on the land planning, the environmental and techno-economical considerations, such as construction and operating costs. On the other hand, we propose the fuzzy extension of AHP for dealing with the vagueness of decision makers' judgments. Since decision makers are not generally able to provide a quantitative evaluation of the alternatives but only a qualitative one, the pairwise comparisons are expressed in fuzzy terms. We use this method in a case study, we discuss its application in real world situations, and we conclude that this approach is a viable evaluation device and a good communication tool between analysts and decision-makers.

Keywords: AHP, decision making, fuzzy sets, triangular fuzzy numbers, multicriteria analysis, wastewater facilities

E11 - Decision Support Systems

EWRA 141B A knowledge based planning and decision support tool for integrated water management (FLUMAGIS)

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The implementation of the EC water framework directive (WFD) requires integrated approaches for assessment, deficit analysis, and co-operative scenario planning and deliberation. This paper discusses the FLUMAGIS prototype, a new framework developed under a joint research effort between six disciplines ranging from Ecology, Socio-Economy to Geoinformatics. The FLUMAGIS-framework is embedded in a planning- and decision support system (PSS) that can be used by groups of planners, decisions makers and stakeholders for the investigation and evaluation of the actual state of rivers, for deficit and causes finding, for knowledge-based derivation of possible management measures, and for the simulation and prognosis of ecological and economical planning effects based on requirements form the WFD. The prototype consists of three main modules: (1) An interactive tool facilitating 2D- and 3D visualization of river basin environments. This comprises the representation of current inshore water and landscape ecological aspects as well as the water balance and substance balances. Editing within the visualisation environment makes it possible to elaborate future planning and management scenarios based on an interdisciplinary data and knowledge platform in accordance with the WFD. Possible alternatives and effects of various planning scenarios become transparent, can be discussed and experienced in a participatory process. This tool is linked with an (2) interdisciplinary knowledge base that includes knowledge from all participated disciplines like ecological or socio-economical indicators. The implemented ontology and causal net allow integrative assessment related to requirements of the WFD, the identification of deficits and their causes, the derivation of suitable measures for managing the deficits, and a prognosis of effects of implemented measures in the virtual environment. (3) Of high relevance for the prognosis is the integration of numerical models that support the simulation of water quality, water balance and matter fluxes, habitat conditions or the calculation of measure costs. The prototypical development of the framework has been focused on five detailed use cases.

Keywords: decision support, SDSS, PSS, WFD, knowledge processing, 3D-visualisation

E12 - Groundwater

EWRA 066B Deep groundwater resources individuation in Piemonte plain (Northern Italy)

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This paper is a synthesis of a preliminary lithostratigraphical and structural study finalized to improve the deep aquifers knowledge in Piemonte (northern Italy).
In detail the work concerns the Piemonte plain sector, that is the most important water reserve in the region.

In this moment most wells take water in the first 200 m of aquifer; therefore, information about lower depths of aquifer are particularly scarce. In order to find exploitable aquifers, a general lithostratigraphical and hydrogeological schematization of the area was carried out about depths lower than those actually intercepted.

Since the main aim of the study is to find groundwater for different use (drinking water, irrigation water, etc.), the surface between fresh and salt water was used as the deepest limit of this research.
Lithostratigraphic studies allowed to detect various deformative structures, such as basins with sedimentary bearing-water successions. These successions, generated by sin and post-depositional tectonic processes, are thicker than 1000 meters. These potentially productive aquifers are present in pliocene marine sands, in permeable levels of "Villafranchiano" sediments and in quaternary alluvional deposits.

In the end it was observed that the fresh and salt water surface is mainly present in pliocenic sand deposits. However, because of this surface is independent of stratigraphic limits, the interface was also found in different deposits.

The Piemonte plain lithostratigraphical and hydrogeological model, obtained with collected data, suggests that there are deep aquifers that, at the present time, are not intercepted but could be exploited in the future.

Keywords: fresh/salty water interface, sequential stratigraphy, sedimentary basin reconstruction, deep aquifers.

EWRA 066A Study of the interactions between surface water and groundwater with in situ tests

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This paper summarizes the results of a research carried out in order to evaluate the complex interactions between surface water and groundwater with the use of seepage-meters and minipiezometers.
The seepage-meters have been constructed with oil drums, open on the bottom, with different heights and capacity; these instruments are also provided with a graduated bag, connected to the top of the drum with a tap, to have a quantitative evaluation of the interactions between groundwater and surface water. Seepage-meters must be insert into the river or lake sediments for half of the height and totally under water level; they allow to gauge the volume of water flowing down or out of the bag, in a fixed time. Minipiezometers consist in steel rod, pierced in the part driven into the ground. Tests have been conducted in two sites of Piedmont plain: Bagnolo Piemonte e Villafranca Piemonte.

In Bagnolo Piemonte the site is an artificial lake used for irrigation and with a 300 meters perimeter. Six tests have been made with seepage-meters and two with minipiezometers. The seepage-meters have been fitted in fine-grained sand, at about 1 meter from the bank and at different depths from 12 to 19 centimeters, totally under water level. Tests with micropiezometers were carried out in the same places as seepage-meters tests.

Tests carried out near Villafranca Piemonte have investigated a 60 meters line along Po river, essentially in sandy-gravelly sediments. Interactions between groundwater and surface water have been analyzed with seepage-meters in twenty points, at different distances from the right stream bank. Minipiezometers have been used in two test sites. Tests results showed that interactions between groundwater and surface water are very different: especially into the lake, in situ test have highlighted recharge zones, losing zones and "Zero exchange" in test points a few meters away each other. Along Po river, instead, more homogeneous areas of losing, recharge or zero exchange have been observed.

Keywords: Groundwater-surface water interactions, Seepage-meters, Minipiezometers, Gaining, Losing, Zero Exchange

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EWRA 160 Use of multivariate analysis to identify the global functioning of hydrosystems. Application to a chalk karst aquifer ...

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Karst aquifers have complex and original characteristics. The karst hydrogeologist has at his disposal a set of methods to explore and study karst aquifers. One of these is the multivariate analysis. But, due to sophisticated experimental designs and to modern instrumental constellations the investigation of N-dimensional (or N-way or N-mode) data arrays is attracting more and more attention. Three-dimensional arrays may be generated by collecting data tables with a fixed set of objects and variables under different experimental conditions, at different sampling times, etc. Moreover, the experimenters can want to treat simultaneously quantitative and qualitative data (mixed data). The traditional methods of the multivariate analysis cannot answer correctly the statistical processing of the three-way data and the mixed data.

To identify the complex functioning of a karst system, we have i) studied the relations between electrical conductivity, turbidity, water discharge and geochemistry by means of Statis method and ii) identified the parameters controlling the transport properties of the particle by means of Hill and Smith analysis. The first method allowed highlighting the processes of pollution-restoration depending on the rain event intensity, and the phenomena of direct transfer and resuspension of intrakarstic sediments. The second method allowed highlighting the natural hydraulic gradient between the piezometric level of ground water and the Seine river tidal range, then the human impact on the transport properties of the particulate matter.

Keywords: karst hydrology, multivariate analysis, Statis, AHS, transport properties, human impact

EWRA 134 A Study on salt intrusion in Grombalia Plain in Cap Bon Aquifer in the North of Tunisia

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This study examines an approach for planning groundwater development in coastal aquifers. The seawater intrusion is controlled through a series of barrier extraction wells. The aim of this paper is to illustrate the hydro chemical evolution of the Tunisian coastal and insular aquifers in order to optimize water management. First, we detected the degradation of aquifer water quality; then we pursue to identify the main sources of salinization problem. Hydro chemical mapping and detailed description of the aquifer characteristics (piezometric level, salinity); Analysis of the available Hydrochimical maps; Assessment of the impact of deteriorating groundwater quality on the agricultural activities; Identification of the main sources of groundwater salinization.

The identification of hydro geological and hydrochimical data showed that: A serious lowering of the water table levels; A serious deterioration of the groundwater quality; and The ground water salinization will limit future agricultural activities.

The salinization of groundwater has two origins. In the coastal part, the seawater intrusion is the principal source of this salinization. In the inland part, salinization may be related to two main factors: the first is related to the geologic formation, and the second is caused by the agriculture return flow. The utility of the study is demonstrated through a trade-off curve between prioritizing groundwater development and controlling seawater intrusion at desired levels.

Keywords: Coastal aquifer, Salinisation, GIS, HIS, Grombalia, Tunisia

EWRA 172C Assessment of karstic interconnection between two adjacent watersheds using deterministic and fuzzy approaches

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The interconnection of adjacent watersheds in case of complicated karstic systems is a significant issue in water resources development planning. In an interesting case study, two watersheds – the Lassithi Plateau and Aposelemis torrent basins – are studied for investigating their possible interconnection. Since the karstic system is very complicated two indirect methods were employed for the estimation of water quantities passing through their common boundaries. In the first approach the daily rainfall – runoff model Medbasin was used for assessing a large number of scenarios formulated through a combination of assumptions for the hydrologic performance of the karstic system. In the second approach a fuzzy linear regression method was applied using the Aposelemis streamflow as the dependent variable, while the precipitation in the same watershed and the streamflow of the Lassithi Plateau watershed were the independent variables. The results obtained from both approaches converge in annual terms varying between 30 and 40 percent of the Plateau surface water potential contributing to Aposelemis streamflow. Useful conclusions were drawn for the implementation of the proposed methods in other similar watershed interconnection studies.

Keywords: watershed interconnection, rainfall – runoff model, fuzzy linear regression, karstic systems, conceptual model, surface water potential

EWRA 021 The effect of irrigation methods on growth and yield of fiber sorghum in Central Greece

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Under two different irrigation methods, gun sprinkler and subsurface drip irrigation. A field experiment was carried out in the experimental farm of the University of Thessaly during 2002, comprising a completely randomized block design with three irrigation treatments in four blocks, including control (non-irrigated). Irrigation was fully automated, and application depths were determined using a class A evaporation pan for fully matching the evapotranspiration needs. In the treatments of the gun sprinkler method 280 mm of water were totally applied, by 17 application depths, while in the treatments of subsurface drip irrigation method 238 mm of water were applied, decreased in percentage of 15%. The growth of the crop was measured by means of plant height and leaf area index (L.A.I.), which were recorded in periodical samplings throughout the growing period. Total and dry biomass productions were measured in six harvests covering entire the growing and productive process of culture. A clear superiority of subsurface versus the gun sprinkler method was found ($LSD_{P=0,05}$) as reflected by much higher plants heights, L.A.I., total and dry biomass production and also by greater soil water conservation. Such results demonstrate the great potentiality of fiber Sorghum as alternative commodity for biomass production in future rotations according to the focus of the sustainable, low-input alternative agriculture.

Keywords: gun sprinkler, subsurface drip irrigation, plant heights, L.A.I., biomass, water conservation, energy crops

EWRA 157 Comparative calculation of optimal diameters in irrigation networks using the nonlinear programming optimization method and ...

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The two decisive factors in designing irrigation networks are the cost of pipes and that of pumping. They both depend directly on the hydraulic head of the pump station. An increase of the pump head involves a reduction of the network construction cost and a parallel increase of the pumping cost. This is why the calculation of the optimal head of the pump station contributes a lot to the minimization of the total cost of the irrigation network. The calculating methods that define the above total network cost are: the linear programming optimization method, the nonlinear programming optimization method, the dynamic programming optimization method and the Labye's method. All the above methods have developed independently and a comparative study between them has not yet been achieved. In this paper, a comparative calculation of optimal diameters using the general nonlinear programming optimization method and a simplified nonlinear optimization method are presented. Application and comparative evaluation in a particular network (Valanidorrachi, Greece) has also been performed.e

Keywords: Irrigation, network, head, pump station, cost, optimization, economic diameter, nonlinear method, Theocharis' method.

EWRA 212 Optimal groundwater remediation under uncertainty using multi-objective optimization

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A methodology is developed for optimal remediation of groundwater aquifers under hydraulic conductivity uncertainty. A multi-objective management method, based on pump-and-treat remediation technology, is proposed. The pumping rates and the well locations are the decision variables and two objectives are chosen: minimization of contaminated groundwater present in the aquifer and minimization of remediation cost. A Monte Carlo simulation method is used to cope with hydraulic conductivity uncertainty. A number of equally probable realizations of hydraulic conductivity are created and a Pareto front is obtained using a modified multi-objective Genetic Algorithm. A penalty function is utilized to maintain the algebraic sum of pumping and recharging rates equal to zero. Since Monte Carlo simulation is CPU time consuming, a method is proposed to identify the most critical realizations. A Pareto front with an assigned probability can be derived, so that the decision maker can make decisions of known reliability.

Keywords: groundwater remediation, multi-objective optimization, Monte Carlo simulation, uncertain hydraulic conductivity, critical realizations

EWRA 221 DSS application to the development of water management strategies in Ribeiras do Algarve River Basin

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The main goal of this paper is to demonstrate the application of the WSM-DSS tool, developed within the WaterStrategyMan Project – "Developing Strategies for Regulating and Managing Water Resources and Demand in Water Deficient Regions" which was funded by the EU in 5th Research Framework Program. According to the project requirements, Ribeiras do Algarve River Basin was chosen as the Portuguese Case Study. Located in the southern stretch of the Portuguese territory this river basin is the most popular tourist destination in mainland Portugal. Crucial conflicting interests exist between tourism and agriculture as both sectors concentrate most of their water needs during the summer months. Additionally, there are still important deficiencies in urban secondary water supply infrastructure and inadequate irrigation methods that combined with the poor quality of water existing in some areas urge the implementation of management measures. Taking into account the drivers and pressures in the region, and following the consultation of the involved stakeholders, different ways to improve water management were analysed: (i) structural options, (ii) demand management options and (iii) socio - economic measures. This analysis was carried out taking into consideration a range of combinations of extreme demand and availability scenarios, to define the range of expected global and sectorial gaps between demand and supply. The different options were ranked based on indicators reflecting the perception of the local stakeholders towards economic development and social and environmental sustainability. On a second phase, the formulation of strategies, using the available options was addressed and two different strategies, resulting from a tentative timeframe of water management options combination, were applied aiming to achieve goals defined with regional stakeholders, namely: (i) on a first stage, the optimization of the domestic and irrigation water demand coverage and aquifer's groundwater exploitation use ratio; (ii) on a second stage, the determination of the water pricing increase necessary to achieve economical sustainability, aiming at cost recovery goals in accordance with the Water Framework Directive compliance.

Keywords: WSM-DSS tool, water resources, sustainable management, Ribeiras do Algarve River Basin, strategies

EWRA 202 Sustainability in water resources management: changes in meaning and perception

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The meaning of sustainability in the context of water resources management has changed through the time. Initially meeting water demand was the dominant concern. While later quality issues became more important followed by wider water reuse, today sustainability must include a whole range of aspects (e.g., energy, pollution, persistent chemicals), spatial and time scales. New approaches to define sustainability metrics are needed. A possible approach is to use fundamentally-based entropy and energy flows.

Keywords:water resources, water quality, water demand, physical sustainability, water reuse, entropy, energy

EWRA 140 Water demand and rates policy in provincial cities in Greece

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This paper explores several social parameters that contribute in the formation of water rates policy in Greece and analyzes the impact on water demand by the application of different tariffs. The water demand function is estimated, based on the financial theory of water demand, in regions with different economic and cultural characteristics correlating water consumption to consumers' income, type of residence and their cultural identity. Seasonal variations in water demand for each consumer category are calculated and the elasticity of water demand is estimated in relation to the price. The behavior of several provincial cities in Greece is compared.

This research was based mainly on data of the last 12 years collected from the archives of the Water Supply and Drainage Boroughs (WSDB) of various provincial cities in Greece, on the collection of questionnaires and on data from the Greek bibliography.

Keywords: Urban water, demand forecast, pricing policy

EWRA 204

Water pricing models: a survey

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This paper surveys water pricing models, highlighting some important results. Efficiency requires marginal cost pricing. Intra-annual price changes or customer differentiation to reflect differences in marginal costs can enhance efficiency. A marginal cost pricing mechanism may signal the value that consumers attribute to further capacity expansions as the water supply system approaches its capacity limit and marginal cost rises. However, pure marginal cost pricing may not be feasible while respecting a revenue requirement because marginal costs may be higher or lower than average costs. The most common ways of combining efficiency and revenue requirements are through the use of two-part tariffs, adjusting the fixed charge to meet the revenue requirement, or through second-best pricing like Ramsey pricing. It is not evident whether the best scheme is a two-part tariff or some other pricing mechanism. The role of block rate pricing, increasingly more frequent in actual pricing practices, is yet to be fully investigated.

Keywords: water pricing models, capacity constraints, scarcity, revenue requirements, second-best pricing, block rate pricing

EWRA 184

Water demand management aspects in the residential sector. The city of Volos case, Greece

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Until recently, efforts to cover the increasing water demand have been focused mainly on increasing the supply from the existing resources, which were available in abundance and at a relatively low cost. The relationship between water abstraction and water availability has turned out to be a major stress factor in the exploitation of water resources. It is nowadays widely recognized that there is a need for strategies to promote the sustainable use of water resources.

A survey on residential water use has been performed recently in the city of Volos. Its aim has been to evaluate various aspects of the current water policy, to investigate the perspectives of water saving and to explore new approaches towards sustainable water management in the water supply sector.
Data analysis is based on descriptive statistics (relative frequencies, deviations etc.) as well as on the analysis of the relationships between the survey variables using the method of "the construction of double entrance matrices of absolute and relative frequencies".

The effect of some selected variables such as the price of water, the members living in the house, the size of the dwelling, the indoor and outdoor uses, environmental consideration of consumers and others, in relation to water demand is examined.

Keywords: urban water use, water resources management, water demand, water price

EWRA 143 Strategy of the exploitation of a coastal water table in hydrous period stress: optimization of the energy cost...

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The values of the refill of the tablecloth due to effetive water rains of the years of dryness of quinquennial, decennial frequency and Bi decennial are respectively 21.5, 16.6 and 8.1 Hm 3 / year. The annual ave rage is 34.4 Hm 3 / year.

The scenario of various refills show, - after chock of the digital model of the tablecloth in transient state and taking into account the capacities of pumping out installed on the collecting fields of the tablecloth (18.7 Hm 3 / year)-that the decennial dry years and Bi decennial present respective negative assessments of –15 and –9 Hm 3 / year. making consequently vulnerable this coastal tablecloth and the ecosystem of the "wetlands " which is associated with it.

What strategy of management of this water table for a durable development? On the assumption of decennial dryness Bi, exploitable reserve 8 Hm3/an, optimal levels piezometric corresponding to the maximum HMT and consumption of minimal electric energetics, the results show that we would make profits of 44 % of electric consumption is 0.80 DA/m3 compared to the current reference 1.83 DA/m 3 could.

Keywords: groundwater, management, optimization, strategy

EWRA 069B Climate and two-type torrential physiography: new interdisciplinary approaches of processes from 'Mediterranean' environmental planning

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The purpose of this article is to place emphasis on some processes as examples of the 'Mediterranean' Environmental Planning (Env/P), on the occasion of emergence of applicable problems due to the Direc tive 2000/60/EE, a current issue especially because of the demand for the territorial division. The Directive, introduces the idea of an integrated water management system at the level of river Drainage Basins (DB) following a natural geographic and hydrologic limit (watershed). The present article studies and re-examines the way and the functional mechanism of torrents, seeking their better understanding in the hydrologic control. It also studies the way one could survey and check certain regular points (rejuvenations), for the Env/P particularly on the up-stream and mountainous lands when it concerns, as necessity the lack of water. The question asked 'in what way certain climatic characteristics of basin and torrents, as impressed in the physiographic and Oreographic configuration be involved and be used better in the Env/P for nature and for human'?

The present paper refers to the Greek physiography of torrents (Mediterranean climate) and in the hydrological control, in the waters reservoir and in the arrangement or regulation via works. It is also located/ referred in the evolution stages (erosion cycle) and 'land mass rejuvenations' points, of the theory of the geomorphologies Davis and other relevant sciences that lead to regularly 'geometrical points', useful to the Env/P. Afterwards, certain interdisciplinary approaches of Env/P processes will be presented as a new proposals concerning, the hydrologic control, a necessity, due to the lack of water, examines four examples, from Greece and Spain, with two characteristic types or perspectives regarding the 'Mediterranean' Env/P.

