Assessing and predicting the effects on water quantity and quality in Iberian rivers caused by global change

SCARCE NEWSLETTER

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Scientific Watch

Presentation of the SCARCE project in the Ebro Hydrographic Confederation

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In June, at the headquarters of the Ebro Hydrographic Confederation (the Ebro River Basin Authority), a presentation of the results obtained until now by the SCARCE Project was held, organized by Concha Durán with the support of SCARCE team (WP9 and WP10). One of the main purposes of the project focuses on addressing the water quality and quantity problems in global change scenarios from different perspectives to give realistic management solutions in Mediterranean river basins. Part of the data used for the research about the Ebro Basin has been provided by the Confederation, so it was interesting to know the results associated.

The conference was inaugurated by the President of the Ebro Hydrographic Confederation (D. Xavier De Pedro) and 20 technicians participated from different areas like the Water Quality Area, the Waste Water Discharge Area, the Office of Hydrological Planning, the Laboratory, the Operating Service and the Control Area of Public Domain. Along the conference it was set out the importance of explaining the hydrological reality in semiarid countries. The measures to fight against the negative consequences of water scarcity in countries with Mediterranean climate are very different

from the ones established in countries with a wet climate. Measures such as the effective management, the need to have regulation systems and a system governed by the principle of basin unity and supported by the water users, are essential for the proper management of water in a horizon of scarcity.

The presentation showed the interest of making detailed studies in specific areas of the basin such as studies of the variation of environmental indicators upstream and downstream of a significant pressure, the study of the relationship of the indicators with different habitats... From the study of these particular cases, clearer and understandable conclusions are obtained. It is a path that can greatly help understanding the impact of measures for improving the water status. Other lines of work focus on modelling studies of sediment traffic in rivers and toxicity indicators. Firstly, it is necessary that the modelling of sediment transport is properly calibrated with data obtained from the bathymetry of reservoirs and experimental basins selected. Regarding the toxicity indicators, little by little more indicators are being developed and it is important that they are established with a great exactitude, which means that the government should have the material and human capacity necessary to control these new indicators, which is not always possible.

Many experiences carried out in the Ebro basin and which generate synergies that lead to an environmental improvement were set in value. This is the case, for example, of the Ebro Delta rice fields, which are producing a significant increase in the number of birds in the Delta or the case of the environmental value of irrigation systems in the Ebro basin, with a very notable development of different species or also recoveries of river brooks. It has also been observed in the Ebro basin that the water regulation caused by dams has led, in many cases, to improve the ecological status with respect to which the river has upstream of the reservoir.

To conclude, the Confederation thanked for the availability of SCARCE team to favour the transference of knowledge, methodologies and results between scientific community and river basin authorities thought this meeting.

Jornadas Internacionales de Sistemas Soporte a la Decisión para la Planificación y Gestión de Recusos Hídricos

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In tune with the WP 9 objectives of putting together science and policy, the Water Resources Engineering Group of the UPV team organised the conference "Jornadas Internacionales de Sistemas Soporte a la Decisión para la Planificación y Gestión de Recusos Hídricos", and an associated course about the Decision Support System (DSS) AQUATOOL. The event started the 18th of June and counted on the invaluable presence of Francisco Mora, Rector of the Technical University of Valencia; Víctor Arqued, General Sub-director of Planning and Sustainable water use; and María Ángeles Ureña, President of the Júcar River Basin District.

During the two-day conference, several representatives of most of the River Basins analysed in SCARCE (i.e.: Llobregat, Ebro, Guadalquivir, and Júcar) gave their points of view about the use of DSS and about the future needs they will face in the next water planning cycle. In the presentation sessions participated: Jesús Galván from the Ebro River Basin District, Antoni Muné from the Catalan Water Agency, and Javier Ferrer and Teodoro Estrela from the Júcar River Basin District. Some of them participated as well in the roundtables about the contributions of DSS to the River Basin Management Plans implementation and about the new challenges and objectives for water planning and management.

The conference also counted on the participation of representatives from the Duero, Tajo, Segura and Guadiana River Basin Districts; from the Spanish Centre of Hydrographic Studies (CEH-CEDEX); from

Valencia, La Coruña, Madrid and Zaragoza Universities; from consulting companies; and from foreign countries namely Ecuador, Mexico, Brazil, Argentina and Perú. In total, more than 60 people attended the conference including technicians from some Spanish River Basin Districts, students, and professors from the Technical University of Valencia.

