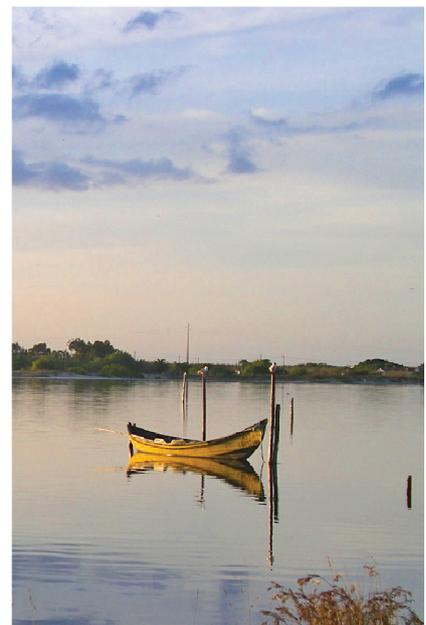


TWAM 2013

International Conference & Workshops

Transboundary water management
across borders and interfaces
present and future challenges



16 - 20th March 2013
Aveiro - Portugal

Book of abstracts

Book of abstracts
TWAM2013 International Conference & Workshops
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- Please note that this Book of Abstracts includes all abstracts that were accepted for TWAM2013 International Conference & Workshops. Not all abstracts will be presented at the conference.



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TWAM 2013

Aims and Scope

Transboundary water management across borders and interfaces:
present and future challenges

Rationale: Terrestrial, freshwater and marine ecosystems are linked through a number of bio-geo-chemical as well as socio-economic and political-institutional processes that are, in turn, affected by pressures from globalisation, climate change/variability, population growth, economic development, resource depletion, pollution and technological progress. These linkages constitute a host of mutual benefits as well as a range of negative impacts and hazards, potentially leading to tensions, conflicts and welfare losses. The application of non-systemic and isolated approaches in watershed, coastal or marine management issues, their limited community and stakeholder integration as well as their deficient inter-institutional and multi-sector coordination efforts to develop and implement holistic intervention strategies, has led to inefficient approaches for tackling the socio-environmental problems that are faced by socio-ecological systems at the land-freshwater-sea interface.

Challenge: A core challenge lies in the provision of research support aiming at risk reduction from environmental hazards in these socio-ecological systems at the land-freshwater-sea interface, through more sustainable use and management of the natural resources and ecosystem services that sustain economies, societies and human well-being. Based in environmental, social and/or economic sciences, water resources management models, approaches and frameworks have been developed within the research community to cope with the complexity of water resources management issues as to improve its outcomes. These studies generally aim to achieve more holistic sustainable water resources management through integration that most adequately reflects the complex relationships between water, land, ecosystems, capitals, technologies, stakeholders, communities and/or governance systems. Water resources management across social boundaries and/or ecological interfaces in linked terrestrial, freshwater and marine socio-ecological systems poses, however, additional scientific and managerial challenges.

Objective: The overarching objective of the TWAM 2013 International Conference & Workshops is to address these challenges in “Transboundary water resources management across borders and interfaces”, with particular focus on:

1. Water resources modelling
2. Technological and natural solutions
3. Environmental impacts, ecosystems services and values
4. Economic incentives and instruments
5. Water governance, institutions and regulations
6. Stakeholder engagement
7. Planning water resources and land use
8. Integrated assessment and decision support tools

TWAM 2013 aims to bring together researchers as well as practitioners from different scientific areas and professional backgrounds, though with a shared interest in sustainable water resources management across complex socio-ecological systems.





Opening Notes



Peter Roebeling

Message from Peter Roebeling
Chairman of the TWAM2013 International Conference & Workshops

On behalf of the Organizing Committee, we are pleased to welcome you at the TWAM 2013 International Conference & Workshops (<http://ibtwm.web.ua.pt/congress/>), hosted by the Centre for Environmental and Marine Studies (CESAM) & Department of Environment and Planning (DAO) at the University of Aveiro (UA), in collaboration with the Institute of Marine Research (IMAR, University of Coimbra) and the Department of Biological Engineering (DBE, University of Minho).

With over 125 delegates from 20 countries and well 85 over contributions, the Organizing Committee is confident the TWAM 2013 will be a highly successful and internationally renowned event – bringing together researchers and practitioners from a wide range of scientific areas and professional backgrounds, and that have a shared interest in sustainable water resources management across complex socio-ecological systems.

We are grateful for the contribution of the members of the Scientific Committee that have provided excellent and timely feedback on proposed paper and poster contributions. We thank the organizers of the SWAT and Rivers workshops for deploying their in-depth and refreshing views on water resources management across borders and interfaces. We also thank our sponsors for their support.

We would like to thank the keynote speakers for having accepted our invitation to provide keynote lectures in the areas of Water resources modelling for sustainable management, Aquatic ecosystems services, values and valuation, and Institutions and stakeholders in sustainable water resources management policy. We are most thankful to all the delegates participating in and contributing to the quality of the TWAM 2013.

The success of the TWAM 2013 would not have been possible without the sheer and continuous effort of the Organizing Committee. On behalf of the Organizing Committee we welcome you to Aveiro, and wish you a pleasant, inspiring and enlightening stay!

Dr. Peter Cornelis Roebeling

Chair of the TWAM 2013 International Conference & Workshops (<http://ibtwm.web.ua.pt/congress/>)

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Carlos Borrego

Message from Carlos Borrego

Director of the Department of Environment and Planning (DAO)

The Department of Environment and Planning (DAO) is one of the 15 academic departments of the University of Aveiro (UA), and was established in 1978 as one of the key university development areas. Its mission is to provide academic education, basic and applied science, and support to societal needs for the protection of environment. It is also a place for research, where innovative products and solutions are developed to contribute to the advance of environmental science and technology. It is a privileged partner for companies and other national and international organisations, with which the University cooperates in numerous projects and for which it provides important services.

DAO carries out research to understand the complex interactions between human activity and the environment, and how to manage strategic resources (air, water, land, forests, coastal zones, etc.) in a more sustainable manner. Together with other UA departments, DAO provides the scientific basis for the conception, development, implementation and evaluation of policies that promote the greening of human activities and the sustainable management of natural resources.

Also, the Department brings together interdisciplinary teams that work with observations and numerical analyses, and develops the necessary infrastructures to share observations and data. It combines this in-house expertise with its role as a scientific catalyst in order to provide the knowledge base necessary to assess the social, environmental and economic aspects education and science. DAO plays an active role in partnerships within Portugal, the EU, other world areas and global scientific communities, which are a prerequisite for finding sustainable solutions to today's global environmental challenges.

The International Conference TWAM 2013: Transboundary water management across borders and interfaces: present and future challenges has in its main objective one of the most challenging issues, which have been addressed by the DAO's personnel from the beginning. In fact, effective water resources management and development are central to sustainable growth. It is well known that water resources management and water services need to be an integral part of national development plans. With water demands and environmental quality standards growing at a steady pace, a 40% gap between global water demand and supply is expected by 2030 – given a 6-fold increase of population living in water-stressed countries. Climate change impacts on the water cycle are expected to further exacerbate the situation, with variations in river flows, changes in groundwater recharge, more intense floods, and longer droughts. Water quality is also at risk: 90% of all wastewater in developing countries is directly discharged untreated into rivers, lakes or the oceans, and 2.6 billion people do not have access to improved sanitation. About 84% of European citizens identified pollution as the main threat to the water environment.

This shows the timeliness of the Conference and the opportunity to exchange knowledge and ideas. It is our belief that the future of water management lies in its interdisciplinary activities and the transfer of technology across different fields, as the Conference has planned. This interaction will take into account the requirements of the society as a whole and in particular the importance of encouraging wealth creating activities.

Thank you to all concerned for contributing to a successful Conference and having nurtured new ideas regarding this cornerstone of environmental resources: water management!

Prof. Dr. Carlos Borrego
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University of Aveiro (UA)

The University of Aveiro (UA) is one of Portugal's 14 public universities. Founded in 1973, it has grown into a successful, dynamic and competitive institution. Integrated in the community and region, it has a strong research dimension and offers a wide range of educational programmes, from post-secondary vocational to doctoral programmes.

Committed from the start to innovation, quality and the attainment of national and international recognition in the pillars of Education, Research and Cooperation with Society, the UA has built a profile based on sciences and technology and in pioneering areas.

Research is organised through a network of Research Units, covering the areas of: Science and Engineering of Materials; Telecommunications; Environmental and Geo Sciences; Teaching/Educational Sciences; and Organic Chemistry/Agro-food. Research activities are managed on a multi-disciplinary and inter-departmental basis and/or around specific programmes and projects, in order to take advantage of the synergies and articulations between different areas.

Inter-institutional and international cooperation are priorities. Doctoral programmes have been launched together with other universities. In particular, the UA is one of six universities to participate in international doctoral programmes in Marine Biology and Nano-Medicine. It also participates in the programme of collaboration between Portugal and Carnegie Mellon University in the field of ICT. The collaboration with Siemens is an example of the way in which the UA has encouraged both innovation and commercialisation linked to research.

For further information, please consult the UA web-site (<http://www.ua.pt/>).

Centre for Environmental and Marine Studies (CESAM)

The Centre for Environmental and Marine Studies (CESAM) is an interdisciplinary Associated Laboratory that aggregates researchers from six Departments of the University of Aveiro (UA) and one Group from the University of Lisbon. The laboratory facilities, located in these Departments, have all the required equipment to perform research in physical oceanography, marine geology, meteorology, hydrology, analytical & environmental chemistry, atmospheric pollution, genomics, toxicology, ecotoxicology, biodiversity, ecology, and environmental planning and management.

To become one of the foremost research units in its field, CESAM pursues the following objectives:

1. Promote the number and quality of research papers published;
2. Develop an integrated approach towards research, hence contributing to the inter-disciplinarity;
3. Use of cutting edge tools such as bionics, genomics and proteomics as well as environmental-economic and other social science tools, supporting the intersection of the different Research Lines;
4. Strengthening institutional cooperation with other Research Units and Associated Laboratories in themes such as risks, environment, coastal and marine sciences;
5. Extension of networks at national and international levels; and
6. Communication strategies aiming for science dissemination towards scientific culture improvement in society, and targeting the development of an interface platform with public and private sectors.

Since 2005, when CESAM attained the status of Associated Laboratory, the number of PhD members has grown from 65 to 176. By 2011, there were more than 200 PhD students supervised by CESAM researchers and carrying out their experimental work within the Associated Laboratory. In 2011, CESAM's team comprised more than 500 members (including students, fellows, pos-doc researchers and academics).

