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PROJECT NEWSLETTER

GLOBAQUA

N° 5 - August 2016

GLOBAQUA is a EU-funded project aiming to identify the prevalence of, and interaction between, stressors under water scarcity in order to improve knowledge of relationships between multiple stressors and to improve water management practices and policies. To have more information please visit www.globaqua-project.eu

▶ We are halfway...time to take stock!

It is now the end of July 2016, and we are half way through the GLOBAQUA project. For this reason, it is the right time to recap the main achievements and to move forward with renewed motivation. When doing research, data gathering is a crucial point and in GLOBAQUA we collected historical data relative to hydrology and climate, implementing an interactive internet platform (Water-Hub) to connect existing databases of potential relevance to GLOBAQUA. We worked hard on case studies modelling: baseline scenarios describing the current conditions in each case study were defined and we worked on future climate change and land use change (with iCLUE model). Existing hydrological and geochemical data were analysed and hydrological modelling tools identified for each study case. We also set-up and preliminarily calibrated hydrological models that will be used to upscale the results to a pan-European scale. Sediment/pollutant related stressors were identified together with the linking of these to proxies based on land-use, hydrology and climate to account for pressure/stressor relationships. GLOBAQUA includes some field work; in particular 2 general sampling campaigns performed within the Sava, Adige and Evrotas rivers. Samples were analysed. For biological samples we elaborated the first results on the application of species trait response models as well as application of invasiveness indexes to determine the hotspot sites where community diversity changes. Another interesting output which is presented also separately in this newsletter is a toolbox

to measure river ecosystem functioning. The potential impact of the toolbox is large, as it should encourage managers to measure river ecosystem functioning. Also integrative statistical models for ecosystem services at the basin scale have been developed. As to ecosystem services we evaluated them under different socio-economic scenarios that will be used to assess the current levels of recovery of the costs of water services. A benchmarking exercise was defined to help identifying implications of using different models in the integrated assessment framework. This delineates an integrated framework for assessing multiple stressors and designing appropriate management measures. A number of stakeholder workshops were organised in different case study areas to explore the nature of policy implementation, decision making and management strategies of freshwater ecosystems in these areas, addressing the need for European policy to move towards an effective implementation of the European Water Framework Directive.



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Welcome to the new GLOBAQUA website

It is with great pleasure that we announce that the new updated version of the GLOBAQUA website is now online. A new interface has been introduced with a more appealing and user-friendly structure of the contents.

Our efforts aimed to make the platform more engaging especially for the general public and policy makers. Indeed, through the new platform it is now possible to easily gather all regularly updated information on GLOBAQUA with special focus on case studies analyses, results achieved and recent development of the research field in general.

We hope you will enjoy the new experience at www.globaqua-project.eu!



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Key outcomes of the 1st GLOBAQUA conference

The 1st GLOBAQUA International Conference has been organized by the Ludwig-Maximilians Universität (München, Germany) and the Institute of Environmental Assessment and Water Research of the Spanish Council for Scientific Research (IDAEA-CSIC) under the title "Managing the effects of multiple stressors on aquatic ecosystems under water scarcity". The conference has been held at the Kardinal-Döpfner-Haus, an educational centre in Freising, Germany on 11-12 January 2016.

This interdisciplinary conference was a platform for exchange and discussion of innovative scientific findings and methods in aquatic ecosystems research. It focused on novel methods of environmental monitoring and modeling of various scopes, scales and structural complexity to improve process understanding in the interconnectivity and feedback mechanisms of climate (regional), land use (regional), economy, hydrology and hydraulics (catchment and river), water quality (river), biology and aquatic ecosystems (reach scale). Further, the conference built the bridge to the scientific assessment of implications on policy and management.

A group of 86 participants, including scientists and managers, coming from 35 different institutions from 13 different countries attended the event. Among these participants, some were also members of MARS and SOLUTIONS projects and around 30% were PhD students.