A new interdisciplinary discussion on the effect of climate in relief configuration and the new two-type or two- perspectives classification, that derive from the natural sciences, methodologically lead the present in a new approach. It derives from a more general interdisciplinary discussion. These examples are presented here in four chapters and the final composition and the final conclusions on the Env/P described in the fifth.

Keywords: environmental planning, erosion cycle and land mass rejuvenations, torrential environment, hydrologic control, waters reservoir

EWRA 017 Relationship between Tropical Pacific and Indian ocean sea surface temperature and precipitation over the central highland, Vietnam

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In this study, the relationship between the monthly sea surface temperature (SST) in the tropical Pacific and Indian oceans and the monthly precipitation over the Vietnamese Central Highland (VCH) is investigated by means of singular value decomposition (SVD). From an atmospheric perspective, the seasonal variation of SST plays a critical role in the onset of the monsoon and the convective rain band movement associated with the intertropical convergence zone (ITCZ). The SST variation, in turn, is affected by the monsoon through cloud-radiation and wind-evaporation feedbacks.

The analyses show that the relationships between precipitation and SST in both oceans vary significantly through the rainy season. In April, ENSO is strongly correlated with the precipitation over the VCH, while Indian Ocean SST only shows a significant correlation with precipitation in the northern VCH. In May, there is no significant relationship between precipitation and SST in either of the oceans. In June, precipitation over the VCH is negatively correlated with northern Indian Ocean and eastern off-equatorial Pacific SST. Through July to September, no significant relationships were found between Indian Ocean SST and precipitation patterns despite the existence of high correlations in SST patterns. Equatorial central to eastern Pacific SST, in turn, is positively correlated with precipitation in a small area from the north to the south of the VCH through the months. In October, precipitation over the VCH is strongly related to ENSO and positively correlated with equatorial eastern Indian Ocean SST. For November, the northwestern Pacific as well as the equatorial eastern Indian Ocean SST is positively and strongly correlated with precipitation over the VCH.

Lag-time analyses reveal that Pacific SST has the potential for forecasting monthly precipitation patterns through the rainy season from one to three months in advance, while Indian Ocean SST is only a significant predictor one to two months in advance for monthly precipitation in October and November. Pacific SST is the good long-term predictor for precipitation over the VCH through all the months of the rainy season.

Keywords: singular value decomposition, sea surface temperature, precipitation, south Asian summer

EWRA 062 Climate variability and change effects on water resources in the western Black Sea coastal zone

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Climate variability and change during the 20th century in the western coastal zone of Black Sea (including East Bulgaria and Northwest Turkey) were investigated. Air temperature increased during the last decade. Annual precipitation as well as runoff and groundwater had a decreasing trend during the last decades. Because of the drier conditions the irrigation demands increased during the last twenty years of the previous century. The effect of the North Atlantic Oscillation on variability of winter precipitation

over the studied region was also considered. HadCM3 climate change scenarios for the western coastal zone of the Black Sea were created. Air temperature is simulated to increase, but precipitation is projected to decrease during the 21st century across the region of interest. These changes will have negative impacts on water resources in Eastern Bulgaria and Northwest Turkey. The influence of warming and precipitation changes on the elements of soil water balance was estimated by a decision support system.

Keywords: East Bulgaria, Northwest Turkey, climate variability and change, NAO, runoff, GCM climate change scenarios, soil water balance, DSSAT

EWRA 208B Groundwater recharge, climatic and vegetation induced variations in the Balkan peninsula: the case of Struma/Strymonas river

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Climate change and man-made interference at the Balkan Peninsula will cause an impact on runoff and groundwater recharge in the future, with the aim to give a convention of seasonal variations and the magnitude of the differences, the HBV model has been used as a tool for similarity climate alternatives in the river catchment.

The impacts of different climate scenarios on the total groundwater recharge have been calculated as long-term mean values and are presented in comparison with model-simulated values with an actual (recorded) climate sequence.

Evapotranspiration and soil water content play a key role in the runoff and recharge processes. This paper conducts also a review on some literature about work performed on the calculation of evapotranspiration. Research is in progress, met only on formulating future climate scenarios, but also on distinguishing evapotranspiration from different kinds of vegetation.

Concerning the effects of logging on runoff and groundwater recharge, well-known methods were implied for simulation. The effects of forest growth were difficult to be quantified than the effects of logging. This was because forest growth is a slower process than logging, and the succession changes can be hidden by weather simulations.

Keywords: Balkan Peninsula, Struma/Strymonas River, HBV modeling, climate change, groundwater

EWRA 088 The feasibility of using FAO-56 model to estimate olive orchards evapotranspiration in semi arid region

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Knowledge of evapotranspiration is useful for different aims like water budget calculations, climatological and meteorological studies. In arid regions evapotranspiration is a significant and often the dominant water flux leaving the Earth´s land surface, nearly all the inputs in the form of rain is lost trough evapotranspiration, therefore the importance of this parameter for controlling watering schedule and determining crops productivity. Hence, estimates of evapotranspiration and its components transpiration and evaporation are of crucial importance in dynamic crop–weather models, irrigation models and SVAT models. Although many approaches were developed and adapted for various applications, there is still a remarkable range of uncertainty for reliable estimation of evapotranspiration. Many of these uncertainties are the result of poor model input data quality, but others are related to the used method itself and its sensitivity to various environmental conditions.

Within the Tensift river basin (region of Marrakech, central Morocco), the "SudMed" project focuses on developing methods that use remote sensing data in junction with field observations and models such as the FAO model and soil-vegetation-atmosphere-transfer models to estimate time-space variation of water needs and consumption. In the present study we focused our effort on the use of the FAO-56 model to estimate the crop evapotranspiration, crop transpiration and soil evaporation over an olive tree site in the Tensift basin. The simulated actual plant transpiration by the FAO-56 crop coefficient model was compared with scaled sap flow measurements. Comparison of simulated components of evapotranspiration (soil evaporation and plant transpiration) with the measurements shows that the model simulates reasonably well the plant transpiration and soil evaporation prior to irrigation. However, the results were poor for the period succeeding irrigation. The estimated values of crop coefficient by the FAO-56 model for olive trees at three crop growth stages (initial, mid season and maturity) were 0.6, 0.65 and 0.65. Therefore, the values of crop coefficients found in this study were lower than suggested by FAO-56. This reduction might be due to various water and agronomic stresses.

Keywords: FAO-56 model, Evapotranspiration, Crop coefficient, Eddy covariance, Sap flow, Olea europaea.

EWRA 055 Time delay artificial neural network models for river flow routing

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River flow routing provides basic information on a wide range of problems related to the design and operation of river systems. In this paper, Time Delay Artificial Neural Network (TDANN) models, which are time lagged feed-formatted networks with delayed memory processing elements at the input layer, are applied to predict the daily flow at "Ilarionas" station on the Aliakmon River in Greece. The network topology is using multiple inputs, which include the time lagged daily flow values further up at "Siatista" station on the Aliakmon River and at "Grevena" station on the Venetikos River, which is a tributary to the Aliakmon River and a single output, which is the daily flow at "Ilarionas" station. The choice of the input variables introduced to the input layer was based on the cross-correlation. The use of cross-correlation between the ith input series and the output provides a short cut to the problem of the delayed memory determination. The training of ANNs suitable for the current application is the cascade correlation algorithm. Kalman's learning rule was used to modify the artificial neural network weights. The networks are designed by putting weights between neurons, by using the hyperbolic-tangent function for training. The results show a good performance of the TDANN models for the prediction of daily flow values at "Ilarionas" station and demonstrate their adequacy and potential for river flow routing.

Keywords: Artificial neural networks, river flow routing, daily flow, time delay, cascade correlation, Aliakmon river

EWRA 173 Riverstrahler, SENEQUE and SENECAM: modeling tools for water resources management from regional to local scales

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In the scope of a large research program (PIREN-Seine) devoted to the understanding of the biogeochemical functioning of the Seine river system in relation with the needs of water resources management, different models have been developed with the aim of establishing the link between water quality and anthropogenic activities (agriculture, domestic and industrial) in the watershed. Each of these models rely on the same basic principles but are adapted to different geographic scales.

The starting point of this construction is the Riverstrahler approach, which uses a simplified characterisation of the drainage network of large regional basins, together with a refined representation of in-stream microbiological processes (RIVE), in order to derive, among other results, an overall estimation of nutrient fluxes at the outlet. This approach was particularly useful, for instance, to evaluate the effect of general measures concerning urban wastewater treatment on coastal marine eutrophication processes.

As a second step, the coupling of the Riverstrahler model with a GIS interface into a generic software (SENEQUE) allowed to considerably enhance the functionalities of the model: (i) by unifying databases, GIS and model in a unique system; (ii) by offering tools to modulate the geographical representation of the drainage network at the resolution required by the specific problem under investigation; (iii) by providing powerful implements for analyzing and simulating changes in water quality. This software has been conceived in order to be easily transferable to water resources managers. Two examples of application to practical management issues, at two different scales, will be presented.

Finally, the limits of this tool when applied to practical problems related to landscape management at the scale of small watersheds, have led to the development of a complementary software (SENECAM), particularly adapted to approach water quality problems linked to erosion or cattle waste management, for which a very high spatial resolution is required.

Keywords: water resources management, surface water model, GIS, modeling software, spatial scaling, data combining, prospective scenario

EWRA 090 Simulation of combined groundwater and surface water dynamics of river floodplains

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The european water framework directive provides a framework for integral protection of surface water, costal water, transitional water and groundwater using the river basin as the geographical and adminis trative basis for the water management. New practical and technical questions arise from the implementation of the framework which needs new holistic approaches and the linkage of different fields of research and practical work like biology, ecology, hydrology, hydraulics, land and river management. This linkage is necessary to realistically describe and predict the interaction of hydrodynamic and ecological processes inside the river basins and floodplains like surface flow, groundwater flow, sediment transport, water quality, biodiversity etc. Understanding the hydrologic and biologic processes which define the relationship between surface und subsurface water, the landscape connectivity of riverine or aquatic habitats and human-induced changes and associated responses of floodplains is essential if one is to understand the ecological effects of water resources management decisions in river basins [1]. This paper includes the concept and first results of research work addressing the hydrodynamic interactions inside river floodplains. The overall aim was to create an expert system which considers in detail the representative abiotic indicators characterizing the surface flow, the groundwater flow and their interaction in dependence on time and space. The expert system was created as a modular system in a way that it can easily be extended to cover further simulation models as well as further data management tools, e.g. the online collection and the visualization of spatial and time-dependent data. The present version of the system includes modules for databank management, integrated simulation of surface and groundwater flow and correlation of long time series with simulated water levels. The expert system will allow to simulate the impact of measures inside the floodplain like dike relocation or the change of land cover on the groundwater tables, the surface water levels and the propagation of flood wave. Regarding the complex flow pattern in natural floodplains and the small scales for which information is required, most recent developments in two-dimensional (2D) surface water modeling were included in the expert system.

Keywords: river floodplain dynamics, groundwater model, surface water model, groundwater, surface water, interaction, expert system

EWRA 215 EU-Project MoNit: Decision support system to assess the impact of actions and changing frameworks on the nitrate load in an aquifer

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Upper Rhine Valley groundwater shows a high nitrate load due to various reasons. To decrease the input of nitrate a lot of regulations are currently in force and first steps are taken in the German as well as in the French part of the Upper Rhine Valley. Furthermore changing directives within the agricultural sector (e.g. the WFD) will affect future management practices and consequently the nitrate input into the aquifer.

The "MoNit - Modelling of the groundwater contamination by nitrate in the Upper Rhine Valley" is developing a simulation tool that allows the assessment of future nitrate load in an integrative way. This tool will lead to well-founded evaluations of the efficiency of political decisions and help to prioritise the steps to reduce the nitrate input.

To achieve the aims six different models will be coupled: spatial interpolation of climate parameters and to assess the groundwater recharge (GWN_BW); Micro-economic model to assess the response of farmers to changing directives; Process-oriented soil-plant-model (STICS) to simulate the nitrate input as function of crop type, management practice, fertilizing method and climate at the plot scale; Nitrate balance model (STOFFBILANZ) to calculate the nitrate load on a larger scale incorporating the results of the soil-plant-model; Three-dimensional groundwater model coupled with a transport model to simulate the transport and reduction of nitrate in the whole aquifer (MODFLOW/MT3D); Regression model to regionalize surface runoff from exterior basis (IWK-Regio)

To simulate future scenarios four aspects are distinguished: climate, land use, management practices and economical factors. The appropriate definition of the different scenarios as well as the corresponding model parameters (e.g. amount of fertilizer, land cover) will result from expert workshops.In scenarios the nitrate input will be calculated at the plot scale and extrapolated to larger areas. Consequently the nitrate transport and reduction in the aquifer will be simulated. In contrast if climate changes (e.g. according to KLIWA 2050) the input of only one model may change...

Keywords: sustainable management, water resources, groundwater model, surface water model, micro-economic model, climatology, Upper Rhine Valley, diffuse pollution, nitrates

EWRA 209 Objective intercomparison of water balance modeling in small watersheds

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The paper deals with the application and intercomparison of five deterministic water balance models in small rural watersheds. The objective of the paper is an objective assessment of the performance of the models using common evaluation criteria leading to hydrological regionalization. The five models are namely Abulohom, Loukas, GRZM, Giakoumakis and Xioug - Guo. The inputs to the models are mouthy regional precipitation, temperature and potential evapotranspiration of the watershed. The model outputs are total runoff and actual evapotranspiration. Time series of the above parameters for 38 years (1960 - 1997) are employed a part being used for model calibration (1960 - 1997) and the remaining data (1978 - 1997) for validation. The results have shown that the main differences between the models remain the computation evapotranspiration, soil moisture, ground water recharge and runoff routing leading to different number of required, parameters for each model. The selected watershed lies in the region of Thessaly with semiarid climate, where Abulohom and Loukas models performed very satisfactorily. This modelling effort can contribute significantly to an hierarchical approach of water resources management studies and monitoring schemes.

Keywords: water balance models, water recourses, watersheds, runoff simulation

EWRA 012 Analysing the diversity of water pricing structures: the case of France

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Water pricing has mostly been analysed by policy makers, planners and scholars as a tool to promote water use efficiency. Numerous studies have investigated the impact of the water price level on water use but not the characteristics of water price structure. These studies often ignore that water can be charged to users with very different and sometimes sophisticated approaches, and that the choice of pricing structure can have a real influence on water use efficiency. This paper presents an attempt to fill this gap through an empirical approach based on primary data collected in France in 2003.

The paper is organised at follows. The first section provides some theoretical background, highlighting that the choice of water pricing structures is often guided by considerations of equity, cost recovery and resource use efficiency – three objectives which can be contradictory. The second section then presents the French context and highlight how the choice of pricing structures has evolved over time. The paper then describes existing pricing structures in France, based on a 429 municipalities sample, statistically representative of the 36 000 municipalities. This data set is then analysed to highlight the factors which explain the choice of water pricing structures.

Keywords: France, survey, water pricing, tariff, urban

EWRA 193 EVEC project : a French approach to mechanisms protecting potable water catchments menaced by agricultural pollution

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The deterioration of water quality due to human activities over the past two decades has become a public policy problem necessitating a response from national governments, the European Community, and local decision-makers as well as private actors, in particular farmers. In France, intensive agricultural practices have come under increasing criticism : since the end of 1980s in relation to nitrates, and in recent years for the use of pesticides. Techniques considered more environmentally sound and compatible with what may be called "sustainable" agriculture are now encouraged, but for such a transformation to be successful, the effective co-operation of farmers willing to convert, at least partially, their production habits is required.

The adoption of the European Framework Directive in 2000 and the water reform bill on March 9, 2005 have posed new challenges to farmers and political authorities in France. In the light of these legal evolutions, we have chosen to focus on various national cases related to the protection of drinking water catchments that have been polluted by farmers : specifically in the Rhone-Mediterranean-Corsican, Seine-Normandy, Loire-Brittany, and Adour-Garonne basins. Our comparative study examines several issues : 1) The public policy decisions to prevent and/or remedy water pollution: water treatment, rehabilitation, connection, creation or closing of water catchments, purchase or exchange of agricultural land, territorial scale of the resolution of the problem (scale of the water catchments and its perimeters of protection, scale of the catchment basin) ; 2) The political strategies used to mobilise farmers and to take into account the requirements for local development: financial compensation, contracts, cooperative efforts, education and awareness of good environmental practices ; 3) The particular characteristics of the local context and the interactions of the actors: conflicts, cooperation, co-administration and governance, dominant interests and the role of administrative, political, and agricultural mediators ; 4) The sustainability of the adopted solutions: reality of the agricultural change, choice of substitute products and risk of future pollution by new molecules, social acceptability of the price of water…

Keywords : protection of potable water catchments, agricultural pollution, nitrates and pesticides, perimeters, negotiation, contracts

EWRA 069C Water as social and economic commodity: efficacy or conservation sustainability methods in Thessaly, Greece

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The new European policies incorporate the objectives in the environmental policies of development-growth giving however priorities more to the territorial entities and less to the development of a sector of the economy as the agriculture.

On the other hand the potential role of economic tools in providing socially acceptable public decisions is not widely appreciated, particularly in many highly regulated situations.

We believe that four critical approaches are necessary for combining the social and economic dimensions of the water as a natural resource: In this framework, the article addressing first the European environmental policies and objectives, as they are also presented in a relative activity of a team in the Thessaly of Greece, seeks the assessment of water and the water resources as a social and economic heritage, that is to say environmental good. And on the other hand makes an approach to the evaluation of methods and tools of environmental assessment, where taking into consideration the new policies, it categorizes and rates the environmental problems and the possible approaches, territorial and quantitative and proposes new approaches concerning policies of development-growth and assessment of water resources in parallel with the objectives-targets in one environmental plan of sustainable development of Thessaly proposing by a voluntary team. In the present article we attempt in general to touch the question of management of the water resources within a frame of effectiveness (exploitation-valorisation / utilization) or conservation (maintenance-preservation) of water resources, as a general economic tool of better approach.

EWRA 147 Simulating the economic impact of groundwater protection scenarios on the farming sector of the upper Rhine valley

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In the upper Rhine valley, as in many other areas in Europe, agriculture is generating a significant nitrate diffuse pollution. Measures implemented up to date to mitigate this risk have not been entirely successful. The ambitious objectives of the water framework directive now compel policy makers to implement more intensive groundwater protection and restoration measures. The choice of measures to be implemented must be based on an assessment of their effectiveness and their cost, both direct and indirect (losses of farm income). This paper presents a methodology developed as part of the INTERREG MONIT project (modelling nitrate in groundwater in the upper Rhine) and illustrates it with the first results obtained. the methodology consist in constructing a farm typology and developing linear programming models at the farm level, the models being used to simulate the impact of various nitrogen management scenarios on cropping patterns, farm income and the risk of nitrate leaching. one specific characteristic of this research is that it focuses on a tranboundary region – where the same policies might have a different impact in France and Germany, due to differences in terms of farming systems, water protection an agricultural policy and simulated responses of the farms to various nitrogen management instruments. The preliminary simulations conducted show that the cap reform is likely to result in a significant reduction of the risk of nitrate diffuse pollution and that uncontrolled factors of change, such as the risk of proliferation of the corn rootworm could lead to an even higher reduction of diffuse pollution. These preliminary results should however be interpreted with caution until the full simulation programme has been completed.

Keywords: upper rhine, groundwater, nitrate, diffuse pollution, economic instruments, tax, scenario, linear programming model, farming sector, common agriculture policy reform.

EWRA 192 How to compare best agricultural management practices at the watershed scale?

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To design the restoration plans requested by the European Water Framework Directive, local regulators need to implement technically designed modifications of farming practices. Their main interest relies on the determination of which modifications are the most appropriate to the local conditions. To help this decision process, a selection grid has been built within the European AgriBMPWater project (5th RTD Framework Program). The main interest of this grid is to allow the comparison of different "Best Management Practices" regarding their environmental effectiveness, the associated costs and their acceptability for farmers. This paper presents the different steps of the method, some tools that have been used and their technical requirements, illustrates with some results the integrated tool that has been developed and provides keys for interpretation.

Keywords: Non Point source pollution, Efficiency, Cost, Acceptability, Best Management Practices, Critical areas.