For further information, please consult the CESAM web-site (<http://www.cesam.ua.pt/>).

Institute of Environment and Development - IDAD

The Institute of Environment and Development (IDAD) is a scientific and technical non-profit organisation and SME established in Aveiro (Portugal), that provides consultancy services in the areas of environment and sustainable development. The Institute works, since its foundation in 1992, in close cooperation with the University of Aveiro (UA) and in particular with the Centre for Environmental and Marine Studies (CESAM). With over 20 years of expertise, the IDAD activities are focused on the development of environmental impact assessment and strategic planning studies as well as on environmental modelling and monitoring activities.

IDAD has a solid experience in the field of Air Quality Modelling to evaluate compliance with ambient air quality standards and to provide relevant information to be used by decision-makers in the assessment of air quality. IDAD has also a valuable expertise in Air Quality Monitoring. IDAD's Laboratory gathers know-how in collecting samples of ambient air (e.g.: dioxins, particles, heavy metals and PAH's), in conducting diverse sampling analysis of waste gas, ambient air and olfactometry and in designing the layout of air quality monitoring programs. The Institute has been on the front row of impact assessment studies in Portugal, gathering a large expertise on the different stages of the Strategic Environmental Assessment and Environmental Impact Assessment processes.

The list of studies of this Institute includes large environmental monitoring programs to control waste incineration units in Portugal, strategic environmental impact studies (such the High-speed railway network in Portugal, the Portuguese Logistic infrastructure plan and the New airport of Lisbon), and environmental policy studies (such as the National Strategic Reference Framework in the fields of environment and risk prevention and the Atmospheric Pollutants Emissions Law).

For further information, please consult the IDAD web-site (<http://www.ua.pt/idad/>).

Aveiro Port - A new generation port

Aveiro Port is the most recent national port infrastructure, it is managed by APA – Administração do Porto de Aveiro, S.A. From this port it is possible to connect multiple destinations and markets: from the centre of Portugal, via A25 or via rail corridor to Spain, where the port of Aveiro offers many comparative advantages for the region north-west of Madrid (Salamanca, Valladolid). The Port of Aveiro it is one of the main Portuguese ports with short sea shipping characteristics, recording an annual traffic of 3.5 million tonnes. Aveiro is a multifunctional port performing a primordial role to the services of its hinterland: ceramics; chemical, viticulture, iron, wood and pulp, agriproducts and building industries. It has been designed among a sustainable strategy it comprises an integrated area from the territorial point of view with the following main facilities:

- 5 Terminals dedicated to different types of segments;
- 2 Terminals dedicated for fishing traffic;
- A highly significant berthing capacity - one of the largest for multipurpose terminals;
- A large embankment area serving the terminals with optimum road accesses;
- A large land reserve for the implementation of the Logistics Platform of Aveiro (included in the National Logistics Plan).

Port of Aveiro has shown considerable dynamism, reflected in an appreciable growth of traffic (annual growth of 1.5%) and from now on aims to increase and diversify the actual traffic. The new focus on flexible logistic solutions will permit its consolidation as a competitive logistical node of the Iberian Peninsula. During 2013 the Maritime access to Aveiro port (bar) will be stabilised to the depth of -13.20 m until June to enable the entrance of bigger ship in order to attract regular container or Roll-on/Roll-off traffic.

For further information, please consult the Aveiro Portweb-site (<http://en.portodeaveiro.pt/>).





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Celeste Coelho (University of Aveiro · Portugal)

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Teresa Fidélis (University of Aveiro · Portugal)



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Peter Roebeling has over 15 years experience in the area of sustainable development, leading several research projects regarding strategic resource use planning and management for environmental improvement, as well as pathways for adoption of sustainable technologies in Oceania, South-East Asia and Latin America. As research scientist, he has lead the development of a range of socio- and environmental-economic approaches that allow for: i) socio, environmental and economic impact assessment, ii) exploration of efficient and sustainable resource use and environmental targets, iii) exploration of spatially efficient technology adoption arrangements that comply with these targets, iv) assessment of (non-) market based instruments and institutional changes that induce change towards these spatial technology adoption arrangements, and v) facilitation and acceleration of sustainable community change using participatory approaches.

Ana Isabel Lillebø (University of Aveiro · Portugal)

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Ana Lillebø is an Assistant Researcher at the Department of Biology & CESAM, University of Aveiro. She holds a PhD in Biology (2001), University of Coimbra. She is a well-established researcher in Coastal Ecosystems, with more than 50 ISI-indexed publications and 14 book chapters. She has research experience in aquatic systems ecology, anthropogenic impacts and environmental chemistry, but also has interests in ecosystem services and integrated coastal management strategies. Presently, she coordinates one EU-FP7 Environment theme project LAGOONS - Integrated water resources and coastal zone management in European lagoons in the context of climate change. She also participates in two other EU-funded research projects (TEAM-Miño: tools for the evaluation, classification, management and environmental education in estuaries, and TPEA - Transboundary Planning in the European Atlantic), and two national research projects.

Andreas Thiel (Humboldt University - Germany)

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Andreas Thiel is Einstein Junior Fellow and temporarily appointed as Professor of Environmental Governance, heading a research group in this topic. He is an economist and spatial planner by training and holds a Ph.D. from Oxford Brookes University, School of the Built Environment. His habilitation addresses the topic: Developing Institutional Economics for the Analysis of Social-ecological Systems. Andreas Thiel's current interests address the way society and individuals organize interaction and interdependence mediated by SES, and their transformation with a specific focus on the drivers of scalar reorganization of natural resource governance in the European Union for the case of water management in Europe.

António Guerreiro de Brito (University of Minho · Portugal)

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António Brito is Environmental Engineer and Assistant Professor at University of Minho, coordinates the water line of the bio4Environment research group, being author/co-author of over 100 international publications concerning resource recovery from wastewater, eutrophication and water resources management. Teacher at graduated courses in environmental engineering areas is board member of the Portuguese Water Partnership, vice-president of the Portuguese Water Resources Association and of the Association Engineers for Development and Humanitarian Assistance. Former President of the North River Basins District (2008-2012), Director of the Land Planning and Water Resources Department in Azores (2000-2002), member of the National Water Council (2007-2012) and President of the College of Environmental Engineering at the portuguese Institute of Engineers (2007-2011).



Bruno Pisani is a Civil Engineer (1997) and has a PhD in Hydrology (2008). He has worked for more than 10 years on research projects regarding the evaluation of water resources by means of hydrologic modeling and GIS.

His scientific research has covered the following areas:

- 1) Assessment of water resources and groundwater recharge, 2) Coupled use of distributed hydrologic models and GIS, 3) Evaluation of the impacts of the climate change, 4) Development of numerical tools for hydrologic studies, and 5) Development of GIS software.



Celeste Coelho is a full professor at the Department of Environment and Planning, University of Aveiro. She has a degree on Geography by the Classical University of Lisbon and a PhD. in Geography at the University of Aberdeen (U.K.) and an Aggregation in Applied Environmental Sciences by the University of Aveiro. She has developed teaching in Urban and Regional Planning and Coastal Sciences, Territorial Planning and Natural and Technological Hazards, at the Universities of Aveiro, of Porto and of Mozambique. She is one of the coordinators of the Doctoral Programme in Territory, Risk and Public Policies, in a partnership between the University of Coimbra, the University of Lisbon and the University of Aveiro. She has a wide experience in participating in EU- and nationally-funded projects, having coordinated (the UAVR team) over 10 (inter-)national during the past 15 years. She is the coordinator of the Integrated Watershed Management group at CESAM (Centre for Environmental and Marine Studies).



Fátima Lopes Alves (Assistant Professor) holds a Ph.D. in Environment Sciences, University of Aveiro, 2006. She has participation in national and EU projects on integrated coastal and marine management and marine pollution, in particular EU LIFE Environment, INTERREG and FP7 projects in Ria de Aveiro. She has also co-coordinated the National Report on EU ICZM Implementation for Environment Ministry (2006 and 2011) and has integrated the national coordinator team for the Portuguese Marine Spatial Planning. Nowadays she coordinates the Coastal Zone Management Plan (center region) and belongs to the international coordination team of Project TPEA - Transboundary Planning in the European Atlantic (funded by DGMare/EU).



Filomena Martins has over 25 years of experience as teacher and researcher in the area of sciences applied to environment. She has been involved in multiple research and consultancy projects, in the fields of Coastal and Marine Planning and Management; Conservation of Natural and Cultural Heritage, Participation and Citizenship, Social Risk Perception and Management, Sustainable Development and Local Agenda 21, both in national and international projects in Europe, Eastern Europe and Latin America.



Francisco Nunes Correia got his Ph. D. in Civil Engineering (Hydrology and Water Resources) at Colorado State University and is currently a Full Professor at IST in Lisbon and President of the Portuguese Water Partnership. Along with his academic career, he was designated for several public positions, notably as Minister of Environment, Spatial Planning and Regional Development (2005 -2009) and President of the National Laboratory of Civil Engineering (2004-2005). He was consultant of water projects of the World Bank in South America and environmental projects in Macao (China). Coordinator of several European research projects, notably EUROWATER and WATER 21. He has extensive professional experience as researcher, teacher, and consultant in the areas of water, environment and regional development. Author or co-author of 9 books and more than 130 articles, chapters and technical reports on those areas.



Iris Bohnet is a Social Ecologist and has over 10 years experience in leading and contributing to a wide range of interdisciplinary and transdisciplinary research projects in the Great Barrier Reef region at a range of scales focussing on sustainable planning and management of tropical land- and sea-scapes. Her research interests include interactions between ecological and social processes in landscapes, planning for future land- and sea-scapes including scenario analyses and visualisation techniques and participatory approaches to planning and landscape management. She is also an Adjunct Senior Lecturer at James Cook University, Australia and a Visiting Scholar at the University of Freiburg, Germany.



Jeff Camkin is a Professor (Water Resource Management) at the Centre of Excellence for Ecohydrology, University of Western Australia, Visiting Professor at the National Laboratory of Civil Engineering, Portugal and one of four Global Ambassadors for the Australian Water Association. He holds tertiary qualifications in science and natural resources law, and has worked in urban and rural water, irrigation, fisheries and other natural resources research, management, policy and governance for the last 20 years. In 2012 Jeff received an Australian Endeavour Executive Award to continue his work developing collaboration between Europe and Australia in water research, education and management.