The programme followed the module structure of the GLOBAQUA project in order to include all the topics that the project deals with. It was structured in four sessions: STRESSORS, RECEPTORS, IMPLICATIONS and MANAGEMENT & POLICY. The meeting included one keynote lecture

given by Manuel Rodríguez-Pinzon (Université Laval, Ville de Québec, Canada) on "Temporal variability of surface water quality: Implications for the management of drinking water". Each of the 4 sessions included one invited oral presentation and 7 regular oral presentations as well as a number of posters. Among all of the abstracts received, the most interesting and varied ones were selected as oral presentations and the rest were accepted as poster presentations. In total the programme included 33 oral presentations and 33 poster presentations. Each of the poster authors had also the opportunity to present their work to the entire audience.

The 1st GLOBAQUA International Conference succeeded in bringing together an interdisciplinary audience including both members and non-members of the project. There were interesting discussions after some of the oral presentations as well as during the poster platform, facilitated by the introduction to the posters performed by the main author. Some interaction also occurred with other projects like MARS and SOLUTIONS that will be increased by the organization of common activities in the future.



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Short Course on Rapid Screening of Aquatic Organic Pollution and Toxicity Using Bioassays and Biosensors

This course was held at the Department of Environmental Chemistry of IDAEA-CSIC (Barcelona, Spain) on 26-27 November 2016 and it was tailored for PhD students, master students and postdoc researchers in chemistry and environmental sciences. The focus of the course was the development and application of biological techniques of analysis for the rapid detection of organic contaminants or their effects. In this course, special attention was devoted to immuno-analytical techniques, miniaturized and remote unmanned operating systems, as well as ecotoxicological approaches to evaluate the effects of toxic mixtures. Practical sessions were organized to show relevant aspects of the above-mentioned approaches.

Six lecturers were invited and 23 participants from 10 different Institutions attended the course. Approximately 50% of the participants were not members of the project, showing the great interest of this topic among the scientific community.

The course combined theoretical sessions in which the students learnt the basis of a number of biological techniques of analysis for the rapid detection of organic contaminants and practical sessions in which these techniques were applied to real samples. The students showed high interest on the topics included in the course as well as on the practical sessions. The content and development of the course completely fulfilled the expectations of both lecturers and students.



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GLOBAQUA Technical Workshop: stressors/receptors & integration & scenarios

During the Module meeting held on 18-20 November 2015, the GLOBAQUA team presented a modelling & integration framework which addresses a suitable theoretical framework for integration. This work was based on presentations of previously performed work in GARBs (GLOBAQUA river basins) as well as methodological approaches. The most important stressors identified are: water scarcity, urban and agricultural pollutants as well as COD, BOD and nutrients and changes in hydrological dynamics, and partly also alien species. These stressors are expressed in the GARBs and are adequately addressed by field investigations/experiments. Multi-stress is expressed in all catchments. To solve the questions on how the identified stressors may be related to the pressures in particular to biological and ecological responses, a scheme

for integrated assessment was developed according to the ideas and instructions given by the European Water Framework Directive: Stressor/pressure/response relationships in GLOBAQUA will finally be tackled by thinking from the endpoint of the "ecological status". A corresponding modelling & integration framework was presented and discussed and suitable criteria and indicators for the selection and evaluation of GLOBAQUA-relevant multi-stress scenarios were defined. All catchment experiments/investigations have been or will be aligned along this framework in the future to come to a common modelling/integration framework. As field investigations and experiments are in general selected according to multi-stress conditions, ecological response might finally be evaluated based on an overall assessment of the results.

In GARB-specific workshops the group tried to link stressors to features that might be input parameters to models (proxies), and looked into possibilities how case studies or specialists' experimental results can be generalized and transferred to other basins and Europe.



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News from Evrotas

In late June 2016, the first pre-drought sampling campaign has been conducted in the Evrotas River, at very low discharge, compared to the 2014 and 2015 campaigns, in order to study the effect of hydrological pressure on pollutants, biodiversity and ecosystem functioning. During the campaign, water and sediment samples were collected from four study reaches, as well as biological material (microbiota, diatoms, macrophytes, macroinvertebrates, and fish). A second pre-drought sampling campaign is planned for September 2016.

In late June 2016, preliminary experiments were performed during day and night hours, in order to explore various processes related to desiccation of intermittent rivers. In particular, field incubation experiments with two types of substrates (sediment, macrophyte-covered pebbles) and water were conducted during day and night. Measurements of dissolved CO₂ were obtained every hour during the 3 hours duration of each incubation, samples were analysed for NH₄ on site, while samples were also collected for nutrient analysis in the lab. Physical-Chemical parameters (Dissolved Oxygen, Salinity, Temperature, TDS etc.) were measured with a sonde at the beginning and end of each incubation. These experiments will be repeated in September 2016.