EWRA 068

Analysis and optimization of cost-effectiveness of measures to minimise P input in river systems

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The identification of the most cost-effective program of measures (PoM) is not only stressed by the WFD, Article 11 it is also an indispensable pre-condition, if the ambiguous task formulated by the WFD should be finance able. For making this selection the cost-effectiveness of each individual measure has to be clear. Therefore a method is developed to determine the catchment-wide effects of measures preventing soil erosion and P export from agricultural areas. Analyses are based on the approach of the erosion model EROSION2D/3D. In this paper we demonstrate that there is no simple figure for cost-effectiveness for a given measure, but that cost-effectiveness changes significantly regarding to site conditions. If the design of the measures takes this into account, significant improvements regarding their cost-effectiveness are possible and hence cost savings. This can only be achieved by a combined hydrologic-economic modeling.

Keywords: surface runoff, phosphorus transport, water framework directive, cost-effectiveness, spatially targeted measures, programs of measures

EWRA 206

Linking drought indicators to policy. The case of the Tagus basin drought plan

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The Tagus basin (Spain) is currently developing drought management plans, which are integrated into the long-term strategies for water management in the basin. One crucial aspect of the plan is to establish a link between basin drought state and policy actions. Basin state is described by a drought indicator system that includes precipitation, streamflow, reservoir inflow, and reservoir storage and groundwater piezometric levels. Basin policy consists on a catalogue of actions, ranging from enforcing demand management strategies to establishing priority of users to allocate scarce water or approving emergency works and projects according to each level of drought risk. In this paper the methodology applied to link drought indicators to policy is presented. Drought indicators, although imperfect, contribute to understand the temporal characteristics of drought and to define pre-alert, alert, and emergency situations, which are associated to a list of pre-specified management actions. The methodology is based on the evaluation of the probability of not being able to satisfy system demands for a given basin state. A simplified model of every water resources system in the basin was built to evaluate the threshold of reservoir volume that is required to overcome the drought situation without deficit. A statistical analysis was performed on naturalized streamflow series in order to define a set of representative droughts, associated to distinct probabilities of occurrence. For each reservoir level, a set of actions is implemented with the goal of guaranteeing essential demands during drought conditions. The methodology was validated with a simulation of system behavior for 60 years of historic streamflow series, finding acceptable results in most systems.

Keywords: water resources, drought management, hydrology, water resources systems, Tagus river

EWRA 060B

Response of drought to climate change in Thessaly, Greece

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The temporal and spatial characteristics of meteorological drought were investigated to provide a framework for sustainable water resources management in the region of Thessaly, Greece under present and future climate change scenarios. Thessaly is an agricultural plain region surrounded by mountains and is traversed by Pinios River. Thessaly was divided into twelve hydrological sub-basins and monthly precipitation data from 50 stations were used for the estimation of sub-basin mean areal precipitation.

The Canadian Centre for Climate Modeling Analysis General Circulation Model (CGCMa2) has been used to estimate the precipitation changes for the periods 2020-2050 and 2070-2100 and for three climate change scenarios (IS92a, SRES A2, SRES B2). The "delta" and statistical methods were employed for the downscaling of precipitation. The Standardized Precipitation Index (SPI) computed at various time scales was used as an indicator of drought characteristics (intensity, duration, and severity) for present and future climate conditions. Comparison of the drought characteristics for the historical period (1960-1990) and the future periods indicated that the drought intensity, duration and severity increases for the three examined climate change scenarios. Furthermore, analysis of two historical drought periods (1976-1977, 1988-1990) has shown that frequent, extreme and spatially extended droughts would be expected in future.

Keywords: climate change, drought, Global Circulation Model, CGCMa2, Standardized Precipitation Index, downscaling, Thessaly

EWRA 131

Methods for predicting drought occurrences

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A comprehensive assessment of future dry events in a region is essential for finding sustainable solu tions for water-related problems concerning water management and preventive risk assessment of drought. It is also a first step in developing a common European strategy for facing up to the negative impacts of present and future dry climatic events. A useful index for drought monitoring, based only on monthly precipitation, is the Standardized Precipitation Index (SPI); here we assume that it properly describes the climatic condition of a particular region. By applying an appropriate forecast method to the precipitation time series and then computing the SPI, it is possible to predict future drought occurrences. Forecasting time series is a well-known field of Statistics and methods are well documented in the scientific literature. In the present paper we apply a standard technique and we contrast it with a new method here presented. As a test case, we use rain gauge data for Sicily, which may be considered a key region for understanding climatic conditions in the Mediterranean basin.

Keywords: water resources, precipitation, drought indexes, forecasting methods

EWRA 172B

Drought assessment: comparing RDI with SPI and deciles

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A new drought index for general use is presented and calculated for a number of years in the hydrological basins of Nestos and Mornos Rivers (Greece). The new index, called Reconnaissance Drought Index, RDI is based both on precipitation and on potential evapotranspiration. RDI is compared with the Standardized Precipitation Index (SPI) and the method of Deciles.

It is argued that although RDI generally responds in a similar fashion as SPI or deciles, it can be more sensitive and suitable for cases of a changing environment.

Keywords: Meteorological drought, drought indices, Reconnaissance Drought Index, climate change, Nestos River Basin, Mornos River Basin

EWRA 186

Assessing unrecoverable losses in water networks

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Leakage management is an efficient tool for saving water resources, that constitutes a major challenge for coming years. This paper specifically aims at proposing a statistical method for modelling the amount of unrecoverable water losses in a distribution system, and in calculating the threshold below which the wasted volume of water cannot be reduced, whatever the efforts invested in leakage detection, or in mitigating either legal or illegal water use. The observation of the minimum value per week of the night flow rate, corrected by the assessment of the minimum night consumption, enables the estimation of the recoverable proportion of losses and the efforts that should be devoted to actually saving them.

It is hence proposed to revisit Allan Lambert's work related to unrecoverable water losses in a distribution system. This study seeks to build a model that enables the division of the corrected time series of minimum night flow rates into a recoverable and an unrecoverable part, and will attempt in its next phase to explain this distribution using network characteristics (age, material, density of connections, pressure).

The model relies upon the assumption that background undetectable leaks occur at a rate that increases exponentially according to the age of the assets, and gradually transform into detectable leaks, and then into manifest bursts ; background leaks and detectable leaks are assumed to be both characterised by an average flow rate and a statistical distribution of their duration, that enable the assessment of their contribution towards the current lost volume. The model is applied to British District Meter Areas (DMA) operated by sister companies of Veolia Water.

Keywords: saving water, unrecoverable leaks, District Meter Area, night flow rate modelling, asset characteristics.

EWRA 145 3-D Modeling of river-groundwater interaction

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According to the existing European and National legal instruments and especially the Water Frame Directive, water resources should, as far as possible, be managed in an integrated manner. It is therefore important that surface water and groundwater should be treated as an entity. Modeling groundwater is a complicated task in itself, due to the stochastic character of the water flow and the uncertainties in the properties under estimation involved. The use of integrated models, i.e. including other components of the hydrological cycle in addition to groundwater flow, is more difficult indeed, however is absolutely necessary for the sustainable development and management of water resources.

An Integrated Surface water - Groundwater Model (ISGM) is presented, describing the interaction between a river and the adjacent groundwater aquifer. The model has been verified with existing analytical solutions for three cases of steady flow, assuming a confined aquifer and various penetration heights and widths of the river. Finally an example of non-steady flow is presented, showing the interaction between a confined aquifer and a partially penetrating river. The ISGM has been used to evaluate the response of the confined aquifer to a sinusoidal passing flood wave in the river. The example of non-steady flow is representative of the possibilities offered by the use of integrated models and depicts clearly a complicated flow field, difficultly to be described by using a traditional groundwater model.

Keywords: modeling, integrated models, river-aquifer interaction, surface waters, groundwater

EWRA 067 A preliminary approach to integrate main biogeochemical processes involved in the mobility of some toxic elements in a river basin model

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The objectives of EU FP6 AQUATERRA are (i) a better understanding of the river-sediment-soil-groundwater system at various temporal and spatial scales, (ii) a scientific basis for improved river basin management, (iii) specific tools for water and soil quality monitoring and (iv) integrated modelling for impact evaluation of pollution as well as climate and land-use changes for definition of long-term management schemes. These objectives are tested on selected sites in five contrasting European river basins (Brévilles, Ebro, Meuse, Elbe and Danube).LIMOS (France), VITO (Belgium), ETHZ (Switzerland) and BRGM (France) collaborate in the BGC3 workpackage of the BIOGEOCHEM sub-program. It identifies and quantifies the key biogeochemical processes and the impact of global change on the filter and transport functions of soils and on water quality in order to integrate these processes in the numerical models developed at the basin scale.

BGC3 will provide the main biogeochemical functions of soil-water transfer for some toxic elements (Pb, Zn, Cd, Hg and As) and a parameterized biogeochemical data system to be integrated in the numerical model of environmental trace metals transfer at the basin scale. The approach used is based on the biogeochemical study of different aquifer compartments. They concern the soils' surface horizons with the study of plant-soil-atmosphere relationships, the vadose zone and the saturated zone. After having determined the main mineralogical, physico-chemical and bacterial characteristics of soils samples, series of tests are performed in batch initially and then in column to get an idea of the impact of microbiological and geochemical processes on the fate of trace metals in the different compartments of soil. Several operating conditions are tested (temperature, CO2 partial pressure, pH, salinity, redox conditions, nitrates and sulphate concentrations). Currently, these experiments are started and first data of the kinetics of metallic pollutant mobilization are determined for few experimental conditions and the biogeochemical database is under development. The innovative aspect of this work is to develop a simplify and integrated approach to provide a parameterised biogeochemical data system for the quantification of metallic pollutant transfer in the river basin since this approach is not yet integrated in existing river basin models.

Keywords: toxic elements, environmental trace metals, river basin, biogeochemical processes, distribution coefficient (Kd), modelling

EWRA 164 Response of groundwater system to various stresses: the Milan Area (Italy)

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The groundwater system in Milan area represents the main water supply for civil and industrial uses. Since the '50s its natural equilibrium has been conditioned by notable water table fluctuations; in particular during the last decade a remarkable rise in the groundwater level determines a real state of emergency. Many buildings and subsurface structures were constructed in the '70s, and they were not designed to coexist with groundwater: at present the foundation and the underground structures of many important constructions (hospitals, parking, subways) are under the water table affecting their durability and security. A complete understanding of the dynamics of the aquifer system is the first step to manage the emergency and to plan opportune interventions.

To achieve this purpose, a 3D finite element model is developed for an area bounded by rivers Po, Ticino, Adda and PreAlps. A reliable model of this groundwater system requires current and historical data on a number of key parameters: geology (deep and surface), topography, surface water rivers and channels and their hydraulic characteristics, groundwater levels, recharge from rainfall, pumping from aquifer for civil and industrial uses. The numerical scheme is applied in both the saturated and in the unsaturated zone.
The numerical model is calibrated in both steady and unsteady state flow. Different scenarios are performed to simulate the response of groundwater system to various stresses: an increasing of water pumping in the city of Milan, a particularly rainy season, the reopening or the obstruction of spring lines located in South Milan. The results of the model can be a useful tool to optimize interventions reducing costs of management.

Keywords: groundwater management, finite element, Po river, water table

EWRA 196A The "géorépertoire" of the Rhone basin data : a hydro-socio-economical metadata web site for the ZABR scientific program ...

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Since decades, the volume of information produced, stored and exchanged does not cease growing in all the fields and in particular in the field of the environment where studies, diagnoses, measurements, and models multiply in particular with the installation of national or regional data repository. The administration and the exchange of these data in the midst of workshops zones become arduous. Since, a few years, the creation of information, is accompanied by a more 'rational' management of available information: development of validation techniques, data criticism, systems of description of information. This article presents the work undertaken within the Zone Atelier du Bassin du Rhône in order to build a tool of documentation about data related to the Rhone river knowledge. This metadata base must allow to the data producer a better management, and publication of information and to the user to find more easily the best information required towards his needs.

Keywords: Metadata, data base, environmental information

EWRA 023 Issues in water pricing

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The perfect competitive market of the economic textbook does four things: determines the optimum level of supply; allocates that supply between competing uses; ensures cost recovery; and induces behavioural change in both the suppliers and the consumers Not only does such a market perform all four functions automatically, it is also homeostatic, returning to the optimum after any disturbance in either supply or demand. The fundamental condition for a perfect competitive market to exist is that none of the suppliers or consumers have the power to influence the total quantity of the good or the price at which that good is traded. A second condition is that transaction costs, the costs of acquiring information and doing business, are so low that they can be ignored.

This paper explores a number of the ways in which extrapolating this perfect competitive market model to water results in misleading conclusions because water differs in fundamental ways to the assumptions underlying a perfect competitive market model. In particular, I will propose a resolution to the problem which Rogers et al (1998) identified but to which they did not provide a viable solution: how to allocate water when the marginal costs and externalities, as well as marginal values, vary between uses. Secondly, I will show the traditional collective provision of water can be more efficient than a market based approach and that whilst the conventional rule of equating marginal cost to marginal value indicates how much water should be supplied, marginal cost pricing should not then be applied. Indeed, the traditional approach of property tax, and even the apparently undesirable declining block tariff approach, can be superior to a marginal cost pricing approach. Finally, I will show how, once transaction costs have been taken into account, water metering will only be viable under strictly limited conditions.

Keywords: economics, pricing, allocation, metering

EWRA 165 PPPs in medium scale water works in the renewable sources energy sector: the Greek experience

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The development of investments in the renewable energy sources sector rendered them profitable and competitive towards respective conventional ones, making imperative the need of examining their economic viability as investment drawings. The present study has been conducted in order to present the feasibility of a small hydro-power station located in a small highland village, in Karditsa Prefecture, Greece. The specific station produces electricity through the exploitation of waters that afterwards are used for the irrigation of cultivated land. The whole project combines high profitability while being environmental friendly. The special characteristic of this investment is that a Public Base Company controls it, where the Community itself holds 35% of the stocks, and the residents hold the rest 65% with an upper limit of 2% per stockholder. This denomination is the legal set up of a Public Base Community Company. Electricity is sold directly to the Greek Electric Power Utility according to the legal framework. The resulting revenues of this investment provide an important income for the Community and its shareholders. The scope of the paper is to present the experience gained from this management system for the investigation of similar investments in Greece demonstrating that localized generation of Energy may not be contrary to the Sustainable Development of the Environment. Thus a presentation of PPP's is included.

Keywords: PPPs, renewable energy, hydropower plants

EWRA 036B

Economical analysis model of catchment area

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This paper tries to reveal a different strategy to approach the economic mechanism for a river basin (Birzava). Therefore the objectives set by the Water Framework Directive 60/2000/EEC and some sug gestions embraced in "The Danube District Water Management Plan" are taken into account.

The structure of the paper includes a part that points out the characteristics of the hydrographical basin (geomorphologic, eco-hydrologic, socio-economic and water resources management), as the background for the economic analysis at a river basin scale. In the paper there are also treated the problems of the mechanisms specific to the water management in the new perspective required by the Water Framework Directive.

The economic analysis for the chosen river basin follows the pattern set by I.C.P.D.R. (The International Committee for the Danube River Protection) and includes the achievement of the costs recovery mathematical models in the water services field, estimating from the efficiency point of view the approaches potential costs and their combination. Within this framework there were estimated: ehe water uses (starting from: the water tariffs present structure, the implementation of stimulating tariffs in order to diminish water requirements and pollution in each socio-economic activity including some penalties based on economic criteria); the trends of water demands, investments and scenario proposals; and the costs recovery for each water service. In a long term forecast there are also taken into account the environmental and resource costs quantifying also the negative impact on the aquatic ecosystems.

Keywords: stimulating tariffs, river basin management plan, water services.

EWRA 219

Water crises and social management of risks in the Mediterranean

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As pointed out by the debates at the International Water Forum in Kyoto (march 2003), water has become a world strategic issue, mainly because of the increasing risk of rarefaction and contamination of this vital resource. The risk issue has an additional dimension in the Mediterranean region, where climatic hazards reinforce the possibilities of crisis and where the unequal distribution of resources, and thus of water shortages, contribute to increase the competition between farm irrigation, on the one hand, and domestic and urban needs, on the other hand. I this context, the research program initiated by Ladyss aims at bringing new knowledge on local perceptions of risks related to farm irrigation, thanks to a better articulation between social and natural sciences. Carried out in four countries of the northern and southern shore of the Mediterranean, this research is geared towards (1) a better understanding of the ways in which the various « water actors », mainly farmers, identify and prioritize problems brought about by the water crisis and the experiencing of environmental risk and (2) towards a better assessment of the way in which new approaches of the water issue generate more complex water management arrangements likely either to minimize or to aggravate risks and inequalities related to irrigation. Our paper will present preliminary results of the comparative research carried in France, Morocco and Tunisia, which indicate that beyond issues of scarcity and contamination, the water crisis is to a large extent a crisis of the social management of the water resource.

EWRA 117 Taking into account agricultural practices for evaluating impact of climate and socio-economic changes on irrigation water demand ...

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Models for estimating regional irrigation demand exist. But most often they do not take into account agricultural practices. When they do so, they only consider the irrigation practice but not the whole technical itinerary. However, the concept of cropping system specifies that it exists a consistency between the various technical operations within the technical itinerary. Furthermore, these models do not account for the determinants of these technical operations. Such determinants may be modified under the influence of climate change or socio-economic changes. The objective is to develop such model for estimating irrigation at a regional scale that accounts for technical operations and their consistency, and that is sensitive to climate change or socio-economic changes. The major assumption of our conceptual framework is about the necessity to take into account strategic and tactic farmer's agricultural practices and their diversity. In this way, we decide to conceive the model as a bio-decisional model i.e. a coupling of a decisional model and a crop model. The decisional model simulates decision rules and allows to reproduce the effect of farmers' practices on irrigation demand over the studied region. The different steps of the global modelling approach, from data analysis to scenario simulation, are: (i) identification and representation of the diversity of technical itineraries in the river basin, the links between the technical operations and the determinants of the spatial distribution of the various technical itineraries (ii) formalization of the algorithm (iii) simulator tool development (iv) validation and (v) climatic and socioeconomic scenarios simulations. The study was conducted in the south-western France, in an irrigated river basin of 500 km² where maize is the main irrigated crop. We focused on three technical tasks having a great impact on irrigation demand: the choice of maize precocity, the maize sowing and the irrigation practice. For data analyses, we used various surveys conducted from 2000 to 2004. The decision rules identified are currently translated into an algorithm which is expected to be coupled with an existing maize crop model to estimate irrigation demand of the study area. The impact of the various strategies on the irrigation demand as well as the effects of various climatic and socio-economic changes are discussed in the last part and will be evaluated.

Keywords: regional irrigation demand, maize, farmers' practices, crop model, decisional model, spatialization, climate and socio-economic scenarios

EWRA 049 Water resources management in Bulgaria - Financial challenges and prospects of EU Water Framework Directive implementation

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The paper outlines two major economic aspects related to the implementation of EU Water Framework Directive (WFD) in Bulgaria: investments in environmental infrastructure and full cost recovery. Environmental expenditure in the water sector is analysed and compared with necessary investments for compliance with EU standards. Problems concerning tools for financing water resources protection are identified on the base of analysis of funding sources - private sector, including public-private partnerships, environmental charges, pre- and post-accession funds. The analysis is focused on the private sector role and the need of partnerships in WFD implementation. It is argued that it is not feasible to apply the pure polluter pays principle in the short-run. Areas for improving the financing of the water sector through strong regulatory framework and capacity building are proposed.

Keywords: integrated water resources management, Water Framework Directive (WFD), accession to the European Union (EU), environmental financing, environmental investments, environmental expenditure, environmental charges, cost-recovery, ISPA, SAPARD, public-private partnerships, participatory approach, Bulgaria

EWRA 061 Computation of sediment graph for a flood event

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In this study, the process for the computation of the sediment graph (variation of sediment discharge with time), due to a flood event, at the outlet of a basin is described. In concrete terms, the sediment graph due to the flood event of 30 November 1996 at the outlet of Kossynthos River basin, with an area of about 235 km2, is computed. The city of Xanthi (Thrace, northeastern Greece) is located at the basin outlet.

For the computation of the sediment graph, a mathematical model consisting of three sub-models is applied: (a) a hydrological sub-model, (b) a soil erosion sub-model, and (c) a sediment transport sub-model for streams. For a more precise computation of runoff, soil erosion and sediment transport, the whole basin is divided into 10 natural sub-basins. The above mentioned sub-models are applied to each sub-basin separately.