João Carlos Marques is coordinator of the Marine and Environmental Research Centre research unit (CMA) as well as coordinator of the Wetlands, Transitional Waters and Coastal Marine Ecosystems research line (RL1) at the Institute of Marine Research (IMAR). His domains of specialization cover Biological and Ecological processes in aquatic ecosystems, Environmental quality assessment and management, and Ecological modeling. Current research interests include: i) Communities structure and functioning; ii) Populations biology, dynamics, and production; iii) Pollution and environmental quality assessment; iv) Ecological Indicators; v) Network analysis; vi) Implementation of environmental European Directives; and vii) Ecosystem services.

João Pato is a post-doc researcher at the Social Sciences Institute of the University of Lisbon (ICS-UL) and at the Netherlands Environmental Assessment Agency. He has a degree in Sociology at the Social Sciences and Labour Institute of the University of Lisbon (ISCTE, 2001) and a PhD by the University of Lisbon (ICS-UL, 2008) with a thesis in Social Sciences regarding public water policies in Portugal within a historical perspective (1884-2007). His work looks for interdisciplinary and longitudinal approaches (in an historical perspective) to problems of public policies, with a special focus on articulation between the expression of values and elaboration of politic purposes as well as the various forms through which they tend to materialize in a particular historical moment and political context (institutions, forms of regulation, scientific knowledge and public participation). He is a permanent member of the MAB/UNESCO Portugal Committee since 2005.



João Pedro Nunes has been working for the past 10 years on eco-hydrological modeling for water resources assessment. His expertise includes integrating catchment modeling in wider, trans-compartment modeling frameworks for integrated water resources assessments. These frameworks include “catchment-to-coast” modeling (catchment hydrology, coastal hydrodynamics and coastal ecosystems), surface and groundwater assessments, combined biophysical and socio-economic approaches, and the combination of large-scale catchment modeling with 2-D water quality assessments at water collection points. Other research interests are the role of forests for water-related ecosystem services, and the impacts of fire disturbances and climatic variability/change; and the improvement of models through in-depth field monitoring.



Karl-Heinz Feger is professor of soil science and ecology at Dresden University of Technology (Germany), Faculty of Environmental Sciences. He studied natural sciences in Freiburg (Germany) and Zurich (Switzerland). In 1983 he graduated in hydrology at the Albert-Ludwig-University Freiburg and received his PhD (forest soils and nutrition) in 1986 from the same university. As a research scientist he was involved in several international projects on forest ecosystem research. In 1992 he obtained his professor qualification (Habilitation) at Freiburg University. From 1998 to 2000 he taught soil physics and hydrology at the Hohenheim University (Faculty of Agricultural Sciences) where he also contributed to experimental research in China. In 2000 he was appointed as full professor at the TU Dresden. He is editor-in-chief of the Journal of Plant Nutrition and Soil Science (Wiley-Blackwell). Since 2012 he serves as faculty dean. He is involved in various research activities worldwide.



Kasper Kok is Assistant Professor of the chair group Soil Geography and Landscape of Wageningen University. His main area of expertise is the development of integrated, multi-scale scenarios related to a number of issues including biodiversity, climate mitigation and adaptation, and water. His key interest is in improving (multi-scale) scenario-development methodologies, using qualitative and semi-quantitative methods in a participatory setting. He was Coordinating Lead Author of the Sub-global Scenarios Chapter of Volume 4 of the Millennium Ecosystem Assessment (MA) and is involved in the development of the new IPCC-guided Shared Socio-economic Pathways for the Fifth Assessment Report. He has extensive hands-on experience with the scenario development process in Latin America and across Europe.



Luis Arroja since 2003 is an Associate Professor for Environmental Engineering at the Environmental and Planning Department of the University of Aveiro. He has a Degree in Chemical Engineering from OPorto University, Portugal (1973), and a Ph. D. in Environmental Applied Sciences by the Aveiro University (1994). He has co-ordinated 14 research projects financed by the Portuguese government, 11 applied research projects financed by the industry and participated in more than other 25 research projects. He was guest editor for two books and has more than 15 papers published in international scientific journals and more than 45 works presented at scientific meetings and conferences at national and international level. He also has developed an activity as consultant on the water and wastewater treatment, operation and control of industrial wastewater treatment plants and control of industrial anaerobic reactors, namely in the dairy, slaughterhouses and pulp and paper industrial effluents fields.



Margarita Robaina Alves is a PhD in Economics, Master in Economics of Enterprise and Graduate in Economics at University of Aveiro. Researcher at Research Unit GOVCOPP at University of Aveiro, since 2007. Her main research areas are Energy Economics, Environmental and Natural Resources Economics, Environmental and Energy Policies, General Equilibrium Models. Assistant Professor in the Department of Economics, Management and Industrial Engineering at University of Aveiro since 2011, Lecturer between 2009 and 2011, Invited Lecturer between 2006 and 2009 and Monitor between 2001 and 2006. She taught the courses of Economics, Theory of Economic Growth, Natural Resources and Environmental Economics, Environmental, Coastal and Marine Resources Economics, Microeconomics, Macroeconomics, Advanced Microeconomics, Public Economics, International Economics and Portuguese Economics.



Maria da Conceição Cunha, Civil Engineer, Professor of the Civil Engineering Department – University of Coimbra, holds a Ph.D in Natural Sciences -Water Sciences (University of Louvain – Belgium, 1990). Invited Professor at the École Polytechnique Fédérale de Lausanne, Lausanne for the Master of Advanced Studies in Hydraulic Engineering teaching Water Resources Planning.

She is the principal investigator of some national research projects and integrates the research team of some international research projects. She is senior research member of research center IMAR-CMA, coordinating the HyWaRe research line. Her main research interest regards the application of decision models for water resources systems management and planning.

Her research gave rise to a series of publications on the application of systems analysis to the planning and management of reservoir-dams, surface and aquifer water systems, irrigation systems, water intake and distribution systems, etc.



Maria do Carmo Sobral is a Civil Engineering at Federal University of Pernambuco (UFPE); Master degree at University of Waterloo, Canada; PhD. and Postdoc at Technical University of Berlin, Germany. Associate Professor of Civil Engineering Department at UFPE. Coordinator of Environmental Sciences Commission by Capes. Held several positions at the government administration of the state of Pernambuco. Scientific production in the areas of: environmental planning and management; environmental impact assessment, water resources management and sustainability indicators.



Nelson Abrantes got his PhD degree in Biology sciences in the University of Aveiro in 2007. He is presently a post-doc researcher in the Department of Environment & CESAM (Centre for Environmental and Marine Studies) of the University of Aveiro and in Bioforsk Norwegian Institute for Agricultural and Environmental Research.

His research interests are related with aquatic ecotoxicology, in particular with aspects dealing with the assessment of the impacts of nonpoint sources of pollution (including agriculture, wildfires, urban runoff) on aquatic ecosystems through the use of integrative approaches that comprise modeling, microcosm experiments and in situ bioassays, and its relation with the ecosystem services. Recently, the implications of climate change on ecological and chemical status of water bodies in predominantly agricultural catchments, particularly in vineyard areas, constitute a main research field of interest.



Oswald Marinoni is a decision analysis researcher with CSIRO Ecosystem Sciences in Brisbane, Australia. He is an expert in the field of spatial decision support with a particular interest in multi-criteria analysis, spatial optimisation and their applications within Geographic Information Systems.

Over the last 15 years, he has successfully delivered a variety of projects in both Europe and Australia. Projects include land suitability and risk assessments for mining, industrial planning, urban planning as well as optimisation of portfolios of environmental investments to maximise environmental and conservation benefits. His more recent work includes the development of a system to produce a national map of agricultural profit for Australia as well as the efficiency analysis of agricultural production systems.



Paulo Canelas de Castro. Currently: Associate Professor, Law Faculty, University of Macau; responsible for Jean Monnet Programmes at the University of Macau; Management Committee, European Union Academic Programme-Macau; Board of Directors, Institute of European Studies of Macau; President, European Union Studies Association-Macau; President, European Union Studies Association, Asia-Pacific; Headquarters Member, International Law Association; Member, Water Resources Committee, International Law Association; Lecturer, Academy of International trade and Investment Law. Formerly: Lecturer, Law Faculty, University of Coimbra, Portugal; Visiting Professorship in Brazil, France, Germany; Counsel at the European Court of Justice and the International Court of Justice; Co-rapporteur for the International Law Commission and UNESCO on issues of international water law; Expert legal advisor in an EU-China cooperation programme for reassessing the legal and institutional framework of China related to its water laws and policy.



Petra Hellegers is Professor of the Economics of Water and Climate Change at Wageningen University and is Senior Water Economist at the Agricultural Economics Research Institute (LEI). She carried out research for the International Water Management Institute (IWMI) from 2005-2007, collaborating with the University of Melbourne. She has extensive experience in the economic analysis of water and water allocation issues, nationally and internationally.



Rodrigo Maia is a PhD in Civil Engineering by the Faculty of Engineering of the University of Porto (FEUP). Associate Professor (AP) at FEUP. Affiliate AP at Colorado State University. Vice-President of EWRA (European Water Resources Association) and EU research evaluation expert. Research Project coordinator on: water resources management with emphasis on extreme events; fluid mechanics and its applications to channel flows. Involved in studies and research on international rivers basins, namely of the Iberian Peninsula. Research Group coordinator in several national and international projects, namely FP5, FP6 and FP7 (currently 3) EU Projects. Involved in the creation of a Drought Early Warning Management System for the Portuguese National Water Authority. Currently supervising 4 PhD Thesis and several MSc Thesis. Author/co-author of 6 chapters in books with 80 publications in international periodicals with referee and papers in conference proceedings.



Roy Brouwer is Professor and head of the Department Environmental Economics at the Vrije Universiteit Amsterdam. He combines both practical water policy experience (he was chief economist in the Dutch Water Ministry between 1999 and 2004) and scientific research (he was a researcher at Wageningen University, University of East Anglia, and since 2005 VU University Amsterdam). In 2008 he received a fellowship award from the Australian Government under its Water Research Program to assist in the development of sustainable water conservation strategies under climate change. In 2009 he was appointed Professor of Water Economics under the Dutch National Research Program Living with Water. Between 2007 and 2010 he coordinated the European research project AQUAMONEY, in which he developed guidelines for economic water resource valuation together with 15 European universities and research institutes in support of implementation of the European Water Framework Directive. Since 2012 he is chief editor of the journal Water Resources & Economics.