Future work in the Evrotas also includes a collaborative field experiment with CSIC, ICRA, UPV/EHU, UB that will be conducted in five tributaries of the Evrotas River Basin, studying the combined impact of flow intermittency and point source pollution from olive mill wastewaters on

biota and ecosystem functioning (autumn 2016 to autumn 2017). In addition, event sampling for cost-effective assessment of water quality parameters in multi-stress conditions will be also conducted in Evrotas that will entail water sampling during flood events in Evrotas in autumn – winter 2016/17. Finally, within the framework of the collaboration between GLOBAQUA and the MARS projects, a ArcSWAT hydrological and water quality model of Evrotas developed by C. Gamvroudis (Technical University of Crete) was run and validated for the period 1973-2015 by HCMR scientists. In July 2016, HCMR scientists attended the 1st data treatment workshop for river basin management in Lisbon, Portugal. Next, the HCMR team will proceed to the implementation of the empirical model of Evrotas basin based on the MARS conceptual model.



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News from Ebro

The effects of water contamination get often mixed with those being produced by hydrological pressures, particularly in areas submitted to water scarcity. This being a main goal of the GLOBAQUA project, has received a great attention for the potential consequences in river ecosystems. The Ebro River offers a good place to study these interactive effects in a variety of situations and perspectives. Several PhD studies funded by the GLOBAQUA project are being currently developed, totally or partly, under this setting. The arrival and attenuation of pharmaceutical products (Ladislav Mandaric, ICRA), the effects on invertebrate communities (Jordi René Mor, ICRA-UB), and in ecosystemic processes such as decomposition and metabolism (Olatz Pereda, EHU), and the implications for the antibiotic resistance genes (Jessica Subirats, ICRA) occurring in the rivers, are some of the aspects currently under development. These particular studies add to several other efforts of the GLOBAQUA consortium in the area, particularly in further biological (UB) and chemical analyses (IDAEA-CSIC), and modelling (LMU, UFZ, ICRA, JRC).

A number of streams have been selected along gradients of hydrological pressure and urban pollution. In all of the cases, and with the aim to measure the magnitude of impact in the environmental and biological descriptors, an upper location has been designed as “control”, and the other receiving the effluent has been named as “impact”. The impact reaches receive waste water treatment plant (WWTP) effluents, but also in some cases may receive directly untreated urban effluents. The study is being conducted in small tributaries of the Lower Ebro Basin during 2015 and 2016. Preliminary results indicate that the two main gradients produce complex outputs in the systems. A much higher concentration of pharmaceutical products and ARGs occur in the sites receiving untreated inputs, and produce relevant effects on the composition and biomass of macroinvertebrate communities, on the organic matter decomposition, on the potential alteration in the phosphate uptake capacity by biofilms, and in the whole-stream metabolism in the two reaches. Integrative conclusions from these studies can hopefully be assembled in coming periods.



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News from Anglian

In the UK, in order to support river basin management, a number of pilot catchment initiatives were undertaken to identify elements of good practice needed for Water Framework Directive (WFD) activities. The pilot and evaluation phase concluded in March 2013, and gave some indication of how catchment level collaboration can better inform river basin district planning.¹ In light of this, the Broadland Rivers catchment (Anglian Region) was selected as a case study for GLOBAQUA. Project activities focused on reviewing the ongoing WFD implementation efforts, and investigating some of the concerns raised by the Commission. Preliminary findings highlighted some of the implementation challenges that could be addressed by GLOBAQUA.

Monitoring data collected between 2009 and 2014 were reviewed to provide insights on the effectiveness of the first WFD cycle. Misunderstandings with the Directive's systemic nature were identified as the underlying cause of the limited progress towards achieving the WFD's good status objective.

In addition, collating data on valuation of ecosystem services (ES) aimed to support a conceptual framework that better accounts for ES in the implementation process. In collaboration with the Broadland Catchment Partnership, and coordinated by Imperial, ALTERRA and TNO, a stakeholder workshop took place in November 2015. It aimed to identify ES and improve the understating of catchment interactions. By creating links between the activities ("what we do") and ES ("what we value"), a framework for understanding catchment

interdependencies was piloted (Figure 1).