On the basis of the hydrological sub-model, the hydrograph (variation of water discharge with time) at the outlet of each sub-basin, as well as at the outlet of the whole basin, due to the flood event, is computed. This sub-model is based on the dimensionless triangular unit hydrograph of the Soil Conservation Service (SCS, USA) on the one hand, and on the flood routing method of Muskingum - Cunge on the other hand (HEC-HMS computer program).

On the basis of the soil erosion sub-model, the sediment inflow into the main stream of each sub-basin, which originates from the soil erosion of the sub-basin, is computed. The soil erosion sub-model is based on the erosion relationships of Poesen (1985) on the one hand, and on the concept of the sediment transport capacity by overland flow on the other hand.

Finally, the sediment graph at the outlet of each sub-basin, as well as at the outlet of the whole basin is computed on the basis of the stream sediment transport sub-model, which is based on the concept of the sediment transport capacity by streamflow. This sediment amount is calculated by the relationships of Yang and Stall (1976).

Keywords: hydrograph, sediment graph, runoff, soil erosion, sediment transport, basin, mathematical model

EWRA 162 Drought preparedness and monitoring: Dealing with risk and climate change in the Mediterranean

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Climate in the Mediterranean is among the most variable of the world and recurrent drought problems often affect entire countries over multi-year periods resulting in serious social problems like water scarcity, stress, and low quality. Over the last three decades spring rainfall has decreased in many areas of the region exacerbating the severe problems associated with drought. The paper outlines the current strategies for drought risk management in Mediterranean countries and the uncertainty associated with climate change. First, characterization of drought episodes provides the adequate framework for developing indicators of risk. Second, an overview of the management is presented. Drought indicators may be used to evaluate the levels of drought risk (pre-alert, alert, and emergency), linking science to policy. When water resources are managed at the basin level, it is possible to respond directly to the needs and problems of the natural hydrological system with policy decisions. Basin authorities can establish priority of users or right holders, or can approve emergency works and projects according to each level of risk. In contrast, when water resources management is linked to administrative units, responses to drought tend to be "crisis based" rather than "preparedness based". The intensive demand of water for agriculture contributes to the conflicts among water users and transboundary water disputes within or between countries. On top of this, climatic change, especially precipitation decreases, further increases in variability and/or an increase in drought episodes, may affect the region severely.

Keywords: water resources, drought management, Mediterranean, climate change

EWRA 120 Drought forecast through the standardized precipitation index

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Unlike other natural disasters, drought events evolve slowly in time and their impacts generally span a long period of time. Such features do make possible a more effective drought mitigation of the most adverse effects than in the case of other natural disasters, provided a timely monitoring of an incoming drought is available.

Among the several proposed drought monitoring indices, the Standardized Precipitation Index (SPI) has found widespread application for describing and comparing drought conditions among different time periods and regions with different climatic conditions. However, little efforts have been made to analyse the role of the SPI for drought forecasting..

The aim of the paper is to provide two methodologies for the seasonal forecasting of SPI, under the hypothesis of uncorrelated and normally distributed monthly precipitation aggregated at various time scales k. In the first methodology, the auto-covariance matrix of a sequence of SPI values is derived analytically as a function of the statistics of the underlying monthly precipitation process in order to analytically compute the transition probabilities from a present drought condition to another in the future. In the second methodology, SPI forecasts at a generic time horizon M are analytically determined, in terms of conditional expectation, as a function of past values of monthly precipitation. Forecasting accuracy is estimated through an analytical expression of the Mean Square Error, which allows deriving confidence intervals of prediction. Validation of the derived expressions is carried out by comparing analytical forecasts and observed SPI values by means of a moving window technique. Results seem to confirm the reliability of the proposed methodologies, which therefore can find useful application within a drought monitoring system.

Keywords: drought, precipitation, SPI, monitoring, sthocastic techniques, transition probabilities, forecast, NAO

EWRA 050 Salinity effects on soils,water and vegetation in Zâafrane area (Algerian steppes domain)

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In Algeria salinity of groundwater presents one of major problems. Its is either due to dissolution of geological formation, evaporation or intrusion of marine water. This is a cause for deterioration of water quality.
The Zaafrane area is situated 300 Km south of Algiers and belongs to the "steppe"s context which covers 20 millions of hectares. Evaporitic formations are very frequent in this zone. The Zahrez Rharbie sebkha occupies a vast syncline where evaporitic sediments, influence the chemistry of superficial aquifer water and cause salts accumulation in the soils.

The use of characteristics analysis between major chemical elements of water (Na+,Cl-,HCO3-,SO4--,Ca++) permits us to give an explanation of the salinity origin. Water as well as spoil samples are taken at two depths (20 and 60 cm). After analysis of the major chemical elements, the "krigeage" of our results by Surfer shows a decrease in salinity when one moves away from Zaharez sebkha. The interpretation of two Landsat satellite images of the region for two period (1987 and 2001) show a rise of the salinity phenomena in these steppes which have experienced long years of dryness. However the pastoral planning started by governmental agency (H.C.D.S) in 1990 has given good results, in the fight against the phenomena of desertification and thus salinity in the study area.

Keywords: steppes, salinity, soils, aquifer, water, radiometry, NDVI.

EWRA 087 Combining large aperture scintillometer and aggregation model to derive ... sensible and latent heat fluxes over two adjacent oliveyards

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The Large Aperture Scintillometer (LAS) offers new opportunities to investigate surface-atmosphere interaction over relatively large and heterogeneous areas at various temporal scales. The objective of this study is to investigate the possibility of using a LAS in conjunction with aggregation schemes to infer area-averaged convective fluxes over heterogeneous surfaces. In this context, two LAS were operated simultaneously over the oliveyard of Agdal which is located near Marrakech (Morocco). This oliveyard is divided into two fields, the southern side and northern side. The northern side is more heterogeneous than the southern side. The heterogeneity was mainly due to soil characteristic, vegetation cover, and therefore roughness length. Although the field conditions might not be ideal for the application of Monin-Obukhov Similarity Theory (MOST), the comparison of the reference area-averages sensible heat fluxes obtained from eddy-covariance systems against the LAS based fluxes at the patch scale shows a good agreement. This study shows also that the MOST can still be applied at the grid scale. The aggregated refractive index structure parameter aggregated using the proposed model, agreed fairly well with the inverted refractive index structure parameter from eddy-covariance data. Simulated area-average sensible and latent heat fluxes obtained using the aggregated refractive index structure parameter collaborated with measured area-average sensible and latent heat fluxes values obtained by weighting the observed values of each field. The contrast in sensible and latent heat fluxes explain most of the bias.

Keywords: Aggregation, Energy balance, Large aperture scintillometer, MOST, Sensible and latent heat fluxes, Structure parameter.

EWRA 075 Reverse Monte Carlo approach for estimating the bottom reflectance of optically shallow inland waters

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In optically shallow inland waters, the bottom reflectance contributes to the water leaving radiance recorded at sensor, and therefore can hinder subtle and valuable information that might permit to retrieve water quality parameters. For such waters, solving the Radiative Transfer Equation (RTE) in the visible spectral domain (400 – 700nm) requires an appropriate bottom effect correction. A high-resolution spectroradiometer FieldSpec Pro ASD was used in a laboratory experiment to measure the spectral responses of various combinations of bottom types and water column content. An algorithm is developed based on the Monte Carlo method in order to estimate the bottom reflectance components of the samples. Monte Carlo algorithm developed herein consists of statistically simulating the distribution of an irradiance incident on top of a water column along its propagation direction within the water column-bottom system. The method can reproduce physical phenomena such as absorption, scattering and bottom reflection. The simulation algorithm is developed in 2 steps, including the downward and the upward radiance parameterizations; and merging the 2 equations through the boundary condition represented by the Bidirectional Reflectance Distribution Function (BRDF). The algorithm shows clear differences between turbid waters, and clear waters where the bottom contribution was significant.

Keywords: optically shallow water, bottom reflectance, radiative transfer equation, bidirectional reflectance distribution function, Monte Carlo simulation

EWRA 123

Estimation of actual evapotranspiration using satellite derived and ground measured fluxes

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Climatic changes observed in the northern hemisphere during the last decades have involved critical conditions in surface water and groundwater availability in southern Italy, that has been frequently affected by recurrent and severe droughts. Evapotranspiration (ET) is one of the main water balance components, and its actual value appears the one most difficult to directly measure. Therefore, the choice of reliable models capable of predicting spatially distributed actual ET represent a fundamental aspect for drought monitoring.

The paper, by means of ground ET measurements obtained from eddy covariance systems at two different sites in southern Italy, analyses the performance given by the Surface Energy Balance Algorithm for Land (SEBAL) model using both National Oceanic Atmospheric Administration-Advanced Very High Resolution Radiometer (NOAA-AVHRR) images and Moderate Resolution Imaging Spectroradiometer (MODIS) on the EOS-1 Terra satellite.

The results obtained during a three-day summer-period pointed out good ET predictions for both satellites in the eddy covariance sites, whilst evident differences were observed in some highly vegetated mountain zones, extending the procedure to the regional scale.

Keywords: drought, evapotranspiration, eddy covariance, energy balance, remote sensing, SEBAL

EWRA 205 Continuous water monitoring on three coastal watersheds in haute normandie: an approach to integrated river basin management

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The coastal watersheds in Haute Normandie are characterized by poorly structured limonous soils that are particularly sensitive to runoff and erosion. At the scale of the watershed, the consequences of such phenomena are numerous: soil erosion and destruction, torrential flow, turbidity of drinking water, floods, collapses, modifications of the aquatic biotopes, etc. Considering soil erosion processes, this study focuses on surface water quality in order to quantify solid and dissolved elements fluxes to the Manche, in accordance with the EU Water Framework Directive.

Three sensitive coastal watersheds have been chosen for which a static approach is coupled with a dynamic approach. The static approach consists in mapping the erosion factors (soil sensivity, topography, vegetation) and according to the dynamic approach principle a downstream watershed outlet is continuously monitored (temperature, turbidity, conductivity and water level) using automated data probes. The relationships between erosion factors and surface water quality are laid out in regard to solid and dissolved fluxes.
In the Yères basin three geomorphologic sub-systems are considered. At the upstream system, the plateaus are characterized by sinkholes and springs, suggesting an intra-karstic transfer with water and sediment loss. The intermediate part of the watershed with important slopes and important soil sensitivity to erosion does not produce important runoffs. Storage zones exist on the slope of the valley. Lastly, in the downstream zone, the exportation of suspended matter to the Manche is conditioned by tidal cycles. However this global deficit is moderated by a low hydrological cycle in 2004.

The coupled approach involving water monitoring and watershed geomorphology is useful to assess the water, sediment and associated geochemical mass balance and their downstream fluxes. It provides a consistent basis for evaluating system components, their connections and evolution. These hypotheses and estimations will be extrapolated to all coastal rivers in Haute Normandie and to the Seine subsidiaries.

Keywords: erosion, water quality, watershed, continuous measurements, geomorphology

EWRA 188 GIS based decision support optimisation for a small communities ... sanitation plan concerning lowcost ... waste water treatment systems

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The main objective of the study carried out in the region of Cantabia (Spain) consists in equipping around 200 communities smaller than 2,000 inhabitants in waste water treatment systems. In a first step, the aim is to count and localise the existing sewage equipments, to evaluate the needs and while using a Geographic Information System (GIS) ; to decide the building of rustic systems, adapted to small communities.

The installation of the equipments is carried out by the region, but the maintenance and management are provided by the communities. The major argument in the decision is the availability in term of financial and human means that are required to the running of the sewage systems, from this derives the choice of rustic equipments?

Keywords: waste water treatment systems, rustic systems, small communities, GIS, GIS based decision.

EWRA 191A ADES : A French national groundwater database. A national reference for groundwater resources and a ... tool for water management

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ADES is the French national groundwater database which provides on a web site all of the quantitative and qualitative public data on groundwaters.

The main objectives are to set up a public data storage tool, to gather all of the available data on groundwater and to make statistical proceedings and mapping easy to produce. Today, ADES contains more than 5 millions of chemical analysis and nearly 4 millions of piezometric levels.

These data are expected to provide information and basic input to hydrological relating to resources inventory, management and planning of the water resource.

ADES is a chartered tool for the implementation of the Water Framework Directive.

Keywords: groundwater, database, France, Water Framework Directive (WFD)

EWRA 142 The changes in water quality in the upper Oder river basin

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The aim of the study is the analysis of runoff and water quality changes in the Upper Oder river basin closed with the Krapkowice gauging station (catchment area A = 10 720.6 km2).

The issue of water quality is of particular importance to Poland, which has comparatively poor water resources as compared with many countries of the European Union (EU). What is more, big pollutant loads in the upper course of the Oder pose huge problems for water consumers and users in its middle and lower course (including the territory of Germany) and pollute the Baltic Sea.

Changes were compared in 8 measurement points, based on the results of monitoring research. Changes of 7 indexes of water pollution were analysed, such as: BOD5 (5-day biochemical oxygen demand) and COD (chemical oxygen demand) (synthetic indexes), sulphates, nitrates and suspended matter (mineral substances) as well as nitrates and phosphates (biogenic substances). The timespan in question is interesting because it encompasses the period before and after political transformation in Poland and the Czech Republic which significantly altered the way the economies of these countries function.

Water quality in the Oder river is a synthesis of many natural factors in combination with powerful effects of anthropogenic influences.

The research results show that water quality in the Oder improved significantly near the end of the last decade of the period 1970-2000. As a result of the fulfilment of the provisions of the EU Water Framework Directive, with time we can expect better water and sewage management in the catchment area, what will definitely contribute to further improvement of water quality in the Oder. Problems that remains to be solved is the issue of saline mine waters and surface washings. Focus is also needed on investigating the impact on water quality of many hazardous substances that for years have accumulated in bottom sediments in rivers and reservoirs.

Keywords: water quality, water pollution, Oder river, water management

EWRA 200 Contribution of remote sensing techniques in the detection of submarine springs in the NE Viotia-Central Evia area, Greece

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In this poster presentation we investigate the potential of using remote sensing methods and techniques in the detection of submarine springs and fresh water discharges towards the sea, in a karst area in Central Greece. Geologic and hydrogeologic conditions have given us the certainty that there are some important submarine springs in the study area.

Remote sensing methods can help us detect the positions of fresh water discharges, that have been located in situ. Thermal changes and anomalies on the seaside, are the best indication of the existence of the submarine springs. This can be achieved with the use of proper image processing methods. ASTER imagery (Advanced Spaceborne Thermal Emission and Reflection Radiometer) was chosen to be used because of the 5 thermal bands and the high resolution(15m-90m) that it provides.

Keywords: submarine springs, coastal springs, fresh water discharge, hydrogeology, remote sensing, Aster

EWRA 220 CABRI-Volga - Cooperation Along a Big RIver: Institutional coordination among stakeholders for environmental risk management in the Volga ...

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CABRI-Volga is an international coordination action to facilitate cooperation and to coordinate research in environmental risk management in river basins in the EU, Russia & the NIS. It focuses on the Volga basin for which environmental risk management is fundamental for protecting the environment, improving socio-economic conditions and promoting agricultural and industrial economies as well as the health of the Caspian Sea. Low effectiveness and deficiencies in governance and civil society involvement, business commitment to sustainable development as well as low levels of cooperation between academic and policy-making institutions have led to a situation of significant ecological, social and economic risks and human vulnerability in the basin.

The strategic objectives of CABRI-Volga are, inter alia, to mobilise existing, isolated human and institutional resources, increase the research potential on environmental risk management in river basins as well as strengthen links between scientific communities and policy-making processes.

A scientifically and institutionally complementary consortium of 18 partners from Russia and the EU is following an elaborated workplan to achieve the project objectives. For three series of parallel working group meetings, Russian and EU experts (~70 per series) from various scientific and institutional backgrounds will be recruited from the extensive network of CABRI-Volga stakeholder organisations to discuss and exchange knowledge and expertise in the CABRI-Volga thematic areas, namely environmental rehabilitation, vulnerabilities & human security, natural resources & their sustainable use, connecting goods & people (transport and mobility), and institutional coordination & cooperation.

CABRI-Volga will achieve a number of concrete outputs to be widely disseminated via the CABRI website, incl. case studies, State-of-the-Art Review, Good Practices Report, Policy Recommendations, Action Plan & Research Agenda, an established network of experts and stakeholders from Russia/NIS & EU as well as coordination mechanisms such as the Volga Basin Council.

Keywords: sustainable management, Volga river, environmental risk analysis, human resources, institutional coordination & cooperation, environmental rehabilitation

EWRA 216 Collaborative work ... to improve water resources knowledge and sustainable management: Kaluvelly & Pondicherry basins, India

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Salinisation process occurs all along the Bay of Bengale and affects a densely populated area. With the "HELP-UNESCO" program support (2004-2005), the Kaluvelly-Pondicherry sedimentary basin, located along the Bay of Bengal, is used as a pilot area to study of the salinisation process and its dynamics. This basin is representative of coastal and multi layered aquifer system submitted to a tropical semi-arid climate. In Tamil Nadu, traditional agricultural practices had been governed by monsoon rainfall. As groundwater resource is more reliable and more productive than rainfall harvest, the drilling of a large number of bore wells has occurred. In the Vanur sandstone aquifer a drastic drawdown of the water table (30 m in less than 30 years) has occurred together with an increase of salinity have been recorded. Salinisation origins have been identified by previous geochemical and isotopic studies, but quantification of the water resources and the evolution in time of their qualities remains open questions that our project will give some guidelines in order to help all the actors in charge of water management in our studied area. Presently, even if water management rules/laws have been enacted at different levels, they never have been fully applied partly because of the complex relationship between institutions from diverse origins: local, state, independent territory, federal government.

Our main hydrological and water management issues are to be able to: i) draw a state of things from a hydrological and socio-economical point of view, with the built up of a GIS data base; ii) quantify the fresh water resources and its time evolution in order to prevent salinisation in aquifers, with the building of 3D hydrogeological modelling; iii) participate in the water staff training, the awareness of the population, water debates and meetings, iv) define methodologies of system evaluation that could be applied and extended to other equivalent sedimentary basins. Last December, crisis situation was encountered as part of the studied area was submitted to tsunami wave. Hydrologic background knowledge of the system, GIS hydrological data base and its improvement by new data collection were used to relieve the population in support of the institutions in charge of water resources and to organize rapid and efficient assistance and the quantification of tsunami impact on groundwater quality.

EWRA 016 The Jordan river basin: a chronicle of plans from the 1900s to date

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The poster presents a review of the more significant plans concerning the Jordan River basin since the 1890s. The Jordan River basin is an international watercourse covering parts of four States and one territory (Lebanon, Syria, Israel, Jordan and Palestine). The River and its tributaries constitute an important source of water to all of these entities, in part because of the generally arid nature of the region as a whole. The five co-riparians of the basin all suffer from serious water deficiencies.

Many development plans have been produced over the last century for the Jordan River valley region. These extend from the efforts of Abraham Bourcart in the late 1890s, through work by Franghia in 1913, and by Mavromatis and Henriques of Britain in the 1920s; to the Ionides Plan (1939), the Lowdermilk proposals (1944); and the work by James Hays in the late 1940s. All of these authors investigated aspects of the use of the regional water resources for irrigation in particular, as the production of crops was then considered to constitute the primary need for water in the region.

A particularly intensive effort occurred in the early to mid-1950s to develop a consensus for the use of the water resources of the Jordan River basin. A review is presented of the main features of the plans produced for the basin as a whole, focusing mainly on the period between 1953 and 1956. The best-known of the proposals (the Johnston Plan of 30 September 1955) is outlined in some detail.

EWRA 105 Altitudinal wet pastures: threats and conservation means; the case of Oukaimeden plateau (High Atlas mountains, Morocco)

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Wet lands are a very important universal heritage; their great ecological value enables them to play a decisive role in the water management: they chop floods and control the river flows, purify water of watersheds and rivers by destructing excess of nutriments of organic matters and pesticides.

The geomorphology and the evolution of the slopes on the High Atlas determine the existence of the numerous projecting ledges of pozzines on plateaus and oozing. This is particularly the case in Oukaimeden site located at 75 Km south of Marrakesh. These wet lawns developing on small surface areas at the mercy of water accumulation in the soils and close to the sources and on some banks constitute wetlands of high floristic richness, which makes them very coveted pastures by local populations and are one of the primordial natural resources that are still allowing to maintain populations in such a marginal and sensitive space.