Stijn Speelman is post-doctoral fellow of the Research Foundation Flanders at the Department of Agricultural Economics, Ghent University, Belgium. His main research interest lies in the socio-economic aspects of human-environment interactions in developing countries. In 2009 he obtained his PhD at Ghent University on decision support for agricultural water management in South Africa. He continues to focus in his work on socio-economic issues related to water management in developing countries in particular studying the impacts of the introduction of economic instruments and the potential of institutional changes.



Teresa Fidelis is Assistant Professor in the Department of Environment and Planning, University of Aveiro, and collaborator in CESAM. She has been responsible for disciplines in the area of Environmental Planning, Assessment and Management in Master Programs in the fields of Environmental Engineering and of Environment and Spatial Planning. It holds a Ph.D. in Applied Environmental Sciences from the University of Aveiro, a "Master of Philosophy in Town and Country Planning" at the University of Manchester, UK and a 5 year degree in Urban and Regional Planning from the University of Aveiro. She is author and co-author of scientific publications on environmental planning and governance. In her scientific work has been devoted to the study of how the decision processes associated to territory incorporate environmental criteria. In her work has also sought to contribute to stronger ties between the academic research and the society through areas associated to environmental and spatial Planning, Environmental Assessment and Local Agenda 21.



Tibor Y. Stigter completed his MSc in Geographical Hydrology in 1997 at the Vrije Universiteit Amsterdam and his PhD in Engineering Sciences (Hydrogeology) in 2005 at the Instituto Superior Técnico (IST), Lisbon. His expertise lies in the fields of groundwater contamination, sustainability and management, where he uses hydrogeological, hydrogeochemical and multivariate geostatistical modeling tools. Since March 2008 he has held a Researcher position at IST, working on groundwater contamination, climate change and sustainability. He coordinated the European CIRCLE-MED project CLIMWAT on the impact of climate change on coastal aquifers and dependent ecosystems and is currently working on the FP7 project ADMICCO - adaptation to climate change in coastal vulnerable cities of Latin-America, as well as in a several national projects. He has published 20 papers in ISI-indexed journals and six peer-reviewed chapters in international books.



General Information

Venue

The TWAM2013 International Conference & Workshops will be held at the University of Aveiro campus, in the “Pedagogical, Scientific and Technological Complex” – see map of the University Campus (nº 23).

Language

English will be the official language of the TWAM2013 International Conference & Workshops, and will be used for all presentations and printed materials. Simultaneous interpretation will not be available.

Registration desk

The registration desk will be open on:

- March 17, from 6 pm to 8 pm (Rectorate Building; nº 25)
- March 18, from 8.30 am to 6 pm (Pedagogical, Scientific and Technological Complex; nº 23)
- March 19, from 8.30 am to 1 pm (Pedagogical, Scientific and Technological Complex; nº 23)
- March 20, from 8.30 am to 6 pm (Pedagogical, Scientific and Technological Complex; nº 23)

The conference registration fee includes: attendance at all scientific sessions, conference materials, welcome reception, social dinner, cultural events, morning and afternoon breaks (18-20 March 2013), lunch (18-20 March 2013) and a conference certificate.

Welcome reception

The Welcome Reception will take place in the Rectorate Building (nº 25) on Sunday 17 March from 6.30 pm to 8pm.

Conference dinner

The conference dinner will be held on Tuesday evening 8.30 pm at the “Melia Ria Hotel & SPA”. See ‘Conference dinner’ on the Walking Map of Aveiro.

Coffee-breaks

Coffee, tea, juice, water, fruits, biscuits, and bread will be available during the conference coffee-breaks.

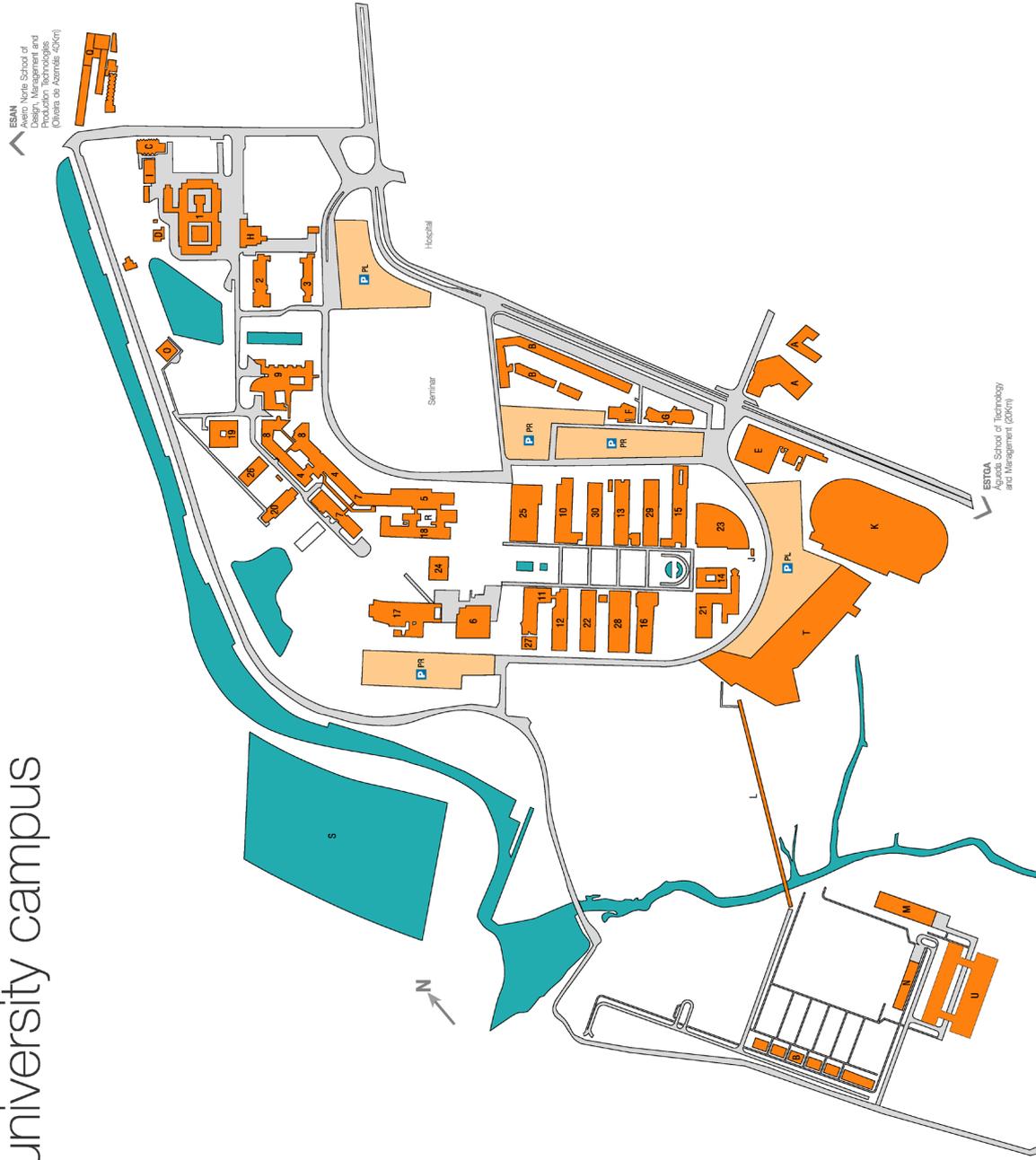
Lunches

Lunch will be served at the “Craсто Canteen Complex”- see map of the University Campus (letter M). You are required to wear your identification badge.

Internet access

Free wireless access is available on the University Campus, using the “eduroam” network. The log-in and password will be provided during the conference.

university campus



- 1 ICT Services - Helpdesk; UNAVE - Association for Professional Training and Research of the University of Aveiro; Kindergarten and Day Care Centre; CS&E Business Incubator
- 2 Department of Languages and Cultures
- 3 ESSUA - Health School; Autonomous Section of Health Sciences
- 4 Department of Electronics, Telecommunications and Informatics
- 5 Department of Education; UNFEDC - Integrated Unit of Continuing Education; Media Library; University Room
- 6 Student Welfare Services; Sanitago Cafeteria; Post Office; Bank; Parapharmacy; Travel Agency; Printing Centre; Bookstore; Snack Bar; AUAUV - Students Union Helpdesk and Shop
- 7 Department of Environment and Planning
- 8 Department of Biology
- 9 Department of Ceramics and Glass Engineering
- 10 Department of Economics, Management and Industrial Engineering
- 11 Department of Mathematics
- 12 Department of Social, Political and Territorial Sciences
- 13 Department of Physics
- 14 Central Testing Laboratory
- 15 Department of Chemistry
- 16 Department of Geosciences
- 17 Library; SBDU - Library; Document Management and Metadata Services; Heléne de Beavoir Exhibition Room
- 18 Department of Education
- 19 IT - Telecommunications Institute
- 20 IETA - Aveiro Institute of Electronics and Telematics Engineering
- 21 Department of Communication and Art
- 22 Department of Mechanical Engineering
- 23 Pedagogical, Scientific and Technological Complex
- 24 Library and Exhibition Room; Centre for Jazz Studies
- 25 Recreable Building - Records; Administration; Academic Management Services; Technical and Logistical Management Services; Human Resources and Financial Management Services; Communications, Image and Public Relations Services
- 26 Department of Biology - Herbarium and training labs
- 27 ICT Services
- 28 Department of Civil Engineering
- 29 Technological Laboratories Complex
- 30 Interdisciplinary Complex of Physical Sciences applied to Nanotechnology and Oceanography (under construction)

- A ISCA-UA - Aveiro Institute of Accounting and Administration
- B Student Halls of Residence
- C Professor, Staff and Post-graduate Student Halls of Residence
- D IDAD - Institute for the Environment and Development
- E Aristides Hall Sports Pavilion
- F Snack-Bar; Self-Service; University Restaurant
- G Day Care Centre and Kindergarten
- H Health School Laboratories - Speech Therapy, Gerontology and Physiotherapy
- I GRETUA - University of Aveiro Experimental Theatre Group
- J Water Tower
- K Athletics Track
- L Footbridge
- M Castelo Carriões Complex
- N Students Union; AUAUV - Academic Association of the University of Aveiro
- O Weather station
- P PL - Free Parking Spaces; PR - Restricted Parking Spaces
- Q Fabrica - Living Sciences Centre
- R Science Garden
- S Sanitago de Forns Sallpan
- T HortUA - community garden project
- U ESSUA - Health School (under construction)