A collective view of the catchment emerged enabling stakeholders to see the many catchment interactions as interdependencies.

This work has contributed to the region's policy needs, enabling GLOBAQUA to contribute to the improvement of water policies and practices in better alignment with the WFD.



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Figure 1. Participatory framework for understanding system interactions



¹ As required under the Water Framework Directive in the UK, the Natural Resource Protection

News from Adige

During 2015 two sampling campaigns were conducted in seven selected sites within the Adige catchment, including two glaciers, Careser and Presena both located within the Noce catchment, one of the main tributaries of the Adige river. The first sampling campaign was conducted in February and the second in July under low and high flow conditions, respectively. The objective of this activity is to investigate the relevance of emerging pollutants in the Alpine region, identifying areas where water quality is the main stressor for the ecosystem and the role played by dilution and natural attenuation processes in reducing the impact of pollutants on the ecosystem.

For each selected site, physical and chemical parameters were measured and water and sediment samples were collected in order to perform analyses of POPs, pesticides, emerging pollutants, ELISA, PFC, PCP, photo degradability and nitrates. All of the sites show a significant presence of pharmaceuticals in both the two sampling periods and in

particular Tonale pass downstream the Waste Water Treatment Plant serving a large ski area: the most significant category is Analgesics/anti-inflammatories both in water (range of 112.5–674.6 ng/l) and sediment samples (range of 14.5–26.43 ng/g). Along the main river stem antidepressive, such as Valsartan (maximum concentration of 344 ng/l near Trento), were found in concentrations higher than Analgesics/anti-inflammatories (Diclofenac concentration of 154 ng/l near Trento) during the winter sampling campaign. In summer, high water discharge due to snowmelt greatly reduces the concentration of pharmaceuticals. The highest concentrations of Personal Care products (UV filters: UV328, UV329 and ODPABA) were detected in the lower course of the Noce river, downstream the Santa Giustina reservoir. The next step is to model the fate and interaction of these compounds with the riverine environment.



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The GLOBAQUA toolbox: a comprehensive compilation of methods to measure river ecosystem functioning

River ecosystems are subject to multiple stressors that affect their structure and functioning. River ecosystem structure refers to characteristics such as channel form, water quality or the composition of biological communities, whereas ecosystem functioning refers to processes such as nutrient cycling, organic matter decomposition or secondary production. Nowadays there is much more information on structural than functional characteristics, and despite the many methods available to measure river functional properties, only structural ones are routinely used by river managers. Although structure and functioning influence each other, their relationship is not straightforward and often one cannot be automatically inferred from the other. Furthermore, environmental stressors can affect structure and functioning in