These wet pastures are highly sensitive to the climatic factors. Well, the recent climatic changes, the anthropic and pastoral pressures and the global environmental changes, affected these zones at the level of their structure and composition (surface area, biodiversity, soil characteristics…) and their ecological functioning and unfortunately are even at the end of their existence. In the Oukaimeden plateau, the use of aerial photography made possible to carry out a detailed follow up of the hydraulic adjustments (building of a dam in the seventies) as well as the setting up of new adjustments (tracks, paths, drain channel) on the structure and functioning of these lawns.

Keywords: wet lawns, high Atlas, biodiversity, cartography, GIS

EWRA 064A Soil erosion and its environmental consequence in the Tecocomulco sub-basin, Central Mexico

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The erosion process was calculated by measuring soil loss at 20 monitoring sites located in those areas where this problem is more active. After 20 months of measuring soil loss at each site, it may be said that erosion acts in different degrees and ways in low-slope areas or in areas with vegetation. The areas covered with vegetation or by a smooth slope are affected by laminate erosion and have an average loss of 0.2 cm/year of soil. In places where vegetation is absent, lineal erosion features (rill and gully erosion) prevail with an average loss of 3.6 cm/year. In the area of ravines there is an average soil loss of 1.9 cm/year. The total volume of eroded sediments in the whole sub-basin is almost 31 x103 m3 of soil, amounting to little more than 40 x 103 tons in a period of 20 months. If the volume of soil loss is distributed in the whole alluvial plain, a layer thickness of 5.7 cm/m2 is obtained which would be deposited in the flat downstream areas. Our results show that soil loss in this area may be due to changes in land use, mishandling of forest resources and inappropriate agricultural and grazing practices in the slope areas.

Keywords: Groundwater modelling, Soil erosion, Tecocomulco, Mexico, Recharge

EWRA 118 The potential water resources of the Oricola plain

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The water demand by the Oricola Plain's industrial area, measuring about 4 km2 and located in central Italy in the Turano river basin, is fulfilled by wells drawing from the alluvial aquifer of the plain. The industrial supplies of water, mainly constant during a year, are in addition to domestic and irrigation supplies, but are variable and strongly variable during a year and are also fulfilled by the alluvial aquifer. With the planned installation of new industrial activities in the next years, the water demand is forecasted increasing about 40%. The alluvial aquifer limited extension, measuring about 9 km2, suggested evaluating its capacity, so as to avoid its unsustainable use.

An inflow-outflow numerical distributed model was created, suited to monthly data, and was calibrated on the Turano river flow data, collected by the "Servizio Idrografico di Roma". The SCS CN method and the soil water balance are the main components of the model. The recharge rate of the Oricola alluvial plain was found to be linked both to direct infiltration and subsurface flow, the first one being strongly lower than the second one.

Keywords: water resources, distributed model

EWRA 094 Hydrogeological study of "Fontanili": a particular kind of spring in the Po Plain (Northern Italy)

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The paper is about a particular kind of canalized spring, called "Fontanili" that is very typical of Po Plain area. Distribution, physical features, chemical water features preservation conditions and origin processes connected to this particular kind of spring is studied.

Fontanili are placed in a territory belt called "Fontanili Line", which corresponds with the change between High and Low Plain and it's characterized by a spring subsurface water emergence, produced by a sediment permeability decrease. The research about Fontanili in the Po Plain started with a data analysis and continued with a field survey.

Origins of Fontanili, have been searched in the investigated area with two different causes:
1) hydrogeological setting of subsoil: with a set of cross sections placed approximately EW, then through the Fontanili Line, it has been shown that a large part of them are placed in correspondence with deposits characterized by low permeability (clayey and silty beds);
2) human action: at the side of natural Fontanili's origin, where the excavation doesn't need big depth, there are a number of them in which the unconfined aquifer is reached and led to reach the surface, thanks to a excavation. In the Po Plain area, Fontanili are decreasing in number and are degradating in their environmental qualities.

Fontanili are considered as naturalistic, rural and cultural emergences, characteristic of many zones of country of Po Plain. Where possible, their recovery and valorisation is a priority and very important in the past for economic development of farmer people who
knew how to reach a remarkable balance between the possibility to take advantage from them and the protection of their naturalistic and environmental features.

Keywords: spring, Po Plain, hydrogeology, irrigation.

EWRA 129 Drinking and irrigation groundwater quality in Bulbule and Zway area (Ethiopia)

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The present paper reports the results of a water drilling campaign carried out in the central sector of the Main Ethiopian Rift Valley. 14 water wells were drilled in the Lake Region of the Zway area, about 160 km to the South of Addis Ababa, in order to avoid new heavy famine and provide water supply for agriculture and human consumption. Despite the presence of few lakes (Zway, Abijata, Langano and Shalla Lake) and seasonal rivers, quantity and quality properties of water are very low.

Water samples were collected from drilled wells and analyzed in order to know the chemical quality of the water extracted. This study reports a synthesis of geological data, resulting from wells drilling works, and chemical data processed in order to verify drinking and agricultural quality water. Values obtained show a very high concentration of fluoride (F^-), dangerous for the human health, Cl^-, HCO_3^- and Na^+, which is responsible of the sodification processes and consequently sterility of soils.

Keywords: Ethiopian Rift Valley, groundwater resources, drinking water quality, agricultural uses

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EWRA 066C Aquifer role in reducing nitrate contamination by means of the dilution process

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The quality of groundwater resources depends on the efficiency with which chemical, physical and biological processes manage to abate the concentration of a certain water-soluble contaminant that leaches vertically into the topsoil and into the unsaturated zone towards the aquifer.

Particularly nitrates are greatly water-soluble and they are not subjected to attenuation phenomena in soil and unsaturated zone, like biodegradation, adsorption or precipitation. In case the contaminant reaches the aquifer, one of the phenomena which allows the most significant reduction of contaminant concentration along the flow direction is the process of dilution.

This paper is the proposal for a simplified methodology to evaluate the ability of the aquifer to operate a nitrate concentration reduction by means of the dilution process. This ability is directly related with aquifer volumetric flow rate per unit perpendicular to the flow direction (qu) and it increases with qu raise. qu evaluation was carried out for three sample areas in the western sector of the Po Plain (northern Italy). Moreover qu values were compared with the nitrates concentration in groundwater. From this comparison emerges that, on equal terms, low values of the nitrates concentration are present in areas where qu values are high, due to the high dilution rate of the pollutant within groundwater. On the contrary, high nitrate concentrations are present in areas with low qu.

Finally, the qu evaluation could allow, especially for studies on regional scale, the localisation of areas more susceptible to groundwater contamination. Moreover this approach can be used as a planning tool with advantages for groundwater management and preservation.

Keywords: Dilution, nitrate, superficial aquifer, diffuse contamination, groundwater resources

EWRA 065 Pollution aspects of heavy metals in citrus irrigated with wastewater

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The increase of irrigated areas and population, multiplied by the consumption of water, and the undesirable discharge of urban wastewater in rivers, lakes and coastal areas, provoke high environmental problems. The treatment of wastewater, before reused, is essential to avoid environmental problems and to protect public health. When reused, irrigation is an additional treatment of the final effluent, just after the plant station treatments. The reuse of reclaimed water is conditioned by laws and recommendations on the water quality, involving aspects of heavy metals and other chemicals, salinity and faecal contamination.

The response of the system Soil-Plant-Atmosphere Continuum (SPAC) to heavy metals (Cd, Ni, Pb and Cr) was studied, when reclaimed water, natural water, and fertigation were applied. The plant indicator was the orange tree (Citrus sinensis [L.] Osbeck) and its habitat was the region of Algarve (South Portugal). Soil concentrations of Ni, Pb e Cr did not increase significantly when wastewater was applied; however, the Cd soil levels (0.2 ppm) were higher than the Cd wastewater levels.

As concluding remarks, it was shown that the heavy metals pollution effects could not threaten the public health in the Algarve region; and, therefore, reclaimed wastewater reuse may represent a profitable alternative to potable water and mineral fertilizers use.

Keywords: wastewater, heavy metals, soil, orange-tree, leachate.

EWRA 199 Large scale spatial/seasonal fluctuations of the microbiological parameters of Iskar river: oversight to water quality

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Iskar River is one of the largest rivers of Republic of Bulgaria. In the upper part this river is the main source of water supply of capital of Bulgaria – Sofia. The investigated subcatchment begins at the river spring, ends at Iskar reservoir and covers an area of 892 km2 with average latitude of 1314 m.
The integral assessment of water quality as well as the ecological sustainability of the river ecosystem is the essential problem on the road of integration of Bulgaria in EU. In the frame of EU project (V-Framework) - TempQsim the spatial, seasonal and tributaries dependent dynamics of the microbiological parameters of the stream water, hyporheic water and sediments have been realized.

The 10 stations of sampling have been selected on the base of geomorphologic, hydrologic, anthropogenic influence considerations. The methodological design was specially constructed on the base of the applicability and comparability: (1) to be in the correspondence of national and EU standards and regulations (ISO-14000) of river water quality; (2) to facilitate of WFD (European Water Framework Directive (Directive 2000/60/EC) introduction and functioning in river system in Bulgaria; (3) to reveal possibilities of risk assessment and management at the system sewer/river when the waste water treatment plants existed or not; (4) the microbiological indicators to be considered together with nutrients dynamic and other ecological factors. All this integrity in the experimental design was directed to an elucidation of the evolution of the self-purification river potential and sustainable ecological development of the river Iskar.

The obtained results confirmed that microbiological parameters play important role in regulation and indication of water river quality. On the base of jointly interpretation of chemical and microbiological parameters has been created the scenario of the spatial and temporal critical control points (CCPs) for Iskar River. All this can be used for valuable control mechanism in the River Management Plan.

Keywords: Spatial, seasonal fluctuation, microbiological parameters, TMC (total microbial count), Oligo (oligotrophic bacteria), Endo (bacteria from family Enterobacteriaceae), river water quality, hyporheic zone, Iskar River

EWRA 172A NAIAS –Time integration of water development projects in strategic management

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The aim of a strategic Water Resources Management Plan is to achieve harmonic relations between demand, availability of water resources and the environment at the present and future conditions. To attain this goal the water system should be clearly defined and a number of viable development scenaria should be selected. The software package -NAIAS- is used for the assessment and comparison of development scenaria at a hydrological basin scale, in an attempt to maintain the delicate balance between accuracy, efficiency, easiness for use and clarity in application. The package is based on previous works of the research team (Tsakiris et.al., 1994, Tsakiris and Todorovic, 1995, Tsakiris et.al., 2002) incorporating a framework of multiobjective planning as presented by Cohon and Marks (1975), Duckstein and Opricovic (1980) and Kindler (1992).

As computers and their capabilities are evolving, the methodologies employed in water resources management are also constantly changing. The level of generalisation needed to model and analyze broader areas influences the way most of parameters are handled. Therefore, one must carefully select the most influential parameters and find the balance in expanding the details for those parameters in order to maintain efficiency in seeking the optimal solution or rational development of water resources through a strategic water management plan.

EWRA 214 Investigation and determination of the effective factors on sediment yield (case study: Taleghan watershed, Iran)

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Erosion and sediment production depend on complex factors and parameters. Determining factors and parameters that play the main role in erosion and sediment production in a watershed can help in better management of catchments for reducing damages caused by erosion and sediment production. In this research, for determining the effective factors on sediment yield, Taleghan Watershed was chosen as the studied area. This watershed is located 90 kilometers, west-north of Tehran and is one of the main Watershed of Sefid-Rood Watershed and plays important role in input of sediments to Sefid-Rood Dam. After determining the effective parameters on sediment yield in four general groups and seventeen subgroups as independent variable, the amount of sediment yield in each sub-catchments was also determined as dependent variables and then by using factorial analysis and performing multiple regression analysis between selected independent variables and dependent variable using SPSS software , the most suitable statistical relationship between sediment yield of sub- catchments and watershed characteristics was obtained. The result of chosen model shows that sediment yield of sub-catchments in Taleghan Watershed depends of four following factors: The area of agricultural lands (dry farming and irrigation), sub-catchments area, the area of pre-quaternary sensitive and semi- sensitive formations and slope, those four factors control %88 of sediment yield changes which in significant at %5 level. With regard to the obtained result, among other effective factors on erosion and sediment yield in Taleghan Watershed, We can mention the effect of geology, topography and human factors.

Keywords: Land use, Sediment yield, Taleghan Watershed, Regression analysis.

EWRA 073A Multi criteria approach for prioritizing of land management practices at the watershed scale

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Land management practices (LMPs) attempt to decrease runoff by increasing infiltration and soil moisture. They functions by increasing storage capacity and delaying overland flow to reduce direct runoff while increasing interflow and base flow. In addition to technical aspects of different LMPs, making land management decisions during the planning stage require comprehensive sets of social, economical and technical criteria in order to properly account for all managerial alternatives. In most cases, economic criteria have been used to evaluate possible alternatives. The most important single point in watershed planning is to consider initially the broadest possible range of criteria and stakeholders' preferences. One of the major concerns when dealing with human and societal systems is the effect of intangible and qualitative criteria. Integration of quantitative and qualitative decision criteria is addressed in this paper through the use of multi criteria decision-making methods. In this paper, Kan watershed in north of Tehran, Iran, was selected as a case study. Historical floods threatening Kan watershed have shown that optimization of land and water resources practices are needed to protect natural resources, tourist sites and metropolitans area. Delphi method was used to extract social decision criteria as preferences of different stakeholders. Economic criteria were determined using an economic survey on different LMPs using field interviews and previous reports. An event-based hydrological model, HEC-HMS, was used to model the watershed response to different land management options and to determine hydrological decision criteria. In this research the best LMPs for each landuse class were prioritized. In this paper different stakeholders' preferences and economical and hydrological criteria were integrated using two different multi criteria decision analysis methods, TOPSIS and SAW.

Keywords: land management practices, multi criteria decision analysis, preference analysis, hydrologic model

EWRA 070 Prediction of Simiyu river (tributary of lake Victoria, Tanzania) discharge using Wetspa model, GIS and remotely sensed landuse data

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Trends of increasing contaminant concentrations such as pesticides and phosphorous with river discharges have been observed in the recent past in the Simiyu river, Tanzania. These contaminants likely originate from domestic, agriculture and industrial activities. The transport of the pollutants is associated with river flow patterns. Higher concentrations are observed during high flows, suggesting high amount of contaminants are released and transported by high flows in the Simiyu river (Rwetabula et al., 2004). Water quality management cannot be done without a clear understanding of the hydrological processes in the Simiyu river basin. Therefore, models capable of predicting flood and water quality, are needed for understanding the hydrologic behaviour and for decision making. Here, a modelling approach is described using remote sensed data, GIS and WetSpa model to predict Simiyu river discharge and hydrological characteristics of the catchment.

EWRA 121 New modeling tools for sewer leakage assessment and the validation at a real world test site

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The continuous aging processes of the sewer network as well as improper connections and high traffic volume on the streets lead to a multitude of defects in the sewer network like cracks, shards, joint displacements, etc. Through these defects within the active sewer network, exfiltration of significant amounts of untreated sewage water into the unsaturated zone and into the groundwater occurs. A suite of computer models to tackle the urban water and contaminant balance as well as the effects of sewer leakage is currently produced within the European Union funded project AISUWRS (Assessing and Improving the Sustainability of Urban Water Resources and Systems). Additionally within the project of the German Research Foundation (DFG) "Hazard potential of waste water from leaky sewers for soil and groundwater" laboratory and field experiments were performed to investigate the effect of leaky sewers on the soil and the groundwater. To investigate the processes and effects of sewage exfiltration, a new test site was constructed in July 2004 where a monitoring program was set up which integrates climate, discharge flow and exfiltration measurements. The catchment of 60 ha upstream of the test site was modelled using the urban water balance model UVQ (Urban Volume and Quality). UVQ represents the water and contaminant flow in the existing drinking water, waste water and storm water systems. A subsequent running model PLM (Pipeline Leakage Model) is linked to the UVQ model and is calculating the exfiltration rates of sewers.

Keywords: leaky sewers, computer models, integrated monitoring program

EWRA 041 Analysis of droughts using the standardized precipitation index (SPI) in Karoon river basin, Iran

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Drought is a recurring problem for Iran as illustrated by widespread economic, social and environmental impacts. Moreover, precipitation temporal variation is inherent characteristic of arid and semi- arid climates like Iran. Recent drought episodes and the widespread drought condition emphasize this vulnerability and the need for a more protective planning to drought management that would place greater emphasis on preparedness planning and mitigation actions. This paper presents the application of Standardized Precipitation Index (SPI) to analyze drought characteristics in Karoon river basin, southwest of Iran. The results showed that the lowest SPI value and the greatest intensity of drought were occurred in Menj station while Darshahi station had the longest duration as well as the highest frequency of drought. Also spatial distribution map of drought showed that southern parts of the basin are more vulnerable for drought occurrence.

Keywords: Drought, Standardized Precipitation Index (SPI), Karoon river basin, Drought intensity, Drought duration, Drought magnitude.

EWRA 073B Hydrological modeling for flood mitigation planning: case study, Kan watershed in Iran

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Increasing attention is being paid to the management of water resources in a watershed basis. This can play an important role in decision making for judicious flood mitigation and establishing criteria for rational planning. Hydrological modelling is needed for integrated watershed assessment, determining the effects of upstream watershed disturbances and flood control measures on flooding. Historical flash floods threatening Kan watershed have shown that flood control measures are urgently needed to protect natural resources, tourist sites and metropolitans area. Kan watershed has two sub-basins with common outlet, which is caused accelerated impacts on peak flows and flood volumes in mainstream. This watershed is a very interesting case for study of synchronized flood hydrographs analysis and possible challenges for reducing the intensity of floods. In this paper, the event based hydrological model, HEC-HMS, was used to modelling the watershed response to any changes by structural and non-structural flood control measures and synchronized hydrograph analysis. A multiple decision-making method was used to find optimal flood mitigation alternative based on 25 and 100 years peak flood discharges and time lag between peak flood discharges at outlet of two sub basins. Synchronized hydrograph analyses have shown that flood control measures should not implement in Kiga sub-basin. For local flood mitigation at the Kiga sub-basin some methods for facilitating the flood flows were proposed. On the other hand some suitable and possible structural and non-structural measures were proposed to delay in stream flow in Rendan sub-basin for decreasing the peak flows at the common outlet. Our analyses showed that magnitudes of the peak discharges downstream could be reduced if upstream peak flows are desynchronised and also in the case where the sub-basins of a watershed have common outlet synchronized hydrograph analyses play the key role in rational flood mitigation planning.

Keywords: Flood Mitigation, Hydrological Modelling, Hydrograph analysis, flood control measures

EWRA 044 The effect of physical and climatic parameters on peak flow (Southern Alborz basins, Iran)

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A regional frequency analysis of annual Peak maximum series (PMF) of flood flows from rivers of the central watersheds in Iran has been conducted, including identification of homogenous regions based on cluster analysis and suitable regional frequency distribution for the regions. A lot of effort was made to establish peak flow procedures and to evaluate methods to estimate peak flow parameters at ungauged sites. The most popular tools in this study of regionalization are based on regression analysis. This method has to be considered the method most used in hydrology and water resource management. In this research, the peak stream flow with the different periods of 19 stations in southern Alborz watersheds in IRAN was estimated from watershed and climatic parameters. Because of the close relationship between elevation stream flow regimes and hydrological features, the model development first involved delimiting homogenous hydrological regions by using two-step cluster analysis. The identification of homogeneous regions is normally required for large territories (countries, large regions/catchments) or with varying physiographic condition and may be skipped for smaller regions. Of the parameters studied, area, watershed average Slope, mean elevation, miller coefficient and mean annual precipitation accounted for about 98.89 percentage of the spatial variability of peak flows in a multivariate regression analysis. The study results reveal that the regional regression models developed in this study could be applied reasonably at ungauged sites.

Keywords: Peak flow, Ungauged sites, Multivariate regression analysis, Factor analysis, Cluster analysis, Regional analysis, Southern Alborz basins.

EWRA 187 Geological and hydrogeological of the Codana gypsum quarry (Monferrato, Italy): ... environmental status and groundwater quality

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The present study is included in a wide ranging environmental survey carried out for the Montiglio Monferrato municipality (Asti), in the Monferrato area (Piedmont, NW Italy). The object of the research was a geostructural and hydrogeological characterization of the abandoned underground gypsum quarry, located in the municipal district of "Località Codana". Exploitation activity started at forties and carried on until 1990. The quarry is set up on more than 52 km of tunnels displaced on seven levels reaching an average depth of 100 metres from surface. Since 1974, when national regulations in terms of dumping didn't exist yet, industrial sludge were stored in the first three levels. The sludge disposal carried on up to 1985. This work includes a detailed geostructural and hydrogeological survey in order to identify the permeability of the rock body and all fractures and faults which could be the way of leakage for leachate produced by the sludge.