Mapa Pedonal de Aveiro

Walking Map of Aveiro



Legenda | Legend

- Zona Pedonal / Pedestrian Zone
- Principais Eixos Pedonais / Main Pedestrian Axes
- Paragem de Transportes Públicos / Public Transport Stop
- Estação de Caminho de Ferro / Railway Station
- Caminho de Ferro / Railway
- Casa de Acolhimento / Hostel
- Loja Buga / Free Shared Bicycles
- Parque Coberto / Covered Parking
- Parque Gratuito / Free Parking
- Parque de Superfície / Surface Parking
- Parque de Autocarros / Bus Parking
- Dormidas / Lodgings
- Monumentos Religiosos (Igreja e Capela) / Religious Monument (Church and Chapel)
- Monumentos Históricos / Historical Monuments
- Ponto de Interesse Turístico / Site of Tourist Interest
- Piscina / Swimming Pool
- Equipamentos Desportivos / Sports Facilities
- Super e Hipermercados / Supermarket
- Loja do Cidadão / Centre for Public Services
- Correios / Post Office
- Informação Turística / Tourist Information
- Bombeiros / Fire Department
- Polícia / Police
- Hospital / Hospital
- Centro de Saúde / First Aid
- Farmácias / Pharmacies

Pontos Estrela | Star Points

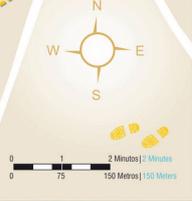
- Centro Histórico (Praça do Peixe) / Historic Centre (Fish Market)
- Universidade Campus (Ribeira) / University Campus (Ribeira)
- Estação Comboios / Railway Station
- Centro Cultural e Congressos / Cultural and Conference Centre
- Palácio da Justiça / Court of Law
- Liceu José Estêvão / José Estêvão Secondary School
- Hospital / Hospital
- Centro de Saúde / First Aid
- Glicínias (para Goveas) / Glicínias (planning office)
- Loja do Cidadão / Centre for Public Services

Distância em minutos a pé entre pontos Estrela

Distances in minutes by foot between Star points

20	17	25	10	14	16	13	33	24
30	28	16	20	10	23	23	33	
10	18	17	28	23	35	10		
16	8	20	17	26	8			
8	6	13	22	21				
12	14	14	13					
14	22	25						
12	21							
30								

Exemplo: Da estação ao Tribunal apenas 18 min. a pé
Example: From Railway Station to Court of Law only 18 min. on foot





Program Overview

Date	Morning	Break	Afternoon	Night
March 16	Workshops	Lunch (provided)	Workshops	Aveiro by night
March 17	Workshops	Lunch (provided)	Workshops	Welcome reception (provided) Opening of the registration desk
March 18	Opening ceremony Plenary session Parallel sessions	Lunch (provided)	Parallel sessions	Aveiro by night
March 19	Plenary session Parallel sessions Poster session	Lunch (provided)	Technical field trip Social program	Conference dinner (provided)
March 20	Plenary session Parallel sessions	Lunch (provided)	Parallel sessions Best paper and poster award session Closing ceremony	Aveiro all night long



Rectorate Building



Pedagogical, Scientific and Technological Complex

Workshop topics

1. SWAT Workshop
2. River basin management



Swat Workshop

This workshop will train users in SWAT2009. The two-day beginner's workshop is designed to introduce new users to the model, review necessary and optional inputs, and familiarize the user with the ArcSWAT interfaces. It will not review basic concepts of ArcGIS usage prior to covering the SWAT/ArcGIS interface.

The SWAT workshop is designed to be approximately 80% hands-on. We provide computers for attendees to use and limit the class size to provide an opportunity for as much one-on-one interaction as possible.

The workshop schedule is as follows:

- Saturday (Morning/Afternoon): Welcome/introductions
 - ☐ Model overview (theory)
 - ☐ Model applications (theory)
 - ☐ Introduction to SWAT/ArcGIS interface (ArcSWAT)
 - ☐ Watershed delineation
 - ☐ Land-use and soil overlay
 - ☐ HRU delineation
 - ☐ Weather and remaining inputs to develop the SWAT model (including point sources)
- Sunday (Morning):
 - ☐ Review of summary outputs
 - ☐ Finish SWAT simulation using ArcSWAT
 - ☐ Address user requests and clarify anything covered on the first day

The workshop will be organised by:

- Pedro Chambel Leitão, IST-MARETEC. E-mail: chambelpc@ist.utl.pt.

New territorial dimensions in a global approach to river basin management Workshop

The workshop aims to discuss the inclusion of new territorial dimensions derived from a broader understanding of the transboundary nature of the water resources contained in a river basin or groundwater system (upstream and downstream), with an interdisciplinary approach and promoting a joint working space and debate among practitioners both from the spatial planning and the water management sides.

Topics to be addressed by invited key-speakers, in order to launch the debate and work in groups, include:

- Land use change and impacts on water resources
- Upstream-downstream-coastal integrated approaches
- Institutional and organizational challenges for transboundary water governance

The workshop will be based on a 'co-learning' approach, built upon the participants' experience and knowledge, and includes a small 'world-café' session around the 3 topics to be discussed. This will allow all the participants to share their visions and opinions, based on their own experience. A set of final conclusions and recommendations for practice and policy will be produced and reported during the Conference.

The workshop schedule is as follows:

- Sunday (Afternoon):
 - ☐ Short key-notes to motivate debate (3 X 10 minutes)
 - ☐ Preliminary discussion (15-20 minutes)
 - ☐ World café (1½ hours)
 - ☐ Final discussion (20-30 minutes)
 - ☐ Conclusions (10-15 minutes)

The workshop will be organised by:

- Susana Neto, Centre of Geography and Regional Planning, e-GEO – FCSH, Universidade NOVA de Lisboa. E-mail: susana.neto@netcabo.pt.
- Jeff Camkin, Centre for Ecohydrology, University of Western Australia. E-mail: Jeff.Camkin@uwa.edu.au.
- Teresa Fidélis, Dept. of Environment & Planning, CESAM, University of Aveiro. E-mail: teresafidelis@ua.pt.

Keynote Speakers

1. Geoffrey D. Gooch
2. Marcus Disse
3. Roy Brouwer



Geoffrey Gooch (University of Dundee)



Professor Geoffrey Gooch holds the Chair of Water and Environmental Policy at the University of Dundee, Scotland. He is also Director of the Dundee Centre for Water Law, Policy and Science (under the auspices of UNESCO), an interdisciplinary centre based at the university. Before taking up his position in Dundee, he was Professor of Political Science at the University of Linköping, Sweden. His research interests are in the development and implementation of water and environmental policy, in the role of institutions in water governance, and in stakeholder and public participation. Professor Gooch has worked closely with hydrologists, modellers, biologists, ecologists, economists, anthropologists, etc. in interdisciplinary and international research projects. He has recently completed a project on livelihoods and biodiversity in riparian areas in Vietnam, India, Costa Rica and South Africa, and he now leads a group from the University of Dundee working in a project on Integrated Coastal Zone Management in Spain, Portugal, Poland and Ukraine. His latest publications include a book on Science, Policy and Stakeholders in Water Management, based in studies in Vietnam, Cambodia, India, Spain and Portugal.

Markus Disse (Universität der Bundeswehr München)



Professor Markus Disse is head of the Department Water Management and Resources Engineering at the Universität der Bundeswehr München. As from the 1st of July 2013 he will move to the Technical University of Munich (Technische Universität München, TUM) and will hold the chair of Hydrology and River Basin management. He has a PhD in civil engineering (1995, Karlsruhe) and worked for seven years as a research assistant for the Federal Institute of Hydrology in Koblenz, Germany. His main research topics include process orientated modeling of water balance and runoff generation, flood forecasting (incl. uncertainties), adaptation strategies to climate change and integrated water resources management in arid regions. Besides basic and applied research projects (including IRMA-LAHoR [IRMA 3/DU/1/002], the German Research Network Natural Disasters [DFNK], the National research program Risk management of extreme flood events [HORIX] and the Sino-German NSFC/DFG cooperation group [CCFD]), Markus Disse leads a large multi-disciplinary research team with the title "Sustainable Management of River Oases along the Tarim River/China" (2011-2016). More information about this project (www.sumario.de).

Roy Brouwer (Vrije Universiteit Amsterdam)



Professor Roy Brouwer is head of the Department Environmental Economics at the Vrije Universiteit Amsterdam, Netherlands. He combines both practical water policy experience (he was chief economist in the Dutch Water Ministry between 1999 and 2004) and scientific research (he was a researcher at Wageningen University, University of East Anglia, and since 2005 VU University Amsterdam). In 2008 he received a fellowship award from the Australian Government under its Water Research Program to assist in the development of sustainable water conservation strategies under climate change. In 2009 he was appointed Professor of Water Economics under the Dutch National Research Program Living with Water. Between 2007 and 2010 he coordinated the European research project AQUAMONEY, in which he developed guidelines for economic water resource valuation together with 15 European universities and research institutes in support of implementation of the European Water Framework Directive. Since 2012 he is chief editor of the journal Water Resources & Economics.

Conference topics

1. Water resources modelling
2. Technological and natural solutions
3. Environmental impacts, ecosystems services and values
4. Economic incentives and instruments
5. Water governance, institutions and regulations
6. Stakeholder engagement
7. Planning water resources and land use
8. Integrated assessment and decision support tools



A decorative graphic consisting of a series of blue water droplets of varying sizes, arranged in a curved path from the bottom left towards the center. Below the droplets is a light blue wavy line that extends across the bottom of the page.

Water resources modelling

The use of catchment models coupled with weather forecasts to support water management in Mozambique Umbeluzi watershed

Almeida, Carina^(a,1) • Pedro Chambel Leitão^(a) • Eduardo Jauch^(a) • Adélio Silva^(b) • Gildo Timóteo^(c) • Ramiro Neves^(a)

⁽¹⁾carina.almeida@ist.utl.pt • ^(a)Maretec - Technical Superior Institute - IST • ^(b)Hidromod • ^(c)Águas da região de Maputo - Maputo - Moçambique

The Umbeluzi River basin has a total area of 5458 km², which 40% are located in Mozambique, 58% in Swaziland and 2% in South Africa. In terms of topography, about 20% of the area is above 500 meters, peaking at 1800 meters. The western is mountainous, followed by a plain area which concentrates the production of sugar cane crop and a small mountain range (Pequenos Libombos). In Umbeluzi watershed there are two dams, which have an important role: Mnjoli in Swaziland and BPL (Pequenos Libombos dam) in Mozambique. The first one is needed for irrigation of mainly sugar cane areas, and the second one is essential for water supply in Maputo.