The DSS AQUATOOL was in the centre of the discussion as a key tool used in the River Basin Management Plans either for the water allocation in normal and drought periods, for water quality modelling, water security assessment, and other applications. Moreover, the UPV team presented the new modules developed for AQUATOOL in order to receive feedback from their potential users.

The main conclusions of the whole conference were that DSS have been essential for more than 30 years and, especially, during the last water planning cycle. Nevertheless, their implementation implied a big effort due to the complexity of the modelled systems and the data treatment. Then, the next water planning cycle will be the time to take real advantage of the quality information that models provide in order to achieve the Water Framework Directive prescriptions, as well as the new suggestions found in the European Commission report entitled "A Blueprint to Safeguard Europe's Water Resources.

Increasing Pesticide concentrations during drought periods in the Spanish River Basins

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During the last decade, the study of contaminants in the environment became of interest for European Union (EU) due to the use of many chemical substances without any control. This has been more evident in agricultural areas because of the frequent use of pesticides. They can be widely dispersed through water runoff from their application areas into the environment affecting not only water, but also sediments and biota. Therefore, our research group, in collaboration with IDAEA, ICRA and ICMAN, has undertaken an extensive pilot survey to sample and evaluate water quality by a monitoring study of 50 currently used pesticides and their transformation products carried out in the Guadalquivir River Basin for 2010 and 2011.

The temporal distribution results showed differences between both sampling campaigns, probably, at least, in the case of the Guadalquivir River related to the river flow. We observed that in 2010 the river presented high flow that caused a dilution effect and an increment of runoff. The pesticides drag to the water and, then, an increasing of the frequency and number of co-occurring pesticides but at low concentrations is observed. On the contrary, 2011 period presented low-medium flow producing a pesticide concentration effect and showing higher levels in water and accumulation in sediments.

This forecasts a hazard in future scenarios if the current situation of the climate change and water scarcity evolves to more critical conditions highlighting the need of these monitoring studies.

Endocrine disrupting compounds can alter reproduction of freshwater snails

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Recent scientific literature indicates a growing interest in environmental contaminants that interfere with the normal endocrine function of aquatic life. Endocrine Disrupting Compounds (EDCs) affect organisms altering the metabolism and effects of hormones and include, among others, natural and synthetic hormones, some pharmaceuticals, alkylphenolic (AP) compounds, some pesticides and bisphenol A (BPA). EDCs enter rivers mainly as a result of the inefficient treatment of estrogenic compounds during sewage treatment and the concentrations are high enough to result in deleterious reproductive consequences. With these points in mind, an *in situ* bioassay was conducted in three Iberian basins (Ebro, Llobregat and Júcar Rivers) to study the effects on the reproduction of the freshwater snail *Physella acuta*. Significant changes in *P. acuta* endpoints were detected in all the rivers: the total number of eggs per snail decreased in the Ebro (Reinosa and Haro) and Llobregat (St. Joan Despí). The complete development of snails was delayed at some sites in the Júcar (Cotes and Alzira) and the Ebro (Haro) basins. These results were contrasted with EDC concentrations and their Estrogenic Equivalent Quotient (EEQ). Positive relationships (Pearson correlation coefficients) were identified between the number of eggs per clutch and the total EDC concentration, BPA and its EEQ, lipid regulators and diuretics. These endocrine-disrupting chemicals constitute a toxicological risk for the reproductive and developmental performance of snails in the studied basins.

Assessing environmental services with stakeholders

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The interface between society and the biophysical environment participates of the complexity of both dimensions. Anticipating future states of socio-ecological relationships without excessively reducing their intrinsic complexity is therefore a challenging task. The Scarce project's Economy work package focuses on the social and economic effects induced by the alteration of ecosystems, as a consequence of global and climate change processes. In close relationship with other Scarce work packages (mainly Processes and Services), the Economy task bases on the ecosystem services (ES) approach. The underlying hypothesis is that changes in climate will affect the well-being of local human populations by modifying the functioning -and even the structure- of aquatic ecosystems, altering so the provision of ecosystem services.

In order to assess the present contribution of aquatic ecosystems to society and to anticipate its possible alteration in the future due to climate change a deliberative scenario approach has been adopted.