By means of a field work and support of a new drillings campaign carried out between June and November 2004, it has been possible to reconstruct the geological and structural setting of the gypsum body which belongs to the messinian "Complesso Caotico di Valle Versa" formation. Gypsum body is affected by three main fault systems NW/SE, NE/SW and E/W oriented that were analyzed and described in terms of persistence and relationship among them. Moreover the permeability of gypsum deposit was tested by means of Lugeon and tracer inflow tests in order to verify the possible connection between water inside the quarry and groundwater outside, flowing to the hydrographic network

Keywords: environmental survey, gypsum quarry, rock body permeability,fracturated aquifer

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EWRA 025 Emerging policy lessons on WFD implementation on the island of Ireland

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The WFD requires Member States to design cost-effective programmes of measures (PoMs). This paper focuses on the prospects and issues surrounding co-operation between The Republic of Ireland and Northern Ireland in the development of PoMs - as 75% of Northern Ireland's River Basin Districts are international, i.e. bordering with the Republic of Ireland. Will this transboundary dynamic undermine the Directive's requirement for administration and management at the RBD scale? Can we reach an 'All Ireland' perspective on the management of water quality? If not – what are the inhibitors?

Articles en langue française

EWRA 058 Etude de la variabilité spatiale des précipitations : cas du bassin versant de l'oued Merguellil en Tunisie

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L'étude de la variabilité spatiale de la pluie sur le bassin versant de l'oued Merguellil est d'un grand intérêt puisqu'elle permet de comprendre et d'expliquer cette distribution à différentes échelles et d'en tenir compte des résultats aux fins d'études hydrologiques (météorologie, modélisation, travaux d'aménagements etc.…). Les données pluviométriques exploitées dans le cadre de notre étude concernent dix-sept stations pluviométriques. La période commune d'observation est de trente années hydrologiques (de 72-73 à 2001-2002). Dans un premier temps, un travail d'homogénéisation et d'analyse de données a été fait. Nous avons effectué des explorations statistiques des séries pluviométriques, pour chaque station, à différents pas de temps visant à l'analyse de la structure spatiale des pluies observées. En effet, nous avons calculé les paramètres de position et de dispersion et ajusté des lois de probabilité sur les fréquences empiriques de ces données. Ensuite, nous nous sommes appuyés sur l'approche des variogrammes afin de comprendre cette structure spatiale. Nous avons tracé les graphiques expérimentaux et calculé les modèles correspondants. Enfin, nous avons cartographié les pluies à différents pas de temps ainsi que les paramètres des lois de distribution de ces précipitations en utilisant la méthode de krigeage. L'étude a conduit à des résultats intéressants, du point de vue métrologie comme celui de la connaissance de la structure spatiale des précipitations. L'étude de la structure spatiale semble indiquer une connaissance satisfaisante des pluies pouvant être atteinte avec une densité de réseau de mesure de 01 poste pour un bassin versant de l'ordre de 1200 km² ,à l'échelle annuelle. Pour des pas de temps inférieurs, cette densité augmente. Quant à la connaissance de la structure spatiale des précipitations à différentes échelles, l'étude de la corrélation spatiale indique que le degré d'uniformité et d'homogénéité des pluies décroît avec le pas de temps. Ces résultats qui devraient faire l'objet de confirmation sur d'autres réseaux, sont à prendre en considération dans la modélisation hydrologique et la densité proposée reste lié à la nature et qualité des observations réalisées.

Mots-clés : variabilité spatiale, précipitation, ajustements, variogrammes, cartographie.

EWRA 081 Estimation et analyse des indices de sécheresse en Tunisie : application au bassin versant du barrage Lakhmess

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La sécheresse est un phénomène récurrent, définit comme une efficience conjoncturelle des pluies par rapport à une valeur de référence. Elle a des répercussions directes sur l'économie du pays (production agricole, tourisme, production d'énergie, etc…). Pour préserver la ressource et intervenir d'une manière efficace et rapide, afin de lutter contre les conséquences de la sécheresse, lorsque le risque de la pénurie d'eau se présente, il faut avoir des indicateurs d'alerte intégrés dans les plans d'aménagement et de gestion des eaux. Le présent travail consiste à calculer deux indices météorologique de sécheresse à savoir «Standardized Precipitation index» SPI et « Reclamation Drougth Index » RDI, de les analyser, de comparer leurs résultats et de proposer, selon les valeurs des deux indices, les différentes classes de sécheresse. Les deux indices sont fondés sur deux variables hydrologiques de base, en l'occurrence la précipitation et l'évapotranspiration. Les résultats de l'étude sont intéressant en terme d'identification et de caractérisation des périodes sèches. La comparaison entre les deux indices, facile à calculer, met en évidence la capacité de l'indice RDI à caractériser les sécheresses. Il peut être employer comme indicateur pour de suivi, de gestion et de prise de décision pour lutter contre la sécheresse.

Mots-clés : Sécheresse, estimation, analyse, précipitation, évaporation, Tunisie.

EWRA 063B — Réaffectation des eaux de ruissellement et efficacité technique de l'agriculture pluviale en zone aride. Cas du bassin versant ...

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Devant la rareté et la faiblesse des ressources en eau, l'état tunisien s'est engagé, depuis les années soixante, dans une politique volontariste de mobilisation et de maîtrise des eaux de surface et de sauvegarde des terres en pente, à travers une panoplie de stratégies successives et complémentaires de Conservation des Eaux et du Sol (CES). Ces stratégies ont contribué à des changements perceptibles au niveau de l'affectation et de la répartition spatiale des eaux de ruissellement à l'échelle des bassins versants.

Cet article, vise à étudier l'impact de la nouvelle réaffectation spatiale des eaux de ruissellement sur l'efficacité technique de l'agriculture pluviale. Le bassin versant d'Oued Oum Zessar (sud-est tunisien) est pris comme cas d'étude. En premier lieu, par compartiment, une fonction de production de type Cobb-Douglas a été estimée. Ensuite, une fonction de production frontière a été ajustée moyennant la méthode des Moindres Carrés Ordinaires Corrigés (MCOC). En dernier lieu, l'efficacité technique par compartiment a été calculée en utilisant la méthode de mesure adoptée par Timmer (1971).

Les résultats montrent une tendance générale vers la baisse avec une variabilité interannuelle à des scores d'efficacités par compartiment et à l'échelle du bassin versant, entre 1986 et 2000.

Mots-clés : Agriculture pluviale, efficacité technique, eaux de ruissellement, CES, bassin versant, Tunisie

EWRA 153 — Confrontation de nappes et estimation des volumes d'eau mis en jeu dans une zone inondable

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Dans cette recherche, nous nous sommes intéressés aux mécanismes qui régissent la submersion d'une zone inondable du bas Adour en intégrant l'ensemble des variables hydrologiques et précisant l'interdépendance entre le lit majeur et le lit mineur de l'Adour tout en montrant l'importance et la part des eaux de surface dans le mécanisme de crue. On a élaboré des cartes simulant les surfaces inondées lors des phases de crues en constatant l'imposant volume d'eau stocké dans cette zone inondable jouant le rôle de bassins compensateurs naturels et aménagée par les Hollandais au 18ème siècle pour permettre un délestage du lit mineur tout en limitant les débits dans l'Adour.

L'étude granulométrique effectuée dans les alluvions de cette zone inondable nous a permis d'entrevoir, du fait de la porosité des sédiments , un stockage variant de 1,5 Mm3 à 2,1 Mm3 et ce, sur une surface d'étude voisine de 7 m2.et une profondeur de 2 mètres. En surface, ce stockage a été quantifié à 5,6 Mm3. Par ailleurs, Il faut remarquer que, lors des périodes d'étiages estivaux, le toit de la nappe varie peu (20 cm). Ceci suggère l'idée d'un volume d'eau accessible seulement lors de graves déficits. Il peut être évalué à 4,2 Mm3. Le volume total de la crue représente 540 Mm3 d'eau qui sont passés à l'aval de la zone d'étude. La capacité de stockage des Barthes représente donc 7,7 Mm3

On a également constaté que le volume d'eau de ruissellement du coteau est équivalent à celui du fleuve durant la phase de montée de crue. Les faibles valeurs des conductivités des eaux dans les piézomètres laissent entrevoir une possibilité de mélange entre des eaux peu minéralisées issues de la terrasse Würmienne et les eaux de l'Adour. La zone inondable des Barthes est donc soumise à une confrontation permanente entre deux nappes. L'importance de la nappe alluviale assure dans un premier temps la remontée du toit piézomètrique puis l'inondation de la Barthe lors de la phase de crue. En période de crue la nappe est donc alimentée par le fleuve: c'est la recharge de la nappe. Au contraire, en période d'étiage, la nappe draine le fleuve. L'eau ainsi stockée dans les Barthes est progressivement restituée au fleuve et permet le soutien du débit d'étiage.

Mots-clés : Adour, Barthes, zone inondable

F1 - Impacts climatiques

EWRA 101 Le risque de pénurie en eau sur les petites îles de la côte ouest française, les îles du Ponant. Réflexion sur l'aléa climatique

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Les îles du Ponant, petites îles côtières françaises de l'Atlantique et de la Manche, sont caractérisées par l'exiguïté de leur territoire et la restriction structurelle de leurs ressources en eau douce. A partir d'exemples, la contribution vise à définir la vulnérabilité de ces îles face à la sécheresse et au risque induit de pénurie en eau. A l'aide des méthodologies simples et classiques d'étude hydroclimatique - bilan de l'eau et distribution statistique des précipitations, leurs caractéristiques climatiques et hydrologiques sont définies. L'analyse détaillée des résultats isole les sécheresses majeures de la seconde moitié du 20ème siècle et permet d'en appréhender le scénario et la gravité en terme de période de retour. Les références aux épisodes de sécheresses et de pénuries en eau potable, relativement nombreux sur les îles étudiées, rappellent, jusqu'à très récemment, à quel point cet élément vital a imprégné les histoires insulaires. Ces événements climatiques ont engendré des situations de crises, parmi lesquelles les années 1976 et 1989. La mise en perspective de ces éléments historiques avec les résultats des modèles hydroclimatiques valident ces derniers et permettent de définir, à l'échelle annuelle, un seuil statistique à partir duquel il y a effectivement risque de pénurie.

Mots-clés : Îles du Ponant, climat, ressources en eau, sécheresse, risque de pénurie, bilan hydrique, méthode de Thornthwaite, loi de Gauss, période de retour, enjeux socioéconomiques

F2 - Socio-économie de l'eau

EWRA 002 L'eau et l'agriculture

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La demande mondiale en eau pour l'agriculture est en constante augmentation. Actuellement, elle est de l'ordre de 62 % de la consommation annuelle globale. Problématique traitée et relations entre les activités agricoles, l'évolution des paysages agraires, la qualité de l'environnement et la santé humaine.

Il s'agit à la fois d'un sujet de débat de société, au travers d'enjeux socio-économiques, et d'un objet de recherche d'une complexité écologique exemplaire. Il met en valeur la multifonctionnalité des paysages agraires qui sont également le reflet du dysfonctionnement agro-écologique : d'une part l'activité agricole pollue les sols et les eaux, d'autre part l'agriculture est aussi un récupérateur des pollutions urbaines et industrielles. Les objectifs principaux sont de concilier les nécessités productives d'une agriculture compétitive avec ses nouvelles fonctions de gestion des ressources naturelles.

Les points principaux qui seront développés sont les suivants : relations environnement/agriculture ; évolution des pratiques culturales et biodiversité ; transferts de polluants en terres de grande culture ; relations sylvosystèmes / agrosystèmes / hydrosystèmes.

EWRA 047 Efficience et obligation de résultats : quelles leçons tirer de la politique points noirs de l'agence Seine Normandie menée de 1987 à 1991 ?

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During the period 1987-1991, the French Water Agency of Seine-Normandy basin experimented with a "black spots" strategy in order to restore aquatic sites of very poor quality and of great interest for usages by identifying needed investments and by concentrating funds and communication efforts there. We tried to draw lessons from this policy with an ex-post appraisal of its results.

Data collection was an important part of our work given the absence of a Geographical Information System in the Agency. We overcome such constraints with a logical diagram for screening "black spots" out of 8,000 agreements of funding and by digitizing needed data from maps. We built a database of 58 "black spots" which can be considered as well informed case studies with comprehensive financial data and water quality monitoring.

We propose indicators to assess the black-spots strategy. We show that, given the general basin-wide quality getting worse, the strategy was effective and efficient. Without any data concerning usage recovery, the weight of the different criteria such as length of restored river or number of restored spots remains subjective. Different variables likely to explain success and failure are tested. Variability of discharges explains partly differences of results. We also enlighten a regional office effect.

Such a site-oriented approach illustrates how different causes combine with each other to impact the environment. Therefore the relevance of an overall appraisal remains limited. To assess consistency and effectiveness of any strategy, one should previously list all possible causes of degradation and possible remediation site by site to make them comparable and to understand properly their evolution. Moreover monitoring options may deeply affect scoring results.

Keywords: water policy, accountability, strategic planning, quality monitoring, cost-effectiveness, investments, subsidies, Seine river, point pollution, domestic pollution, industrial pollution

EWRA 046B Analyse de la demande de l'eau résidentielle en Tunisie ... par la technique de cointegration et des modèles à correction d'erreurs

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L'objectif de ce travail est d'estimer les élasticités de court et long terme de la demande régionale en eau résidentielle en utilisant des données agrégées sur la consommation trimestrielle en eau. La cointégration et les techniques d'ECM linéaires et non linéaires sont utilisées dans cette étude afin de montrer l'existence d'une multiplicité d'équilibres et de tester les effets à court et à long terme du prix sur la demande.

Mots clés : Demande eau résidentielle, Elasticités, Cointégration, ECM non linéaire,

EWRA 083 Appui scientifique à la mise en œuvre de la directive cadre sur l'eau. Modèles ... reliant les invertébrés (ibgn) à l'occupation du sol

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For the implementation of the European Water Framework Directive, there is a need of ecological status diagnostic methods and pressures/impacts models allowing to set the priority actions of restoration. In order to respond to these goals we developed "large scale" pressures/impacts models, linking aquatic invertebrate index (IBGN) to watershed land cover. We used decision trees method to generate classifications allowing spatial extrapolation. Validated spatial extrapolation models were used to represent on a national scale the probable current ecological status of rivers based on IBGN. Urban land cover appeared as the first negative impact factor followed by intensive agriculture; natural areas appeared as a positive factor on ecological status. We used also this model to test two hypothesis ("high" and "low") for the "good status" boundary, and to simulate the results at the national scale. Many areas under high agricultural pressure (lowlands and Mediterranean region) could be classified "bad" or "good" according to the boundary hypothesis.

Keywords : ecological status, land cover, aquatic invertebrate, spatial extrapolation, decision tree

EWRA 010 Contribution pour la modélisation numérique de la sédimentation d'une retenue de barrage en Algérie

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L'envasement des barrages en Algérie réduit rapidement et considérablement leur volume utile. En effet, le taux d'envasement moyen annuel est très élevé, il peut atteindre pour certaines retenues des valeurs de l'ordre de 5%. La prédiction de ce phénomène est alors primordiale afin de cerner son intensité, et définir les actions nécessaires à sa minimisation. A cet effet, l'utilisation de modèles mathématiques prédictifs constitue un outil intéressant, en particulier pour le choix de l'implantation des nouveaux projets de construction des retenues.

Sur la base de ces différents modèles existants, dans le contexte Algérien, seules quelques retenues ont et pourront être soumises à des observations suffisantes. Le modèle hydraulique développé est bidimensionnel horizontal. Il est appliqué sur la retenue de Zardezas de la région de Skikda en Algérie.

Les résultats de telles simulations permettent d'avoir des informations simultanées sur la sédimentation des retenues existantes, en voie de réalisation ou bien encore prévisionnelles. Pour ce dernier cas, il est possible de simuler des situations de sédimentation à différents emplacements de futures retenues, afin de décider de la meilleure variante, ce qui contribue fortement au développement durable sur le plan hydrique, et représente un paramètre important dans la définition d'une stratégie pour la préservation des ressources en eau.

En définitif, le modèle numérique adopté peut constituer un outil de travail pour les responsables d'exploitation des retenues et au-delà un appui à la gestion et la préservation des ressources en eau à l'échelle du Maghreb Arabe.

Mots-clés : modèle, hydrogramme de crue, sédiments, barrage, préservation.

EWRA 030 Approche de la connaissance régionale de la ressource en eau par modélisation: application a la moitié Sud du territoire Français

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L'objectif du travail est la connaissance des débits de référence d'étiage (module et débit mensuel mini mal de fréquence quinquennale) en tout point du réseau hydrographique du grand sud de la France (43 départements).

Une approche par modélisation continue des écoulements mensuels, à partir de la pluie a été adoptée. Le modèle retenu est réglé par deux paramètres. Un module a été ajouté pour générer le stockage et le déstockage de la neige. La précision du modèle est excellente pour l'estimation des modules. Bien qu'une certaine dispersion affecte les débits d'étiage, les performances du modèle restent très correctes. Une régionalisation des deux paramètres du modèle a pu être proposée. L'outil de modélisation et les banques de données ont été incorporés dans un logiciel convivial : LOIEAU. L'utilisateur dispose ainsi d'un outil général qui synthétise l'ensemble de l'information hydrologique du réseau de mesure et permet de traiter très rapidement un grand nombre de problèmes hydrologiques liés à la ressource en eau, à sa variabilité saisonnière et interannuelle. Les chroniques de débits générés permettent d'aborder le dimensionnement des retenues et leur optimisation, et les modules statistiques associés au logiciel proposent une estimation des débits de référence.

Mots-clés : resource en eau/water resource, modèle hydrologique /hydrologic model, régionalisation/ regionalization

EWRA 115 Utilisation d'indices de risque d'étiage dans l'élaboration de règles de gestion de retenue

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L'objet de cet article est d'intégrer deux indices de risque d'étiage issus de la modélisation de débits moyens journaliers par un processus de Poisson non homogène (PPNH) dans des règles de décisions liées à la gestion de retenue. Le premier indice P1 est la probabilité qu'un étiage qui a débuté à l'instant u dure plus de x jours et le second est la probabilité P2 d'entrer en étiage sur (u, u+x), sachant qu'on est entré en surplus à l'instant u.

L'étude concerne l'utilisation des indices P1 et P2 dans l'analyse du risque hydrologique, la démarche adopte des règles de décision basées sur un concept bayésien. Deux actions sont considérées et concernent le stockage de l'eau ou au contraire un lâcher. La situation particulière de risque considérée est « un étiage de x jours, débutant à l'instant u ».

Les conséquences dommageables des actions sont évaluées sur une échelle de sévérité croissante et un modèle exponentiel d'utilité est associé à ces conséquences. Nous faisons l'hypothèse que l'année hydrologique ou le contexte climatique à l'instant (u 1) permettent de penser que le cours d'eau sera soit dans un état d'hydraulicité faible ou dans un état d'hydraulicité forte, et nous introduisons la probabilité subjective Pi, dite loi a priori, que le cours d'eau soit dans un état d'hydraulicité faible. Si à l'instant u, le cours d'eau est dans l'état d'hydraulicité faible (respectivement hydraulicité forte), nous considérons l'indice de risque P1 (respectivement P2).

Les différents cheminements de l'arbre de décision conduisent à quatre règles de décisions. Pour chacune d'elles, nous évaluons son utilité moyenne selon le critère du risque bayésien ; la règle de décision Delta* optimale sera celle qui minimise le risque bayésien. Comme application, nous avons considéré le cas d'un barrage situé à l'extrême Nord de la Tunisie. La date à laquelle les décisions doivent être prisent est le 1er février, période déterminante dans les décisions concernant l'allocation d'eau. Pour le cas de stock étudié, les règles de décision développées vont dans le sens de la prudence dès que Pi dépasse 0,5.

Mots-clés : étiages, indices de risque, analyse du risque, risque bayésien, gestion de réservoir

EWRA 144B — Simulation et modélisation numérique pour l'évaluation ... des effets des pratiques agricoles sur les flux et concentration d'azote ...