To support water management in Umbeluzi watershed, a platform to manage available data and models will be developed in the context of MyWater FP7 project (<http://mywater-fp7.eu/>). This platform will be developed to support the water stakeholders in their decisions.

One of the models is managed by this platform is SWAT model, a basin hydrological model which vastly used around the world. This model calculates the water balance at watershed scale. Another model that will be implemented is Mohid Land which is also a catchment model with the advantage of having a sub-daily time step that makes it useful for sub-daily events like floods.

For the hydrological characterization of this basin it was used available datasets that include topographical map, soil type and land use map, meteorological and flow data.

Models were calibrated and validated with available flow datasets from gage stations. Additional validation was produced comparing model results of evapotranspiration with evapotranspiration obtained with SEBAL model that uses satellite data as input. A good validation of the model guarantees high reliability and accuracy of the water balance in the watershed that will support water management. The possibility of predicting the water balance can also support managers in decision making. Because of that, model will also be run in a forecast mode using as input results from weather forecasts models like GFS - Global Forecast System (<http://www.emc.ncep.noaa.gov/>) and ETA model implemented by CPTEC (<http://www.cptec.inpe.br/>). Comparisons of model results using both weather forecasts as input will be presented.

Modelling of the transboundary Vistula lagoon catchment for climate and land use impact assessment

Hesse, Cornelia^(a,1) • Anastassi Stefanova^(a) • Dmitry Domnin^(b) • Malgorzata Bielecka^(c) • Valentina Krysanova^(a)

⁽¹⁾cohesse@pik-potsdam.de • ^(a)Potsdam Institute for Climate Impact Research • ^(b)P.P. Shirshov Institute of Oceanology of RAS • ^(c)Institute of Hydro Engineering of PAS

Vistula Lagoon in the Baltic Sea is one of the largest inner marine water basins in Europe. It covers an area of 838 km² and has a drainage basin of 23870 km². The lagoon as well as its catchment is shared by the two states Poland and Russia, additionally representing a bridge between EU and non-EU countries.

More than 20 rivers are draining to the Vistula lagoon (3.49 km³ water per year on average), whereof the Pregolya River is the most important one, delivering more than 40% of the incoming water discharge and covering almost 60% of the total lagoon catchment. The most significant Polish river flowing to the Vistula lagoon is the Pasleka River with a catchment size of about 2250 km².

The drainage basin of the Vistula lagoon is mainly used by agriculture (54%), which causes nutrient inputs to the marine water body. Other sources of nutrients are: release of nutrients from sediments and emissions from sewage treatment plants or industrial point sources. Besides, due to poor technical condition of anti-flood and drainage infrastructure there is danger of flooding of low-laying areas.

The status of the Vistula lagoon highly depends on the condition of its catchment and inflowing rivers. Changes in climate and land use, which can be expected due to overall global trends and regional development, may cause variations in water quantity and quality coming from the drainage basin and affect the lagoon's ecological and socio-economical potential. To tackle possible future threats and problems, a coordinated transboundary water management is needed. This can be effectively supported by the use of watershed models to evaluate possible future problems and feasible adaptation measures.

The objective of the study presented here is modelling of the runoff conditions and freshwater inflows coming from the total catchment to the Vistula lagoon with the Soil and Water Integrated Model (SWIM) using available climate data within and around the basin as well as spatial data for elevation, land use, and soil types. Time series of measured water discharge are used for model calibration. As a next step, the model can be calibrated for water quality and applied for analysis of nutrient input to the lagoon.

SWIM is a process based semi-distributed eco-hydrological model for the river basin and regional scale calculating processes by subdividing the catchment into subbasins and hydrotopes. These smallest spatial units (defined by overlaying land use, soil and subbasin maps) are used to simulate hydrological processes and nutrient cycles as well as vegetation growth in the basin. Climate data as one of the most important drivers of the different model processes are interpolated to the subbasin centroids by using an inverse weighted distance method.

After successful hydrological calibration and validation of the SWIM model comparing observed and simulated daily discharges measured at the two influents Pregolya and Pasleka with satisfactory results (NSEdaily=0.66/0.62, NSEmonthly=0.74/0.73, PBIAS=6/-3%) the model was extended to the entire Vistula lagoon basin to estimate total inflows from the watershed. Long term averages and seasonal dynamics of the total water inflow into the Vistula lagoon for the reference period were estimated for further comparisons with scenario simulations.

This model setup and calibration delivered a base for water quality modelling and climate and land use change impact assessment taking into account projected future climate and land use options according to the ENSEMBLES and regional land use change scenarios to evaluate flooding and eutrophication risks of the Vistula lagoon system.

The study was performed in the framework of the project LAGOONS supported by the European Commission 7th Framework Programme for Research under grant agreement N° 283157.

Challenges for integrated catchment-to-coast modelling in the context of science-policy interface: the Ria de Aveiro coastal lagoon

Lillebø, Ana^(a, 1) • João M. Dias^(b) • João D. Lecart e Silva^(b) • Fátima Alves^(c) • Anastassi Stefanova^(d) • Valentina Krysanova^(d)

⁽¹⁾lillebo@ua.pt • ^(a) Department of Biology & CESAM, University of Aveiro - Portugal • ^(b) Department of Physics & CESAM, University of Aveiro • ^(c) Dept. Environment and Planning & CESAM, University of Aveiro • ^(d) Potsdam Institute for Climate Impact Research

Ria de Aveiro is one of the European “hotspot” coastal lagoons being studied within the EU-FP7 LAGOONS project. Regarding the water quality status of Ria, the main policy context of relevance is the EU-Water Framework Directive and the activities related to its implementation. In this context, the environmental issue of concern within LAGOONS is the anthropogenic deterioration of Ria’s surface waters from the catchment, with particular emphasis on the lagoon water-body. The considered anthropogenic deterioration may be affected by changing climate, land use and water use in future. Therefore, the interaction between climate change, land use change and Ria ecosystems will be examined. The aim of the modelling effort within LAGOONS is to project the Ria’s response to climate change and land use change scenarios. For the modelling of the catchment the semi-distributed ecohydrological model SWIM, integrating hydrological processes, vegetation growth, nutrient cycling, and sediment transport at the river basin scale, is used. For the modelling of the lagoon and adjacent shelf Delft3D, an integrated suite for coasts and estuarine areas, simulating flow, sediment transport, water quality and ecological processes, is used. For the climate impact assessment the sets of existing regional climate scenarios from the ENSAMBLES project are used. The use of modelling tools to assess the spatial impacts in the context of the EU-policies pose some additional challenges, namely due to the gaps in data sets and the lack of effective information-sharing systems. The challenges posed by modelling results in the science-policy context will be discussed as well.

Alcántara dam in the Tagus River: a case study of the effect of a large reservoir in the droughts in a trans-boundary basin

López-Moreno, Ignacio^(a, 1) • Sérgio Vicente-Serrano^(a) • Santiago Beguería^(a) • José García-Ruiz^(a) • Maria Manuela Portela^(b) • António Betâmio de Almeida^(b)

⁽¹⁾nlopez@ipe.csic.es • ^(a)Instituto Pirenaico de Ecología - Zaragoza • ^(b)Technical Superior Institute - IST/UTL

The effect on the hydrological droughts of the large reservoir created by the dam of Alcántara, located in the trans-boundary Tagus River, almost in the border between Portugal and Spain, is discussed. The magnitude and duration of droughts are analyzed by comparing a monthly drought index calculated for the flow series upstream and downstream of the dam. The results achieved show that, as a consequence of the exploitation of Alcántara reservoir, (1) during periods of water scarcity, the releases in winter and spring are reduced dramatically and the magnitude and duration of summer low flow show a slight increase and (2) the nature of droughts along the Tagus river basin downstream of Alcántara has shown severe changes since the construction of the dam. In fact, during the predam period (1943–1969), droughts were longer and more intense in the Spanish part of the basin than that in the Portuguese part. However, since the construction of the Alcántara dam the Portuguese part of the basin has experienced more severe droughts than did the upstream part in terms of both magnitude and duration.

A multi-compartment modeling framework to study the impacts of climate change on the Lisbon water supplies

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The Lisbon water supply is mostly originated from the Tagus river basin, a large transnational watershed with complex land-uses and geology. Project ADAPTACLIMA-EPAL aimed at assessing the vulnerability of these water sources to climate change. This required the construction of a complex modeling framework, capable of simulating the watershed in general while focusing on the various water uptake points in detail. This framework had to tackle a number of interfaces between water resource compartments, including: the Castelo de Bode reservoir, EPAL's main source of water and where streamflow from the river Zêzere is collected in a large artificial lake; the Valada do Tejo withdrawal point, located just upstream from the estuary in the river Tagus, a secondary source of water which is dependent on transboundary streamflow from Spain, potentially affected by downstream saltwater tides associated with sea level rise; multiple groundwater uptakes in several aquifers.

In order to achieve these goals, a catchment-scale eco-hydrological model was applied to simulate the entire study area, linked with sub-models for different interfaces: a 2-D water quality model for the Castelo de Bode reservoir; a simple climate-based estimate for streamflow inputs from Spain; a 2-D hydrodynamic model for the interface between the river Tagus and the estuary; groundwater recharge and transport models for selected aquifers.

The framework had to tackle issues such as model links at the interfaces, including the link between different modeling concepts and different spatial and temporal scales and extents of modeling. The results indicate that, for the selected climate change scenarios (downscaled from the A2 and B2 scenarios taken from the HADCM3 GCM), the Lisbon water supplies will not be under threat as long as they are properly managed. Identified threats to management include the competition between consumptive and electrical production uses in the Castelo de Bode reservoir; potential water quality deterioration caused by increased phosphorous inputs in Castelo de Bode; important changes to streamflow from the Spanish part of the river Tagus; and the need to increase water uptakes to extend the water supply network to other populated areas.

Hydrodynamic math models are the main instrument for assessment of transboundary ground water flows

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The results of studying transboundary groundwater interaction in Russian-Kazakhstan and Russian-Ukraine boundary areas are given. The direction of undisturbed groundwater flows is determined, and changes caused by the exploitation of the aquifers are assessed. The methodological approaches for solving transboundary problems applied to groundwater are determined as a result of mathematical modelling.

Transboundary watershed modelling - problems and limitations on the Minho international river (Iberian Peninsula)

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In this paper we discuss the problems encountered in applying the Soil and Water Assessment Tool (SWAT) to international river basins, and propose solutions to overcome these problems. A case study is provided for the application of SWAT2009 model assemblage for the Minho international river basin (Iberian Peninsula).