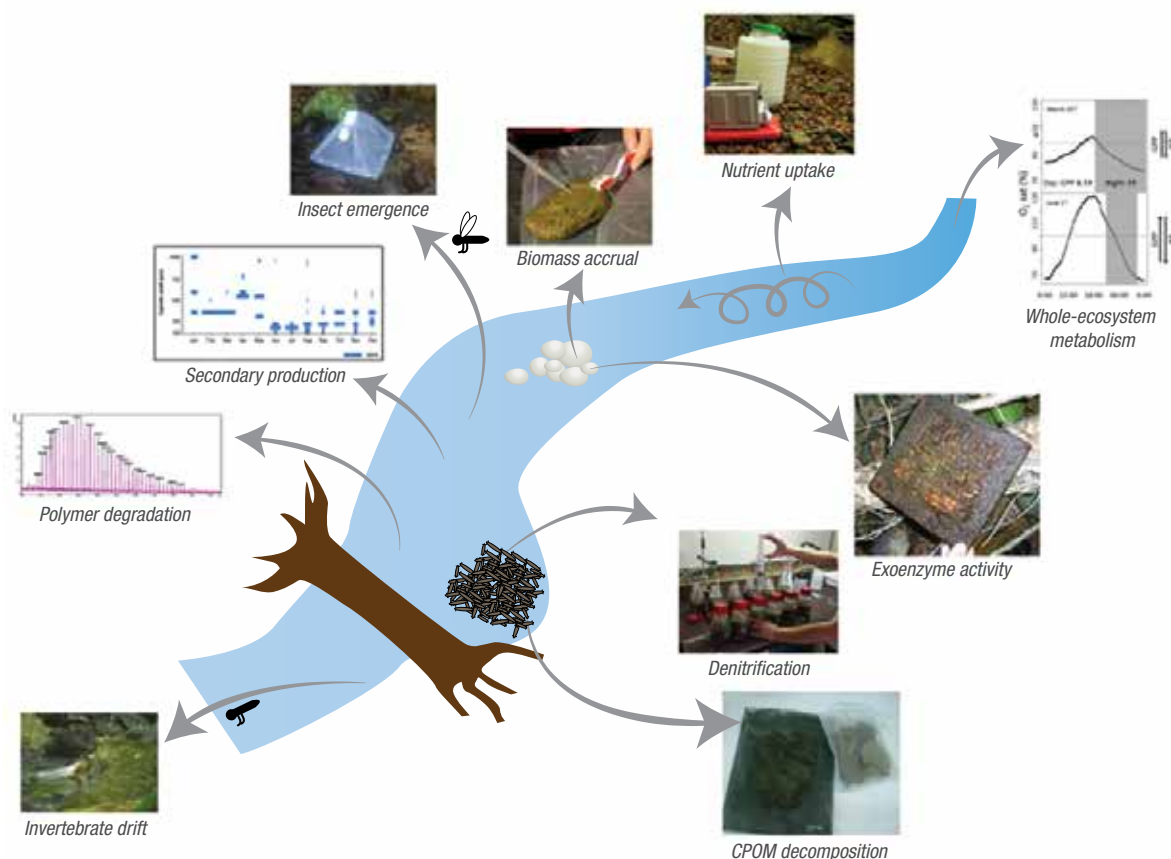
contrasting ways. Thus, lack of development and implementation of tools to measure ecosystem functioning prevents the complete assessment and understanding of river ecosystems and the services they provide.

The GLOBAQUA toolbox consists on a critical and synthetic compilation of methods to measure ecosystem functioning in rivers, which can be adapted to different objectives, situations, budgets and levels of expertise. The toolbox includes a description of the main characteristics of each method, the aspects of the ecosystem they address, the environmental stressors they are sensitive to, possible difficulties in their implementation, as well as their general advantages and disadvantages. Current limitations, potential improvements and future steps in the development of the toolbox are also discussed.

The toolbox is tailored for scientists as well as for routine monitoring by water managers. Our ultimate purpose is to contribute to a more functional perspective in river research and management. The toolbox is openly available on the internet (<http://www.globaquaproject.eu/en/content/Toolbox.50>) and will be updated continuously through the inputs of GLOBAQUA researchers and other contributors.



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Recent publications

Module 1 ■ STRESSORS

Does streambed heterogeneity matter for hyporheic residence time distribution in sand-bedded streams? - Tonina et al., *Advances in Water Resources* 96, 120–126.

Application of the Water Pollution Index in the Assessment of the Ecological Status of Rivers: a Case Study of the Sava River, Serbia - Popović et al., *Acta Zoologica Bulgarica* 68, 97–102.

Optimization of the procedure for efficient dispersion of titanium dioxide nanoparticles in aqueous samples - Vidmar et al., *Analytical Methods* 8, 1194–1201.

MALDI-TOF MS Imaging evidences spatial differences in the degradation of solid polycaprolactone diol in water under aerobic and denitrifying conditions - Rivas et al., *Science of the Total Environment* 566, 27–33.

Using total suspended solids (TSS) and turbidity as proxies for evaluation of metal transport in river water - Nasrabadi et al., *Applied Geochemistry* 68, 1–9.

Selecting regional climate scenarios for impact modelling studies - Renate et al., *Environmental Modelling & Software* 78, 191–201.

Pesticides in the Ebro River basin: Occurrence and risk assessment - Ccanccapaa et al., *Environmental Pollution* 211, 414–424.

Flooding modifies the genotoxic effects of pollution on a worm, a mussel and two fish species from the Sava River - Aborgiba et al., *Science of the Total Environment* 540, 358–367.