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L'objectif de l'étude est de déterminer le niveau de concentration en nitrate dans les eaux de surface et le niveau des émissions gazeuses d'azote (N20, N2) que l'on peut atteindre par l'adoption d'une meilleure gestion environnementale de l'épandage des effluents d'élevage. Les sites d'application sont trois petits bassins versants d'élevage de l'Ouest de la France. Nous avons utilisé pour cela un SIRS interfacé avec des logiciels constructeurs de jeu de données à partir de scénarios et un modèle agro-hydrologique distribué continu. Les résultats montrent sur chaque site que le total annuel de l'azote perdu dans l'eau sous forme de nitrate et dans l'air sous forme de di-azote et de protoxyde d'azote est du même ordre de grandeur que l'excédent annuel du bilan minéral de l'azote. Le coefficient moyen d'émission de N2O par rapport aux apports est significativement plus élevé que les coefficients généralement utilisés pour l'évaluation de ces pertes. Les flux totaux d'azote émis dans l'atmosphère sont quantitativement aussi élevés dans les sols cultivés de la zone insaturée que dans les zones humides de fond de vallée. Les stratégies d'optimisation les plus simples et les plus acceptables à priori par les agriculteurs ont une efficacité d'environ 25 % au bout de 21 ans pour la réduction des concentrations dans l'eau, ce qui en général conduit à repasser en dessous de 50 NO3 mg l-1 mais ne suffit pas pour atteindre 25 mg l-1 au bout de 21 ans. La mise en œuvre des modifications provoque aussi une réduction des flux d'azote dans l'atmosphère de 12 à 20 % par rapport aux pratiques actuelles. Le temps nécessaire pour atteindre ces résultats est au moins de 10 ans. Il apparaît que l'évaluation d'une filière de gestion environnementale des effluents doit prendre en compte des temps de quelques dizaines d'année. Elle doit aussi tenir compte des usages du sol et des caractéristiques agronomiques et hydrodynamiques du territoire épandu, sinon il sera impossible d'évaluer les risques de reports de pollution et par là d'évaluer la « durabilité » des nouveaux systèmes proposés.

Mots-clés : Modèle, nitrate, simulation, pollution diffuse, bassin versant, azote, dénitrification, émissions gazeuses, protoxyde d'azote N2O

EWRA 011 — Etude de l'influence de l'effet de stockage sur le dimensionnement des ouvrages d'assainissement pluvial

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Les méthodes globales d'estimation du débit de ruissellement, telle que la méthode rationnel ou la méthode de Caquot, ne peuvent conduire qu'à des valeurs ponctuelles des débits. Leurs emplois n'est recommandés que pour des bassins de petite taille. Pour le calcul des réseaux plus complexes, elles doivent être remplacées par des modèles plus développés tenant compte de l'aspect dynamique de la transformation de la pluie en débit de ruissellement. Il existe un certain nombre de ces modèles à travers le monde qui se distinguent par le fait qu'ils fournissent un hydrogramme, courbe débit en fonction du temps, à l'exutoire du bassin. Nous proposons d'étudier le dimensionnement des réseaux d'assainissement pluvial et les ouvrages qui s'y attachent, par les méthodes des hydrogrammes. En premier lieu on étudiera la pluie de projet synthétique selon les modèles qui existent. Ceci permettra de construire l'heytogramme de la pluie de projet et d'évaluer après transformation via le modèle à réservoir linéaire l'hydrogramme de ruissellement qui entre dans le réseau d'assainissement pluvial. Cette démarche sera appliquée pour la région de Annaba

Mots-clés : pluie de projet, assainissement pluvial, courbes I.D.F., hydrogramme de Ruissellement, Annaba.

F3 - Modèles de l'eau et aide à la décision

EWRA 112B — Détermination des zones inondables - Application aux plaines de la Soummam

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De nos jours, l'un des problèmes considérés comme des plus alarmants dans le domaine de l'eau est celui du risque éventuel qui peut survenir d'une crue violente et dévastatrice. Pour minimiser ce risque, l'analyse des ondes de submersion engendrées par une crue est le plus souvent menée pour l'établissement des cartes des surfaces submersibles situées dans les plaines du bassin versant. Pour atteindre cet objectif les nouvelles technologies (SIG, MNT, Visualiseurs, mailleurs) sont d'une grande utilité.
La simulation de l'écoulement dans le cours d'eau de la Soummam est effectuée à l'aide du code de calcul FESWMS (Finite Elemet Surface Water Modeling System)-2DH.

La partie pré-processing du code passe par plusieurs étapes. La première a consisté à collecter le maximum d'informations sur la topographie du cours d'eau et de la plaine inondable. Le volume important de données liées à la géométrie complexe du cours d'eau et de la topographie de la plaine a nécessité leur intégration dans le système d'information géographique SIG. Le terrain est donné sous forme d'un Modèle numérique d'altitude MNA. Le Maillage bidimensionnel -2D du domaine d'étude a été réalisé moyennant le mailleur EMC2 (Edition de Maillage et de Contours bidimensionnel) et le MNA. Le raffinement du maillage de surface 3D est effectué en ayant recours au logiciel YAMS.

FESWMS donne comme résultats de calcul, en chaque nœuds du maillage, une hauteur d'eau et la vitesse moyennée sur la verticale. Pour une approche plus physique des résultats, il est important de visualiser la direction de cette vitesse ainsi que sa norme. Les limites du champ d'inondation ont été visualisées en utilisant le logiciel SMS (Surface Modeling System).

Mots clés : Crue, Soummam, SIG, MNA, EMC2, YAMS, Saint Venant, FESWMS 2H, SMS

F4 - Qualité de l'eau et environnement

EWRA 027B — Problématique des rejets de polluants dans la ville de Mahajanga - Madagascar

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La ville de Mahajanga est en pleine extension. L'un des problèmes qui préoccupe actuellement la Commune urbaine de Mahajanga concerne l'assainissement de la ville avec la recherche des moyens de traitement et/ou d'élimination des rejets polluants urbains avec les eaux usées domestiques, les eaux usées des industries, des installations à caractère collectif (casernes, hôpitaux, restaurants).

Compte tenu de cette situation, une équipe des Enseignants chercheurs de la Faculté des Sciences de l'Université de Mahajanga, a pris l'initiative de prendre part à la résolution de ces problèmes en initiant deux sous-projets de recherche appliquée sur la « Contribution à la détermination d'une méthodologie de traitement des déchets urbains de la ville de Mahajanga » et la « Contribution à la recherche des procédés de traitement des eaux usées de la ville de Mahajanga ».

Mots-clés : traitement, caractérisation, déchet, eaux usées, développement, laboratoire

EWRA 089 Qualité des eaux des oueds et des nappes de l'Est Algérien: cas des wilayas de Annaba, Skikda, El-Tarf, Guelma, Souk-Ahras et Tebessa

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La zone étudiée est située dans la partie Extrême Est de l'Algérie. Elle est limitée au Nord, par la mer Méditerranée et elle est aux portes du désert du Sud. Cette position lui confère une variation du régime climatique. Ce dernier est méditerranéen au Nord et aride au Sud, se traduisant par une baisse très importante des précipitations, passant de 1200 mm/an au Nord, à 300 mm/an au Sud. Le réseau hydrographique est très dense; des oueds très importants (Seybouse, Mellague, Medjerda, Kébir-Est, Kébir-Ouest) parcourent cette région, ce qui implique des apports (solides et liquides) importants. Les eaux des nappes superficielles se caractérisent par une salinité assez élevée. Pour expliquer l'origine de cette salinité, nous avons utilisé plusieurs approches, telles que: l'outil statistique, qui par le biais de l'ACP, donne un aperçu sur les éléments à l'origine de la salinité observée; l'intrusion marine, la sécheresse et les excès de pompages ont peut-être entraîné une rupture de l'interface eau douce-eau salée, entraînant ainsi une augmentation de la salinité; la méthode de Stuyfzand, basée essentiellement sur les chlorures, permet de déterminer différentes classes de salinité; l'outil thermodynamique montre l'influence de certains minéraux sur la salinité des eaux.

La compilation de tous les résultats nous permet de cerner les différentes origines de la salinité observée. La carte de salinité globale obtenue met en évidence l'influence des facteurs énumérés.

Mots-clés : Salinité, Algérie, ACP, Thermodynamique, Stuyfzand

EWRA 079C Etudes comparatives des différents systèmes mécaniques impliqués dans la restauration des lacs et réservoirs

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Les techniques de restauration des lacs ou prévention contre l'eutrophisation sont nombreuses (chimiques, biologiques, mécaniques,…). vu le coût excessif et le rendement relativement faible de quelques unes d'entres elles, le processus d'aération dynamique est un des moyen les plus prometteurs.

Quatre techniques de stratégies de contrôle des éléments nutritives sont sélectionnées pour cette étude : déstratification artificielle par les bulles plumes, l'aérateur d'élévation partiel (ou total) d'air, l'oxygénation par les bulles plumes et l'oxygénation par le Speece Cône.

Chacune de ces méthodes a ses avantages et ses inconvénients. Une analyse technique et économique élaborées par différentes recherches révèle que l'oxygénation hypolimnétique est la stratégie la plus favorable pour le contrôle des éléments nutritifs. Dans tous les systèmes d'aération hypolimnétique, le système d'aération par les bulles plumes apparaît d'être le plus économique, et peut être le plus simple pour les systèmes utilisés dans le lac standley (Colorado, U.S.A). Alors que d'autres recherches sélectionnent le système

Sur la base de ces recherches, l'étude présentée ici fait un état de synthèse sur un nombre d'issues liées à l'aération dans les lacs et réservoirs, incluant les avantages et les inconvénients de ces systèmes d'aération. Aussi, cette étude se concentre sur le cote économique et technique associés avec ces systèmes d'aération.

Le travail qu'on doit présenter ici, est une étude d'avant projet, qui consiste à présenter les limites d'utilisations et les impacts de ces techniques sur les réserves d'eau, et ceci pour décider a un choix de la technique la plus efficace pour la projeter dans notre future projet.

Mots-clés : pollution, eutrophisation, aération, stratification, techniques de restauration

EWRA 112C Etude expérimentale des paramètres physico - chimiques de la pollution dans un canal

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L'étude de la réponse d'un système d'eaux de surface aux échanges de masse et d'énergie avec le milieu environnant nécessite de se donner au préalable un certain nombre de grandeurs macroscopiques de nature physique au mécanisme susceptible d'apporter une description complète du milieu. Les eaux de surface constituent un système physico-chimique contenant soit en suspension, soit sous forme dissoute des gaz, des substrats minéraux et organiques et de la biomasse.

L'étude du transport de pollution dans les cours d'eau présente un intérêt particulier. La chaleur et d'autres polluants injectés dans les milieux aquatiques sont transportés sous l'effet du mouvement moyen du fluide par convection et diffusés dans le milieu par agitation turbulente. Les deux processus convection – diffusion gouvernent la distribution de la pollution dans un écoulement à surface libre.

Afin de mesurer le pouvoir d'auto - épuration d'un cours d'eau à l'échelle laboratoire, nous avons simulé la pollution en introduisant dans le canal un colorant et suivi l'évolution d'un certain nombre de paramètres dans le temps et dans l'espace. Dans une première partie, nous avons suivi l'évolution de la pollution pour différents débits d'écoulement, en introduisant le polluant à débit et teneur constant au milieu du canal. Des échantillons ont été prélevés le long du canal. Dans une deuxième partie, le polluant est introduit moyennant une injection latérale. Des mesures d'oxygène dissous, de DCO et de matières en suspension ont été effectuées durant toutes les opérations de pollution.

Mots-clés : Pollution, convection, Diffusion, autoépuration, DCO

EWRA 039 L'estimation de l'interaction entre la qualité du ruissellement, l'utilisation du sol et l'état de l'écosystème aquatique

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L'article est focalisé à l'estimation de l'influence des particularités individuelles de bassin versant sur la quantité et la qualité du ruissellement. Le ruissellement forme une grandeur de la déjection de pollutions du bassin versant dans l'objet d'eau. La déjection excédante de pollutions détériore la qualité de l'eau dans l'objet d'eau et opprime l'écosystème aquatique. Pour améliorer la qualité de l'eau, on a proposé d'utiliser l'interaction existante naturelle entre l'utilisation du sol sur le bassin versant, la qualité du ruissellement et l'état de l'écosystème aquatique. Quelques approches méthodologiques sont proposées pour estimer cette interaction. La première comprend l'utilisation des grandeurs du ruissellement, et non pas de grandeurs de l'écoulement du lit. La deuxième comprend l'utilisation des périodes hydrologiques, et non pas de période annuelle. La troisième comprend l'utilisation des concentrations écologiques pour la substance, et non pas de concentrations orientées vers les demandes du service d'eau.

Mots-clés : ruissellement, quantité et qualité de l'eau, bassin versant, utilisation du sol, pollution, réservoir, écosystème aquatique

EWRA 024 Gestion de l'eau dans les pays arabes

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Ce travail a permis de constater que les potentialités totales en eau des pays arabes sont à la limite du seuil critique normatif. Le taux de prélèvement global est de 64% mais il dépasse la ressource totale pour certains pays qui ont limité les déficits en eau en ayant recours aux ressources hydriques non conventionnelles. Seuls 20% de la population dispose de potentialités en eau suffisantes. La superficie agricole ne représente que 5% la superficie totale et les superficies irriguées ne dépassent pas 30% la superficie agricole, caractérisée par une sur-irrigation pour les uns et une sous-irrigation pour les autres. Globalement, l'agriculture des pays arabes est très peu mécanisée et les rendements agricoles sont faibles ce qui a engendré une dépendance alimentaire pour l'ensemble des pays arabes. Celle ci se manifeste par une importation déguisée d'eau, de technologie et de savoir faire. La moitié des ressources en eau est d'origine exogène, potentiellement source de conflits, ce qui nécessite une gestion rigoureuse.

Mots-clés : Potentialités, irrigation, désert, rendement, dépendance

EWRA 098 Une vision intégrale du bilan hydrique de la Tunisie : Eau Bleue, Eau Verte, Eau virtuelle

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In the integral water vision developed in this paper all kind of water resources are considered: mobilized water "Blue Water", Equivalent-Water of the rain fed agriculture "Green Water" and the Equivalent-Water of the import-export food balance "Virtual Water".

In countries where the water resources are limited, this global assessment of water resources, that goes further than the traditional concept of the blue water leads to a better comprehension of the relation between water and the agricultural production and allows to optimize the use of all the water resources.

The global assessment of water resources gives a real evaluation of the possibility of the agricultural production. When applied to the Tunisian water balance, this analysis indicates that, the improvement of food security will depend, in the future, on the capacity to manage all the available water in particular by improving the potential of the rain fed agriculture.

Keywords: water resources, blue water, green water, virtual water, food security

EWRA 154 Ressources en eau en Algérie

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En Algérie, les potentialités d'utilisation de l'eau dans le domaine de l'agriculture, représentent 80 % de la superficie agricole utile (SAU) irriguée et 54 % de la superficie concernée par la grande hydraulique actuellement dominée à 71,3 % par une irrigation traditionnelle et 28,7 % en aspersion. L'économie d'eau induite avoisine 1 milliard de mètres cubes d'eau sur les volumes actuellement gérés. Un doublement de la SAU irriguée et une nette amélioration des rendements agricoles seront ainsi potentiellement réalisés.

Actuellement, une plus grande priorité est accordée à la mobilisation des eaux superficielles. Les statistiques donnent le chiffre de 65 milliards de m3 comme apport pluviométrique annuel, dont : 46 milliards de m3 s'évaporent ; 15 milliards de m3 ruissellent et 4 milliards de m3 s'infiltrent. Les possibilités de mobilisation en 2010 sont estimées à 4,52 milliards de m3. C'est ainsi que 10 barrages sont déjà achevés et dont la ressource mobilisée est susceptible d'être utilisée pour l'irrigation.

Pour utiliser les ressources en eau et augmenter le potentiel productif agricole le programme de développement de l'irrigation mis en œuvre doit être renforcé pour couvrir une cadence annuelle moyenne de 3000 ha.

Mots-clés : Ressources hydriques, nappes, potentialités, disponibilité, eau de surface, eau souterraine

EWRA 150 La surexploitation des nappes phréatiques du Roussillon : un problème préoccupant

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En région méditerranéenne, les ressources en eau sont peu abondantes et souvent vulnérables. Il semblerait donc logique que l'utilisation de l'eau soit planifiée et réglementée ; c'est le cas, historiquement, des eaux de surface mais cela est rare en ce qui concerne les eaux souterraines. En effet, la réalité met souvent en évidence des pratiques où les besoins de tous ordres sont rapidement satisfaits sans contrainte. Tel est le cas de la plaine du Roussillon où sont prélevés dans les différentes nappes phréatiques, d'importants volumes d'eau par des particuliers, des sociétés privées et des collectivités locales.

Depuis deux décennies, une augmentation des prélèvements, liés notamment à une pression démographique accrue, a pour conséquence une baisse tendancielle du niveau de ces nappes phréatiques et une altération de la qualité des eaux. L'aquifère pliocène est particulièrement affecté par des prélèvements excessifs et le problème est d'autant plus préoccupant que le renouvellement de cette eau ne se réalise que sur une période excessivement longue, de l'ordre de 5000 à 7000 ans. Dans ces conditions, la gestion durable de cette ressource n'est plus assurée. Dans certaines zones, les signes deviennent même alarmants avec la pénétration du biseau salé en bordure du littoral ainsi que la pollution par des nitrates…

Fort heureusement, une prise de conscience a récemment commencé à poindre. À l'automne 2004, a été organisée par le Conseil général des Pyrénées-Orientales, une réunion du 1er Comité départemental de l'eau consacrée à ce problème. Des thèmes de réflexion ont été proposés. La gestion concertée de ces ressources en eau est apparue comme une nécessité. Nul doute que l'application des principes généraux définis par la Directive Cadre Européenne sur l'Eau (2000/60/CE) permettra une meilleure gestion de ces précieuses ressources.

Mots-clés : nappes phréatiques, Méditerranée, Roussillon, pollution, surexploitation, développement soutenable, nitrates, démographie

EWRA 008 Stratégie de la gestion des ressources en eau à Tripoli (Liban)

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La Communauté Urbaine de Tripoli représente plus de 10% de la population du Liban (soit 400 000 habitants). Afin d'éviter une situation de pénurie liée à l'augmentation prévisionnelle de la population et aux besoins des grandes villes, les pouvoirs publics libanais ont souhaité rationaliser la consommation de l'eau. Ils ont confié (pour la première fois au Liban) à ONDEO Liban (filiale du groupe Suez Environnement), le contrat de gestion du service de l'eau de la Communauté Urbaine de Tripoli pour une durée de 4 ans. Les objectifs prioritaires peuvent se résumer en l'amélioration de la distribution d'eau en réduisant les fuites, la garantie d'une qualité constante d'approvisionnement en eau potable et l'assurance d'une gestion clientèle efficace

L'amélioration des infrastructures et une gestion plus rigoureuses sont les priorités recherchées, le prêt de l'Agence Française de Développement devrait permettre : l'extension de la station de traitement des eaux de Bahsas pour un accroissement de sa capacité, la remise en état et l'extension d'une partie des réseaux secondaires et tertiaires, et la réfection des raccordements d'abonnés en eau potable, l'établissement d'un contrat de service et de gestion avec un opérateur privé en appui à l'Office des Eaux de Tripoli, l'appui au ministère libanais de l'Eau et de l'Energie pour la mise en place des réformes institutionnelles dans le secteur de l'eau, comprenant notamment un plan de gestion d'un futur Office du Nord.

Outre ses résultats directs, en quantité et en qualité d'eau potable, et indirects, en termes de santé publique, pour la population de Tripoli, ce projet constituera pour les autorités libanaises une première expérience de régulation du secteur de l'eau. En effet, un audit périodique est prévu, pour s'assurer du respect des engagements contractuels et mesurer les performances faisant l'objet de la rémunération de l'opérateur privé. Deux ans après le démarrage de ce projet ambitieux, un premier bilan dresse les premières réalisations.

Mots-clés : Gestion déléguée, Ressources en eau, Liban, Développement durable.

EWRA 183 La gestion durable des ressources en eau en agriculture

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L'eau est une ressource naturelle de plus en plus rare, elle constitue une partie importante du patrimoine d'une région. Son manque dans les zones arides et semi-arides constitue une des plus grands obstacles devant leur développement. En Algérie qui est un pays situé en zone semi-aride, les ressources en eau deviennent de plus en plus limitées et difficiles à exploiter. Ces ressources sont conditionnées par les précipitations très irrégulières dans le temps et dans l'espace. Elles sont aussi exposées à des risques de pollution de plus en plus importants, ce qui compromet leurs utilisations dans de nombreuses régions du pays.