Three major areas of concern were identified: non harmonized spatial data; non harmonized time series data; and non-normalized input data. First, the SWAT model assemblage data acquisition process was initially a major concern as the input data (climate, hydrology) and the gaps on the daily records reduced the analysis scope from a 20 year to 10 year period. Second, the different types of cartographic data (scale, output cell size, projections and coordinate systems) created several issues on the two countries databases overlay. Finally, the model calibration represented also a challenge due to heterogeneous distribution of temporal and spatial data.

Proposed solutions to these problems included: alternative data sources to fill the gaps on spatial and temporal databases, statistical correlations between different climate stations, and GIS geo-mathematical techniques. The overall SWAT modelling presented several challenges throughout the model data acquisition, assemblage and later calibration and validation processes for the simulated scenarios.

Watershed modelling of the Ria de Aveiro lagoon for climate impact assessment

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Ria de Aveiro in Portugal is a coastal lagoon under various anthropogenic pressures, which are increasing during the last decades. It represents an interface between terrestrial environment and coastal waters. The lagoon ecosystem may face serious threats in future with regards to the overall trends of global change and regional development. Important problems related to changes of salinity and variations in water level are driven mainly by processes taking place in the watershed. Therefore watershed modelling and impact assessment are needed, as their outcomes can provide useful information for researchers as well as for decision makers.

This study focuses on the freshwater inflow into the lagoon under different scenarios. Its purpose is to analyse the impacts of different land use and climate change scenarios on the runoff conditions in the drainage basin and on the water discharge to the lagoon. The total area of the Ria de Aveiro watershed is about 3600km². The main source of freshwater is the Vouga River, with an average annual discharge of 25m³/s. The Vouga basin stretches over an area of about 2600km². The altitude ranges from 16m in the lower part up to 1000m in the upper mountainous part. Cropland occupies about 26% of the total area and is mainly concentrated in the lower valley of the basin.

The Soil and Water Integrated Model (SWIM) was used for hydrological modelling of the Vouga basin and the total watershed of the Ria de Aveiro. SWIM is a process based semi-distributed ecohydrological model integrating hydrological process, vegetation/crop growth and nutrient cycles at the river basin scale. The model uses a three-level spatial disaggregation by subdividing the whole watershed into subbasins and hydrotopes. The latter ones are sets of units within subbasins, which have a unique combination of land use and soil characteristics.

Three gauges measuring water level were used for the model calibration, whereas water discharge was estimated from the water level using flow curve equations. Meteorological data has a satisfactory coverage over the basin, though measurements at high elevations are missing. Weather parameters were interpolated to the centroids of subbasins using inverse weighted distance method. SWIM was calibrated based on the results of a preceding sensitivity analysis performed towards daily water discharge records. Two different quantitative statistics were used to assess the goodness of model calibration: the Nash and Sutcliffe efficiency (NSE) and the percent bias (PBIAS). The statistics showed sufficiently good results for monthly (NSE=0.7, PBIAS=1%) as well as daily (NSE=0.66, PBIAS=1%) streamflow simulations for the main gauge in the period of observation.

After the successful calibration for all three gauges the model was extended to the entire watershed of the lagoon. As a result, long term averages, seasonal dynamics as well as monthly variations of the total water inflow into the lagoon for the reference period were estimated. As the next step, different climate change scenarios from the ENSEMBLES project were applied for the reference and scenario periods, and the SWIM outputs were compared between these periods. The results of the climate impact assessment were analysed and provided to the lagoon modellers.

The study was performed in the framework of the project LAGOONS supported by the European Commission 7th Framework Programme for Research under grant agreement N° 283157.

An IWRM approach in western Ukraine: Integrated eco-hydrological modeling and diffuse pollution simulation strategies

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Pollution of surface and groundwater, due to improper land management, has become a major problem worldwide. It has been predicted that, as pollution can no longer be remedied by dilution in many countries, freshwater quality will become the principal limitation for sustainable development in these countries early in the 21st century. Therefore, there is a need to adapt land management to minimize leaching of nutrients and other chemicals. This requires the development and successful implementation of new concepts of land management.

The work presented here was carried out within the framework of the ongoing project IWAS, the “International Water Research Alliance of Saxony – Water Research in the Ukraine”. Within this project a wide range of fields are investigated. The overall aim of our working group was to assess how severe the diffuse pollution has impacted the Western Bug catchment by means of spatially distributed water and matter modelling. The models resultant from the IWAS project research will be then combined and extended in order to address coupled processes in the hydrosphere in the IWAS-Toolbox. This water related research counts with studies e.g. focusing the impacts of climate change to studies focusing the modelling of urban drainage systems. In the Western Bug catchment, data insufficiency hinders the modelling process. Therefore, in this study we present a strategy to simulate long term diffuse pollution trends while dealing with the socio-economic modifications and system dynamic brought by the political turnover in 1991.

A decorative graphic consisting of a series of blue water droplets of varying sizes, arranged in a curved path from the bottom left towards the center. Below the droplets is a light blue wavy line that extends across the bottom of the page.

Technological and natural solutions

Dune restoration and requalification of the main avenue in Furadouro beach, OvarBarbosa, Mónica^(a, 1) • Laura Costa^(a) • Edna Cabecinha^(a)⁽¹⁾monicabarbosa.la@sapo.pt • ^(a) University of Trás-os-Montes and Alto Douro

Very early in time, man has chosen coastal areas due to its unique landscapes with wide and rich scenarios. The socioeconomic notability associated with leisure and tourism activities, as well as the environmental value of these areas, have led to the growing settling of the population at sea shore.

The effects of human activities in association with natural factors has result in disastrous environmental impacts, such as loss of territory, destruction of natural sea defenses (usually dune systems) and the weakening protection capability, representing a growing danger to these ecosystems and ultimately to human life.

Coastal dune system is a natural structure and represents space dynamic and defensive systems against see attacks, but the instability of these natural structures, mainly due to anthropogenic pressure, has led to an intensive phenomenon of coastal erosion and its vast negative environmental and economic impacts.

In the last decades, due to the anthropic pressures and climate changes, several damages have been registered in the urban coastline as well as a growing loss of coast dune fields, causing high destruction compromising the population safety in Furadouro Beach, located close to the city of Ovar, Aveiro district, in the Central Region of Portugal.

In this context, with this work, we intend to understand coast degradation causes on furadouro beach; create management tools which may be applied in environmental planning; understand local natural and patrimonial facts, and to present an intervention proposal for these area combining the technical, science and art of space designing.

Water- boundaries and borders- the great intangibles in water quality management: can new technologies enable more effective compliance?Coles, Neil^(a, 1) • Jeff Camkin^(a) • Nick Harris^(b) • Andy Cranny^(b) • Phil Hall^(a) • Huma Zia^(b)⁽¹⁾neil.coles@uwa.edu.au • ^(a)Centre for Ecohydrology, Faculty of Engineering, Computing and mathematics University of Western Australia •^(b)Electronics and Computer Science, University of Southampton, Highfield, UK

The challenge of improving water quality has been a longstanding global concern. There has also been a general acceptance that the main drivers of poor water quality are economics, poor water management, agricultural practices, and urban development. Development, implementation, and compliance with transboundary water quality agreements, whether they be across basin, across water bodies or across national or international boundaries, remains constrained by our ability to monitor their effectiveness in real time. Despite significant advances in sensor and communication technologies, water quality monitoring (WQM) is primarily undertaken through small-scale and single-application sampling and testing that is limited by the available techniques, requires expensive highly technical instrumentation, and only provides selective data for decision support tools. The effects of diffuse pollutants and their distribution within water bodies and transboundary rivers systems are, therefore, difficult to capture, as is determination of the exact point and timing of their release into a defined “water system”.

Improved data capture and timely analysis, enabled by innovative sensor technologies and communication networks, is an important aspect of compliance monitoring. This is particularly important for international and trans-border agreements where changes in water distribution, quality, and availability associated with regional climate variability are already creating challenges for future water, energy, and food security. Therefore, it is argued that by including all the multi-level impacts of various stakeholders in a water catchment, on water resources, and by removing the long lead times between when the sample was taken to when sample testing and data analysis has been completed, it is possible to develop and implement an effective water quality monitoring and management framework.

This paper examines the prospect of improved sensor technologies and assessment frameworks that have the potential to be linked with water quality governance, policies and compliance requirements. By employing, a real time integrated and targeted monitoring system, which allows for the assessment of both the catchment functions and modifications to those functions or (eco) services by the various stakeholders, improvements in water quality is possible.



Environmental impacts, ecosystems services and values



Development projects, trans-boundary issues and cumulative impacts on the Mackenzie River's Watershed (NWT, Canada)

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The Mackenzie River Watershed (MRW) located in the northwest of Canada is a natural water-ice-climate system that helps stabilize the Earth's climate. Its vast drainage area includes all the North West Territories (NWT) and portions of the provinces of Alberta, British Columbia, Saskatchewan and the Yukon. These provinces and territories have various levels of jurisdiction over lands and rivers forming part of the MRW.

The MRW is the most valuable water resource for the NWT. The MRW land contains numerous natural resources such as oil, gas, precious metals/stones and timber. Planet warming means milder winters so previously non-viable projects, because of excess snow, ice and cold, are now being proposed by national and international conglomerates. Any perturbation within its hydrological regime will affect directly the ecosystem and the people living in NWT. The enormous territorial extent and vulnerability of the MRW, and worldwide awareness of this region's importance, demonstrate that environmental impact assessments of new developments (e.g. hydroelectricity, pipelines) can no longer focus just on direct impacts. Indirect and cumulative impacts need to be considered in order to sustainably protect the natural resources and ecosystem of the MRW.

This paper explores a new proposed dam project (Site C) in British Columbia and its impact on the MRW. In its preliminary environmental assessment, the promoter stated the potential impacts due to Site C are negligible, except for ice regime changes requiring further study. However, this assessment covered only a limited 100 km corridor downstream from the proposed location. Further, several rehabilitation works are being conducted by BC Hydro as mitigation measures for past impacts caused by an upstream water project, the mega WAC Bennett Dam. In this study we aim at presenting key issues that demonstrate the vulnerability of the Mackenzie watershed and the need to include indirect and cumulative effects (due to other projects) during environmental impact evaluations.