A review of hydrological and chemical stressors in the Adige catchment and its ecological status - Chiogna et al., *Science of the Total Environment* 540, 429–443.

A high-precision sampling scheme to assess persistence and transport characteristics of micropollutants in rivers - Schwientek et al., *Science of the Total Environment* 540, 444–454.

Hydrological conditions control in situ DOM retention and release along a Mediterranean river - Butturini et al., *Water Research* 99, 33–45.

Module 2 ■ RECEPTORS

The Alburnus benthopelagic fish species of the Western Balkan Peninsula: An assessment of their sustainable use - Simić et al., *Science of the Total Environment* 540, 410–417.

Nutrients versus emerging contaminants - or a dynamic march between subsidy and stress effects on stream biofilms - Aristi et al., *Environmental Pollution* 212, 208–215.

Haplotype variation in the *Physa acuta* group (Basommatophora): genetic diversity and distribution in Serbia - Raković et al., *Mediterranean Marine Science* 17, 292–301.

Shared effects of organic microcontaminants and environmental stressors on biofilms and invertebrates in impaired rivers - Sabater et al., *Environmental Pollution* 210, 303–314.

Ecotoxicity of sediments in rivers: invertebrate community, toxicity bioassays and the Toxic Unit approach as complementary assessment tools. *Science of the Total Environment* - de Castro-Català et al., *Science of the Total Environment* 540, 297–306.

Stream Biofilm Responses to Flow Intermittency: From Cells to Ecosystems - Sabater et al., *Frontiers in Environmental Science* 4, 14.

Synthesising the trait information of European Chironomidae (Insecta: Diptera): Towards a new database - Serra et al., *Ecological Indicators* 61, 282–292.

Module 3 ■ IMPLICATIONS

Biochemical indicators and biomarkers in chub (*Squalius cephalus* L.) from the Sava River - Mihailović et al., *Science of the Total Environment* 540, 368–376.

Integrating ecosystem services in river basin management plans - Terrado et al., *Journal of Applied Ecology* 53, 865–875.

Module 4 ■ ENVIRONMENTAL MANAGEMENT

Development of an integrated methodology for the sustainable environmental and socio-economic management of river ecosystems - Koundouri et al., *Science of the Total Environment* 540, 90–100.

This is a selection of the articles published in 2016, these ones and much more can be downloaded at www.globaqua-project.eu





SAVE THE DATE

10-13 October 2016

Globaqua training course on the use of stable isotopes in investigations of hydrological processes and climate change

The course will be organized in Ljubljana (Slovenia) by Jožef Stefan Institute (JSI) within the framework of GLOBAQUA and will introduce the basic principles behind isotopic and chemical tracer modeling. Of all the methods used to model hydrological processes in small watersheds, tracers (isotopic and chemical) have provided the best new insights into the age, origin and pathway of water movement. They are among the few truly integrated measures of watershed function. In addition the training will offer a set of methods and techniques for analysis and monitoring of climate change impacts on riverine systems. Training in field methods, sample preparation, and use of Isotope Ratio Mass Spectrometry (IRMS) will be included. The training course is design for researchers (master, doctoral and postdoctoral level) and other scientists interested in the use of stable isotopes and other tracers in hydrological studies.



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Forthcoming events

- **DIOXIN 2016** - 36th International Symposium on Halogenated Persistent Organic Pollutants
28 August - 2 September 2016, Florence, Italy.
www.dioxin2016firenze.org
- **ICRAPHE** - 1st International conference on risk assessment of pharmaceuticals in the environment
8 - 9 September 2016, Paris, France.
www.icraphe.com
- **NET-SCARCE International Conference** - Rivers under water scarcity: Threats and Challenges
15 - 16 November 2016, Barcelona, Spain.
www.scarceconsolider.es
- **Stakeholders Infoday** - Responding to Societal Challenges through Nature and Cultural Heritage based solutions
8 December 2016 Brussels, Belgium.
www.ec.europa.eu/research
- **International Symposium** - The effects of global change on floods, fluvial geomorphology and related hazards in mountainous rivers
6 - 8 March 2017, Potsdam, Germany.
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- **IASWS 2017** - 14th International Symposium on the Interactions between Sediments and Water
21 - 26 May 2017, Taormina, Italy.
www.iasws2017.altervista.org

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