After selecting case study areas (Noguera de Tor basin, Anoia basin and Isla Mayor Municipality) and drawing a relevant actors map, the research protocol has been outlined in three steps:

1. Identification and characterisation of water related ES, validated by stakeholders.
2. Stakeholders' future vision of water related ES under two alternative future scenarios and identification of strategic water related ES.
3. Selection of possible measures for the protection of the prioritised water related ES and discussion about the opportunities and drawbacks for their implementation.

First results confirm the usefulness of an ES approach for tackling the complex relationships between society and ecosystems with stakeholders. Furthermore, the research carried out till now can be considered as a solid first step for future refinements and extensions of the ES approach, especially in relation to the application of models carried out by the Services work package.

Visualizing how biomass growth and extracellular polymeric substances (EPS) alter the infiltration path in variable saturated soils

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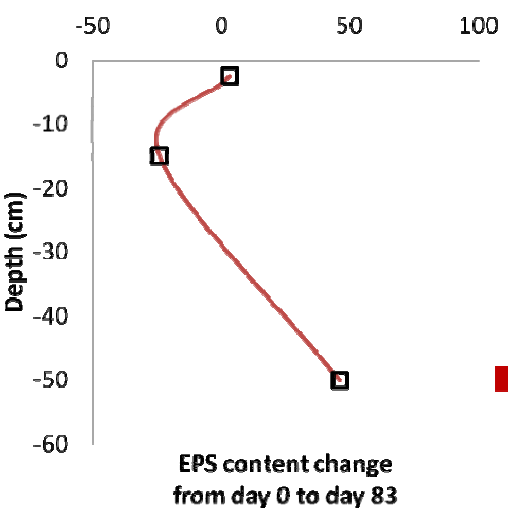
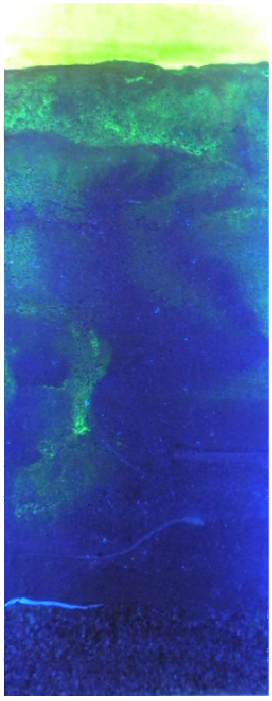
During infiltration from either riverbed or artificial recharge facilities, a wide range of biogeochemical and hydrological processes take place, being directly responsible for water quality and infiltration capacity changes with time. Most of the phenomena occurring in the vadose zone are complex and poorly understood, leading to the need to use simplified models, which neglect the biological component. Our work aims at providing a mathematical description of the processes affecting infiltration that accounts for biological growth and the presence of extracellular polymeric substances (EPS) giving structural integrity to biofilms. The work is based on flow and biochemical data provided by an infiltration test carried on a middle-scale experimental tank where bioclogging and preferential flow paths control the infiltration (see the attached figure).

Conductivity reduction due to bioaccumulation in unsaturated media is a subject of a growing interest because of its complexity and importance. Bacterial growth is a function of many parameters, but the most relevant topics are related to the soil type, substrate supplies and soil moisture. This bacterial growth, being a function of time, ends up affecting the open pore size distribution and thus, modifying the flow path section (shape and thickness) in many ways. Among others, available porosity is modified by the progressive presence of EP substances at different

depths and the associated respiration (creation of biogenic air bubbles) and osmotic processes related to changes in substrate supply (and the corresponding changes in volumetric biomass content due to swell/shrinking processes).





Red arrow indicates zone with greater EPS at day 83. In the same zone higher water holding capacity was measured

SCARCE Activities

Dissemination activities

One of the most important activities that have taken place during the last months in the frame of SCARCE project has been the celebration of direct meetings with two different river basin managers:

- Workshop at the Ebro Hydrographic Confederation (20th June 2013)
- Workshop at the Basque Water Agency (21st June 2013)

While the international conferences that take place one a year are devoted to scientific public and, although river basin managers are also present, the interaction between scientists and managers is limited, these meetings are organised in the water manager's facilities with a representation of all the disciplines present in the project and meant to bridge science and management practise through a management and regulatory oriented language. Both workshops organised during June 2013 have been very helpful as a tool to fill communication gaps between scientists and water managers. More details about the workshop celebrated in the Ebro Hydrographic Confederation from the view of the water managers are included in the first article of this newsletter.