Le secteur agricole demeure le plus grand consommateur des ressources en eau. Ainsi, l'eau constitue une contrainte majeure et un facteur limitant la production agricole pour 76 % de la superficie agricole utile. La concurrence autour de l'eau existe non pas entre les différents secteurs d'activités socio-économiques mais au sein du secteur agricole lui même. Actuellement, l'eau commence à manquer sérieusement au niveau du secteur agricole, notamment pour les cultures hautement consommatrice d'eau, comme les cultures maraîchères et les cultures arboricoles.

Le présent article vise à présenter l'exploitation et la gestion des ressources naturelles disponibles, plus particulièrement une ressource aussi fragile et vitale qui est l'eau. Nous essaierons de présenter l'attribution des ressources en eau aux différentes cultures du secteur agricole. Les agriculteurs ne réinvestissent plus ou peu dans de nouveaux réseaux d'irrigation. Ils recourent jusqu'à aujourd'hui à des anciennes techniques d'irrigation qui sont caractérisées par des pertes conséquentes en eau. Gérer donc cette situation est devenu de plus en plus pressant pour le pays. Pour ce faire et dans l'optique d'optimiser l'exploitation et la gestion de l'eau en agriculture, l'Etat a mis en place une politique d'irrigation dans le cadre du plan national du développement agricole (PNDA) et qui consiste principalement à utiliser les techniques d'irrigation performante afin d'économiser, utiliser mieux et davantage l'eau. Ceci permettra une utilisation rationnelle et durable de cette ressource naturelle rare et précieuse.

Mots-clés : Ressources en eau, exploitation, gestion, agriculture, durabilité, Algérie.

EWRA 169 Surveillance piézométrique transfrontière : le système aquifère du Sahara Septentrional

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Le Système Aquifère du Sahara Septentrional (SASS) est partagé entre trois pays : l'Algérie, la Tunisie et la Libye. Il recouvre une étendue de plus de un million de km2 dont 70% se trouvent en Algérie, 6% en Tunisie, et 24% en Libye. Le SASS est la superposition de deux principales couches aquifères profondes : a) la formation du Continental Intercalaire (CI), la plus profonde, et b) celle du Complexe Terminal (CT). Au cours de la réalisation de l'étude du SASS par l'Observatoire du Sahara et du Sahel, et en collaboration avec les Directions des Ressources en Eau des trois pays, une Base de Données (BD) a été mise en place.

Cette BD comporte 7600 forages dont 2761 présentant une valeur de niveau piézométrique correspondant aux nappes du CI ou du CT. La particularité du SASS tient au fait que l'on n'y dispose pas d'un véritable réseau piézométrique, mais d'un ensemble d'informations piézométriques disparates. On s'emploie alors, par un ensemble de critères, d'opérations de critiques, de regroupements et de filtrages, à organiser et à identifier un réseau de référence. En prenant en considération le critère d'au moins de deux mesures de niveaux piézométriques, le nombre passe à 1069. Par la suite, cette population est soumise à une série de vérifications et de filtres en vue d'éliminer le maximum de données aberrantes. Le résultat final est un réseau constitué de 73 points d'eau.

La répartition spatiale du réseau de référence du SASS est très inégale. Il était donc nécessaire de rationaliser le réseau piézométrique par un certain nombre de procédures destinées à renforcer et à consolider ce réseau, de sorte qu'il puisse répondre aux objectifs poursuivis par la surveillance piézométrique des aquifères sahariens. Les critères de rationalisation utilisés sont relatifs à la couverture spatiale des aquifères, la surveillance des rabattements généralisés, le contrôle des zones à risques, la couverture des conditions aux limites particulières et des zones autorisant une meilleure connaissance du système.

Mots-clés : réseau de surveillance, piézométrie, Sahara, rationalisation.

EWRA 217 Contribution au dimensionnement et à la fiabilité d'un bassin de dissipation

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Le dissipateur d'énergie est un ouvrage primordial et très important dans l'exploitation d'un barrage, il permet de régulariser les crues et de dissiper l'énergie potentielle créée par ce dernier afin de préserver un impact positif.

La conception, le dimensionnement et l'exploitation doivent obéir à plusieurs facteurs tels que l'aspect technico-économique de l'ouvrage, la dissipation d'énergie, la protection de l'environnement (inondation et érosion, préservation de la flore et de la faune aquatiques).Le bon dimensionnement du bassin de dissipation a un impact important sur l'exploitation du barrage, sa fiabilité et la sécurité de l'aménagement hydraulique.

Son dimensionnement dépend de plusieurs paramètres liés à l'hydrologie, l'hydraulique, la topographie du site et aux conditions en aval imposées par les règles de protection de l'environnement Actuellement, les méthodes de dimensionnement existantes sont partielles, laborieuses, lentes, indirectes et procèdent par itérations successives, ce qui les rend moins formelles et souvent non adaptées à l'objectif assigné par la réalité du terrain. Cette contribution a permis l'élaboration d'une méthode simple, expéditive et rapide, prenant en considération les différents paramètres d'un bassin de dissipation avec les différentes contraintes imposées. La vérification des résultats obtenus par leur comparaison à des données pratiques confirme la validité de la méthode proposée.

Mots-clés : Bassin de dissipation, ressaut hydraulique , bassin d'amortissement, ouvrages hydrauliques.

EWRA 051 Accroissement des ressources en eau par la recharge artificielle des nappes aquifères ... : cas de la nappe alluviale Ain-Chabro _ Tébessa ...

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Actuellement, les ressources en eau souterraines sont limitées dans la région de Tébessa. Evidem ment, cette situation est le résultat d'une période de sécheresse très longue ces dernières années. Devant la gravite de cette situation, qui intervient dans un temps ou les besoins en eau sont en augmentation continu, il est important de mettre en place une politique, qui permettrait d'accroître nos ressources en eau. Cette dernière, doit reposer d'une part, sur la protection des ressources existantes, et sur la recharge artificielle des nappes aquifères existantes d'autre part. La réalimentation artificielle des nappes souterraines, consiste à introduire de l'eau dans une formation perméable, par l'intermédiaire d'un dispositif aménagé cet effet. Cette nouvelle technique a donné des résultats positifs et très encourageants dans différents pays dans le monde. Pour le cas particulier de la wilaya de Tébessa, la technique est basée sur l'augmentation de l'infiltration efficace du sol, du site en question, par des galeries verticales de profondeur 30 m remplies par des graviers (Diam. 2-5 mm).a travers cette communication, nous allons présenter l'étude de toutes les caractéristiques, hydrologiques et hydrogéologiques de la région concernée par la réalimentation artificielle.

Mots-clés : recharge artificielle, semi arides, filtration, Oued Bouakous.

EWRA 038 L'envasement des barrages des régions semi-arides. Quelques exemples Algériens

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En Algérie, dans les régions semi arides, le taux d'érosion spécifique des bassins versants est générale ment très élevé et les quantités transportées sont extrêmement variables suivant les dispositions des bassins versants (les pentes des rives ; l'état de la végétation…).L'importance de l'envasement des barrages est défini par le taux d'érosion, il peut atteindre la valeur de 5000 t/km2.an comme le cas du bassin versant de Oued Agrioum à l'amont du barrage d'Ighil Emda. Ces quantités des sédiments sont transportées par les cours d'eau pendant les crues, variant de 50 à 150 g/l avec des valeurs maximales dépassant même 500 à 600 g/l. Cette forte concentration en particules fines dans les oueds provoque l'apparition des courants de turbidité à l'entrée des retenues en périodes de crues. Cette étude s'est limitée à l'étude de l'envasement les barrages situés dans les zones arides et semi-arides, de l'Algérie. Le choix de ces sites est justifié par leurs fort taux d'envasement annuel et surtout, ils sont menacés de comblement total si, des dispositions de dévasement ne seront pas prises à court terme. Nous examinons un constat sur la problématique de ce phénomène et la formation des courants de turbidité dans les retenues. Nous traitons ensuite, les différentes solutions proposées et les soutirages des courants de turbidité pratiqués au niveau de ces barrages.

Mots-clés : Barrage, aride, envasement, Courant de turbidité, Soutirage.

EWRA 135A

Contribution à l'étude de la variabilité des apports hydriques des lacs collinaires : étude de cas dans la région de Jendouba ...

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Les lacs collinaires, de plus en plus répandus en Tunisie, sont conçus pour satisfaire localement les besoins en eau et contribuer au développement de petits périmètres irrigués. Le dimensionnement de ces ouvrages, en particulier les conditions de remplissage des retenues, est souvent basé sur l'utilisation de formules empiriques permettant d'évaluer les apports liquides provenant des bassins versants correspondants. L'objet de la présente étude étant d'analyser la variabilité du stock d'eau au niveau des retenues en relation avec les objectifs de développement et de vérifier la validité des approches empiriques employées lors de la conception. Pour cela, quatre lacs collinaires ont été retenus pour une période d'observation de sept années.

Les termes du bilan ont été évalués à partir du suivi du taux de remplissage des retenues durant la période d'observation et des informations collectés par enquête auprès des différents exploitants des lacs. Les enregistrements pluviométriques au niveau des stations de la zone d'étude ont été utilisés pour l'estimation de la lame ruisselée et des volumes mensuels des apports liquides en appliquant les formules empiriques adaptées à la région. Les résultats obtenus montrent que les apports liquides au niveau des retenues des lacs collinaires présentent une forte variabilité annuelle et interannuelle illustrant d'une part, la contexte hydrologique de la zone d'étude et d'autre part la dynamique de remplissage et de vidange des retenues. Les apports moyens annuels reconstitués à partir du bilan hydrique ont variés de 66.000m3/an à environ 100.000m3/an durant la période d'observation. Les volumes évaporés représentent en moyenne 15% à 24% des apports moyens annuels et les prélèvements pour les besoins d'irrigation ont atteint 40% à 60% de ces apports.

La comparaison des apports mensuels évalués par la méthode du bilan hydrique et par les formules empiriques montre des écarts relatifs variant selon les retenues de 34% à 136%. L'approche empirique semble surestimer les apports liquides au niveau de ces retenues, des propositions d'ajustement et de sélection des formules employées sont formulées afin d'améliorer la prévision de ces apports.

EWRA 027A — Contribution à la recherche des procédés de traitement des eaux usées

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L'un des problèmes qui préoccupe actuellement la Commune urbaine de Mahajanga concerne l'assainissement de la ville avec la recherche des moyens de traitement et/ou d'élimination des rejets polluants urbains avec les eaux usées domestiques, les eaux usées des industries, des installations à caractère collectif (casernes, hôpitaux, restaurants).

Compte tenu de cette situation, une équipe de chercheurs de la Faculté des Sciences de l'Université de Mahajanga, a pris l'initiative de prendre part à la résolution de ces problèmes en initiant un sous-projet de recherche appliquée sur la « Contribution à la recherche des procédés de traitement des eaux usées de la ville de Mahajanga ».

Mots-clés : traitement, caractérisation, déchet, eaux usées, développement, laboratoire

EWRA 196B — La Zone Atelier Bassin du Rhône (ZABR) : un observatoire ... sur la gestion durable des hydrosystèmes du Rhône

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Rhône Basin Long term environmental research: an multi-disciplinarian observatory for sustainable management of Rhône hydrosystems. In 2000, the C.N.R.S. project " Environment, Life, and Society " proposed the setting up of " workshop zones " or Long Term Ecological Research groups dedicated to develop interdisciplinary research on anthroposystems (complex ecological systems including biophysical components and societies (sociological aspects)).

Located in Lyon, the Rhone Watershed Workshop Zone (Zone Atelier Bassin du Rhône or ZABR) was officially labeled in 2001. It is the result of the mobilization of about 20 teams working in the watershed, and belonging to multiple academic disciplines contributing in studies dealing with water management. The ZABR aims at setting up field sites dedicated to observation and/or experimentation. The ZABR is laying research programs, intending to bring up new and updated data to public decision making when dealing with sustainable management of rivers and watersheds.

The operational target of the Workshop Zone is to provide decision makers with a methodology to better evaluate the effects of watersheds rehabilitation applied to the functioning of hydrosystems, in terms of biodiversity (potential effects of restoration and rehabilitation steps on biodiversity), of sustainability (perennity of the effects of restoration works), and of potential water uses.

Keywords: Multidisciplinary research, Observatory, data

EWRA 135B — Analyse de la variabilite du stock d'eau dans les petites retenues collinaires dans la region du Tell maritime

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La réalisation de petites retenues d'eau au niveau des dépressions collinaires permet la collecte de l'eau de pluie et des ruissellements. L'implantation de ces lacs collinaires correspond à un choix stratégique adopté par la Tunisie afin de mobiliser des ressources hydrauliques naturelles et de répondre aux besoins en eau sans cesse croissants. Ces retenues s'intègrent de façon naturelle dans le paysage et peuvent contribuer au maintien de la population rurale en assurant de réelles possibilités de développement. Cependant, la disponibilité de l'eau en quantité et en qualité suffisantes pour subvenir aux besoins des différents usagers durant toute les périodes de l'année est un élément très important dans la gestion rationnelle de cette ressource. Dans ce sens, la prévision des apports liquides et des stocks d'eau dans les retenues permet de contribuer à une meilleure planification des aménagements en relation avec les ressources disponibles.

L'objet de la présente étude est d'analyser la variabilité du stock d'eau au niveau des retenues en relation avec les besoins potentiels en eau et l'importance des transformations constatées autour des lacs collinaires. Pour cela, sept lacs collinaires ont été sélectionnés dans la région de Bizerte au nord est de la Tunisie pour une période d'observation de sept années. Les stocks d'eau au niveau de ces retenues ont été suivis et relevés au pas de temps mensuel durant la période d'observation. La variabilité du stock d'eau disponible dans les différentes retenues considérées est relativement importante et illustre une irrégularité inter saisonnière liée à la faible superficie des bassins versants et la capacité des retenues.

Par ailleurs, un bilan hydrique établi au niveau de chaque retenue a permis de reconstituer les apports liquides mensuels provenant du ruissellement pluvial. La comparaison de ces apports avec ceux estimés par les formules empiriques habituellement utilisées lors de la conception, montre globalement une bonne concordance entre les valeurs obtenues. Toutefois, les stocks d'eau disponibles dans les lacs durant les différentes périodes de l'année ne semblent pas constituer un facteur limitant au développement d'autres périmètres irrigués dans les zones considérés.

Mots-Clés : Lacs collinaires, apport liquide, stock d'eau, variabilité saisonnière, bilan annuel.

EWRA 185 — Méthodologie analytique de détection de substances pharmaceutiques dans les eaux superficielles et les effluents de stations d'épuration

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Les produits pharmaceutiques et leurs produits de dégradations sont suspectés d'être présents dans l'environnement au niveau d'effluents de stations d'épuration, d'eaux superficielles, de sédiments, et même d'eaux souterraines.

C'est pourquoi, une méthode d'analyse a été mise au point pour l'analyse et l'identification de 17 composés, dont cinq antalgiques, sept médicaments psychotropes, deux hypolipidémiants, deux bêtabloquants et un antiépileptique.

Les techniques de chromatographie en phase liquide et en phase gazeuse ont été couplées à de la spectrométrie de masse en mode tandem et une extraction sur phase solide de ces composés a également été optimisée, à la fois en terme de protocole et en terme de nature de la phase adsorbante ; une concentration d'un facteur 1000 et des rendements de récupération supérieurs à 70% ont ainsi pu être obtenus pour la majorité des molécules étudiées. Les limites de quantification atteintes pour les deux techniques d'analyse sont de l'ordre de la dizaine de ng/L dans l'échantillon.

Il a ainsi été possible d'analyser les rejets de cinq stations d'épuration de la Région Centre. 10 molécules ont y été détectées, dont 2 anti-inflammatoires (kétoprofène et naproxène), un antileptique (carbamazépine) et un psychotrope (zolpidem) à des concentrations de l'ordre du µg/L.

Même sur une vie complète d'exposition à une eau contaminée, la dose thérapeutique journalière n'est pas atteinte. Néanmoins, on ne peut négliger la nécessité d'évaluer les risques à long terme d'une exposition prolongée à des traces de produits pharmaceutiques et de produits de dégradation, notamment pour les organismes aquatiques ainsi que certaines populations à risques comme les enfants, les fœtus et les personnes souffrant de déficiences enzymatiques.

EWRA 211 Tarissement et prévision de l'étiage. Essai de prédétermination des paramètres de modèles conceptuels

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Le retour d'expérience de la sécheresse hydrologique de 2003 a incité de nombreux services gestionnaires à se pourvoir d'outils pour la prévision des étiages. A ce titre, le CEGUM travaille avec l'Agence de l'Eau Rhin-Meuse sur la prévision et la simulation des étiages sévères par une modélisation conceptuelle pluie-débit à court et long terme. Cette recherche fonde la prévision des débits d'étiage sur l'analyse des tarissements. Cette démarche permet, en outre, de limiter les problèmes d'équifinalité afférents à l'assignation empirique de valeurs dans les phases de calage. En effet, la modélisation recourt à l'« optimisation assistée », car elle utilise les valeurs des coefficients de tarissement pour initialiser le paramètre de vidange linéaire des réservoirs d'eau gravitaire. Or, ce paramètre ne peut être calculé de la même façon pour un modèle mensuel et pour un modèle journalier, en raison de la gestion différente des flux et des réservoirs. Nous proposons donc de présenter sur le poster deux méthodes de calcul des coefficients de tarissement pour différencier ces deux pas de temps, et leur utilisation dans les modèles pluie-débit. La première méthode utilise les données moyennes mensuelles pour quantifier la vidange mensuelle des aquifères. La méthode de calcul de la pente de décroissance des débits, à partir du régime des cours d'eau, intègre donc à la fois la pluie et la recharge des nappes. Les coefficients de tarissement peuvent être directement utilisés pour la prévision à long terme. La seconde méthode utilise les hydrogrammes de données journalières à partir desquels sont extraits les phases de tarissement. Un outil d'extraction automatique de toutes les phases de débits décroissants consécutifs non influencés par les pluies a été élaboré. Cet outil produit une statistique des coefficients de tarissement (calculés par la loi de Maillet), et propose également une courbe maîtresse de tarissement. Enfin, la connaissance des coefficients de tarissement aboutit à la proposition d'une méthode de séparation des écoulements dont nous déduisons les coefficients d'écoulement de crue. De la même manière que pour les tarissements, ces coefficients sont intégrés dans le modèle pour estimer l'écoulement de crue. La connaissance des coefficients de tarissement et d'écoulement de crue permet, au final, d'encadrer le paramétrage des modèles.

Mots-clés : étiage, prévision, tarissement, modèle, écoulement de base

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EWRA 207 Une base de données environnementales (Biche : Biologie Chimie Hydrologie pour l'étude des écosystèmes)

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Le CEMAGREF Lyon a développé une base de données environnementales accessibles par Internet (en client-serveur) permettant d'archiver et de consulter en ligne les données d'un bassin, sur plusieurs domaines de recherche différents: l'hydrologie hydraulique, la physico-chimie et la biologie. Le référentiel commun utilisé de la base « BICHE » (Biologie, Chimie Hydrologie Hydraulique pour l'étude des écosystèmes) est celui du bassin versant (ou du cours d'eau) et de la station.

La base permet de consulter en ligne les données sous forme graphique ou d'annuaires et de télécharger les données. Celles-ci peuvent être soit forme de chroniques (données continues), ce qui est le cas des chroniques hydrologiques, soit sous forme de donnée issues de campagnes ponctuelles de prélèvement (cas de la biologie et de la physico-chimie). Cette base sert ensuite aux chercehurs pour étudier le niveau de qualité écologique du cours d'eau.

Une gestion fine des droits d'accès en consultation et administration permet de sécuriser et de personnaliser les accès à la base.

Mots-clés : Base de données environnementales, Internet.

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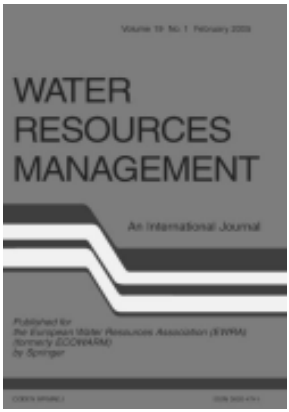

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