Publications

Since the start of the project, each of the participants of SCARCE has published its scientific results in peer reviewed journals with a total of more than 150 papers. Among them there is an increasing percentage of collaborations between different disciplines, accomplishing in this way one of the initial objectives of the project: obtaining an integrated view of the river ecosystem through the simultaneous study of the threats present in Iberian river basins under different perspectives. Some examples are:

- ARISTI, I. DÍEZ, J.R., LARRAÑAGA, A., NAVARRO-ORTEGA, A., BARCELÓ, D. and ELOSEGI, A. Assessing the effects of multiple stressors on the functioning of Mediterranean rivers using poplar wood breakdown. Science of the Total Environment, 440 (2012), 272-279
- GUILLÉN, D., GINEBREDA, A., FARRÉ, M., DARBRA, R.M., PETROVIC, M., GROS, M. and BARCELÓ, D. Prioritization of chemicals in the aquatic environment based on risk assessment:

Analytical, modeling and regulatory perspective. Science of the Total Environment, 440 (2012), 236-252

- OSORIO, V., MARCÉ, R., PÉREZ, S., GINEBREDA, A., CORTINA J.L. and BARCELÓ, D. Occurrence and modeling of pharmaceuticals on a sewage-impacted Mediterranean river and their dynamics under different hydrological conditions. Science of the Total Environment, 440 (2012), 3–13
- ACUÑA, V., DÍEZ, J.R., FLORES, L., MELEASON, M. and ELOSEGI, A. Does it make economic sense to restore rivers for their ecosystem services? Journal of Applied Ecology, 50 (2013), 988-997
- Pulido-Velazquez, M., Alvarez-Mendiola, E., Andreu, J., in press. Design of efficient water pricing policies integrating basinwide resource opportunity costs. Journal of Water Resources Planning and Management. Posted ahead of print August 17, 2012. DOI10.1061/(ASCE)WR.1943-5452.0000262
- ELOSEGI, A. and SABATER, S. Effects of hydromorphological impacts on river ecosystem functioning: a review and suggestions for assessing ecological impacts. Hydrobiologia, 712 (2013), 129-143
- ARTIGAS, J., GARCÍA-BERTHOU, E., BAUER, D.E., CASTRO, M.I., COCHERO, J., COLAUTTI, D.C., CORTELEZZI, A., DONATO, J.C., ELOSEGI, A., FEIJOÓ, C., GIORGI, A., GÓMEZ, N., LEGGIERI, L., MUÑOZ, I., RODRIGUES-CAPÍTULO, A., ROMANÍ, A.M. and SABATER, S. Global pressures, specific responses: effects of nutrient enrichment in streams from different biomes. Environmental Research Letters 8(2013), 014002

Another success of the project, considering the diffusion of the scientific results, is the publication of special issues in international journals associated to the conferences celebrated each year. After the 1st SCARCE special issue published in Environmental Science and Pollution research (19, 915-1042, May 2012) and the 2nd SCARCE special issue published in Science of the Total Environment (440, 1-320, December 2012), which include selected works from the 1st and 2nd SCARCE International Conference, we are preparing the third special issue that will be released during the last months of 2013 in the Journal of Hazardous Materials. Under the title **"Stressors in Mediterranean River Basins under Water Scarcity"**, the third SCARCE Special Issue devoted to the 3rd SCARCE International Conference will focus on improving our understanding of the hazards and risks that certain materials pose to human being and the environment as well as on dealing with ways of controlling these hazards and associated risks. The contributions, some of which are already accepted, are focused on characterization of the harmful effects of chemicals, measurement and monitoring of hazardous materials, transport and fate of stressors in environment, risk assessment and management, physico-chemical and separation processes as well as biological processes. This broad scope is limited by the area of application "Mediterranean River Basins" and the forthcoming and dangerous situation "water scarcity".

Forthcoming Events

4th SCARCE International Conference: Towards a better understanding of the links between stressors, hazard assessment and ecosystem services under water scarcity

25-26 November 2013, Cádiz, Spain

- More information at www.scarceconsolider.es

Advanced Course on Ecosystem Services

18-19 November 2013, Tarragona, Spain

- More information at www.scarceconsolider.es

>>>>>>>>> Contributing to the Newsletter

If you wish to contribute to a future issue of the Newsletter or announce a forthcoming event, please contact: alicia.navarro@idaea.csic.es