An integrative toolbox to evaluate the environmental quality of transitional waters: the case studies of Minho and Lima rivers

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The Directive 2000/60/CE (Water Framework Directive–WFD) intends establishing a framework for the protection of inland waters, transitional, coastal and groundwater. Accordingly, each member state has to protect, improve and recover the conditions of all aquatic ecosystems to achieve, by 2015, a good quality status for all water bodies. To attain these purposes, further specific measures for pollution control and for setting environmental quality standards will be required. Meeting these needs, the TEAM-Minho project aimed at establishing harmonized scientific criteria, which would allow typing, referencing and classifying the ecological status of transitional water bodies in southern Galicia and northern Portugal, including the transboundary Minho river estuary, and the transfer of results to the relevant public institutions, local social agents and society in general, in order to assist in the implementation of the WFD by providing a framework for the effective protection of transitional waters. This presentation will introduce the results obtained within the TEAM-Minho project regarding the application of sensitive, rapid and economic bioassays to establish reference conditions and for the evaluation and classification of the ecological status. Ecotoxicological assays, with species representative of different taxonomic and functional groups, from different trophic levels, were carried out for water and sediment samples collected at two case studies: the Minho and Lima river estuaries. The obtained results point to a different status of contamination of the water and sediment compartments at both transitional systems. The integration of the ecotoxicological indicators in the classification of the two water bodies within the WFD will be discussed.

Transboundary water environmental impacts assessment of river basin transboundary projects in arid and semiarid regions: a case study between projects of Brazil and Argentina

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The projects of river basin transboundary has been increasingly used because of the demand for water supply and multiple uses. This research aims to evaluate the environmental impacts of river basin transboundary projects in arid and semiarid regions, taking into account the strategic importance of the Integration Project of the São Francisco River Basin in Brazil and the Transfer from Río Grande to Río Atuel in Argentina, for the development. The Integration Project of the São Francisco River Basin is a project to develop the water infrastructure in order to guarantee the water supply of about 12 million people that live in the semiarid region of Brazilian Northeast. The study of environmental impacts identified 44 impacts, including 23 considered most relevant. The project of the river basin water transfer from Río Grande to Río Atuel means the incorporation of a discharge, in a first step, of 24 m³/s, increasingly in two times natural water supply. Some environmental impacts can be identified inside the Río Grande basin and there will be other impacts over the target basin (Río Atuel). These impacts can be minimized by the adoption of integrated management strategies that enable the mitigation of the problems inherent to the water degradation and satisfy the expectations of the users within the context of sustainability. It is expected that the results achieved with this research subsidize the improvement of the management of reservoirs, contributing to the maintenance of water quality in accordance with the environmental legislation and the people's life quality.

The African Dams Project: reservoir impacts and floodplain biogeochemistry in the Zambezi River Basin

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The goal of the African dams project (ADAPT) is to adapt planning and operation of large dams to social needs and environmental constraints in a tropical wetland area in Zambia. Our integrated water resource management (IWRM) study in the Zambezi river basin combines expertise from biogeochemistry, aquatic physics, ecology, economy, political science, hydraulic engineering and hydrology. With the involvement of partner universities and stakeholders from governmental institutions, NGOs, environmental agencies, and the energy and agricultural sector, we promote knowledge exchange and the identification of knowledge gaps and research needs for implementing adequate IWRM. During its four years duration this interdisciplinary project enhanced the scientific basis of IWRM by developing new models that can be used to improve the operation of existing large hydraulic structures and in designing future schemes at the basin-scale. In a final phase we assess the water-use conflicts in the area between hydropower, food production and the environment/tourism.

In this contribution we document how to analyze the biogeochemical processes in a large subcatchment and how to derive operation rules for mitigating downstream effects of hydropower operations. Dams may have negative effects on downstream wetlands due to (i) releasing anoxic water or due to (ii) nutrient trapping in upstream reservoirs. A study on the Itezhi-Tezhi reservoir on the Kafue river system in Zambia aimed at quantifying nutrient and sediment retention and at defining optimized turbine withdrawal to prevent anoxia and to relieve nutrient deficits in the downstream Kafue flats floodplain. A biogeochemical model was used for simulating reservoir-internal processes and the outflow water quality. Changing the current practice of spilling exclusively surface water to releasing hypolimnetic water via turbines was shown to result in anoxia during up to 200 days. On the one hand, this translates to a lower average outflow DO of 3.4 to 6.5 mg l⁻¹ compared to the current 7.6 mg l⁻¹. On the other hand, due to withdrawing nutrient-rich hypolimnetic water instead of nutrient-depleted surface water, n and p sediment losses were most effectively compensated for. Outflow DO as well as n and p output loads may be optimized by replacing 50% of the hypolimnetic turbine water with epilimnetic water originating from ~10 m depth. In this optimal scenario, anoxia was prevented entirely, and higher n and p loads were released to the Kafue flats, in comparison to the current loads.

A study on the dynamics of the downstream wetland, the Kafue flats revealed that the seasonality of the hydrological exchange between river and floodplain remained similar before and after dam closure in 1972, but the amplitude of the overflow and downstream recharge is now reduced to 50% resulting in significant changes in the biogeochemical functioning of the downstream wetland. Therefore the planned modification of dam operations holds the potential for additional positive or negative ecological changes and presents an illustrative case study for IWRM in action.

Estimating the (cultural) environmental-economic benefits/values of surface water status improvements in freshwater ecosystems: the Pateira de Fermentelos in Portugal

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Freshwater wetlands provide crucial ecosystem services that influence climate, nutrient cycles and primary productivity – hence contributing to social welfare and human well-being. These ecosystems are subject to anthropogenic and natural stressors, including from pollution, population growth, economic development, resource depletion and climate change. Anthropogenic stressors have, frequently, provoked devastating impacts on freshwater wetland ecosystems, resulting in a loss of ecosystem services and values. The EU Water Framework Directive (WFD; 2000/60/EC) aims to achieve good status of surface waters across EU member states by 2015, through implementation of Catchment Management Plans (CMPs). While implementation of CMPs is known to be costly for farmers, industries and citizens, associated benefits from improvements in surface water status are less well known. In particular, there is a lack of studies that consistently assess environmental-economic benefits/values of continuous changes in surface water status (i.e. chemical and ecological status). This paper establishes a functional relationship between surface water status and (cultural) environmental-economic benefits/values of freshwater systems. Hence we develop an environmental-economic valuation approach, in which we relate ecological status and chemical status of surface waters (based on local cross-section survey data) to willingness-to-pay (using benefit-function transfer techniques). Results for the Pateira de Fermentelos freshwater wetland (central Portugal) show that the current status of surface waters is good from a chemical perspective though only mediocre from an ecological perspective. The current (cultural) ecosystem service value of the Pateira de Fermentelos is estimated at 1.54 m€/yr – increasing to 2.02 m€/yr in case good status of surface waters is obtained.

Hydrological modelling and forestation scenarios – predicting how forests will contribute to the provision of hydrological services in a small watershed using SWAT

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Forests are among the most important ecosystems for the provision of hydrological services. These include: water supply and water damage mitigation. Because forests may play different hydrological roles according to the environmental characteristics of each region, it is important to model how forests will contribute to the provision of hydrological services. Distributed and physically based hydrological models, such as SWAT, can help to predict the impact of land-use changes and management involving forests and other land uses, on water resources. In this context, the objective of this paper is to apply SWAT hydrological model to Vez watershed, in Northwest Portugal, and to analyse the hydrological consequences of different land cover scenarios.

SWAT was applied in Vez watershed with climatic daily records for a period of 10 years (1999-2008), and calibrated with observed discharge and sediment records. SWAT provided data about water yield, amount of sediments, evapotranspiration and water balance. Those variables were used to forecast the hydrological effects of three scenarios of forestation: conservation, production and degradation.

Expected results will be the change of water yield after increase of forest cover. Water supply services quantity will probably be affected mainly in dry years, but timing will improve under forest cover. The benefits of having forests will be more important for water damage mitigation services, including the decrease of soil erosion and reduction of peak flows due to increased infiltration.

The outcomes of the modelling exercise may be useful to improve options for forest planning and water management under an ecosystem service framework.

Coastal lagoons ecosystem goods and services: bringing science to stakeholders of Ria de Aveiro (Portugal)

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Coastal lagoons, such as Ria de Aveiro, are valuable areas of extreme variability, diversity and multifunctionality that provide a variety of goods and services which are essential to the human wellbeing. They are among the most productive ecosystems and simultaneously among the most modified and threatened coastal environments, compromising the associated goods and services, which endangers their ecological functions. As ecosystems within coastal lagoons are changed, lost or degraded, their capacity to deliver services to satisfy human wellbeing is changed, threatening the overall ability to sustainably support human society. Meaning that coastal lagoons constitute complex social-ecological systems, where sustenance of ecological functions are also supporting the availability of ecosystem goods and services. Therefore, the continued availability of ecosystem goods and services is predicated on a complex combination of social, economic, political and ecological drivers. This interdependency is clearly recognized in the Marine Strategy directive. In addition, following the 14th article of the Water Framework Directive, it is essential to address and encourage the active participation of stakeholders in the protection, development and management of coastal lagoons. Furthermore, climate change is also predicted to have a significant impact on the availability of ecosystems goods and services. In this context, policy makers, managers and the scientific community have been manifesting an increasing interest on ecosystem services approach as a mean to draw attention to the importance of natural capital for society and human wellbeing and to trigger political action to address the issues of biodiversity and ecosystems change and loss. However, there are still many challenges regarding its practical application, e.g. there is no consensus between authors about ecosystem services classification, and the definition itself is not stabilized: the term 'ecosystem services' is commonly used to express goods, services, benefits and/or functions.

Ria de Aveiro is one of the European "hotspot" coastal lagoons being studied within the EU-FP7 LAGOONS project – Integrated water resources and coastal zone management in European lagoons in the context of climate change. Within the project we aim to develop strategies and methodologies for integrated decision support for stakeholders, with special focus on recommendations of suitable use of ecosystem services. In addition, it is our aim to better understand and manage the dynamics of the relationship between humans and the coastal lagoons, including ecosystem services tradeoffs, in the context of climate change. Therefore, we propose to discuss and contribute to clarify the concept of ecosystem services, goods, functions and processes, having Ria de Aveiro coastal lagoon as case study area, and foreseeing to contribute to the integrated management of coastal lagoons.

Ecological limits to socio-economic developments

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The principle of sustainable development supports the idea of obtaining a long-term equilibrium between the economic, social and natural capitals. This requires the valuation of ecosystems and the economy and of the ecosystem goods and services (ES G&Ss) that relates them. A flow-chart must be drawn to relate the fundamental elements and processes of the environment and the economy in order to evaluate their mutual impacts. Analysis reveals that ES G&Ss - in particular the biotic value - are not fully reflected in economic pricing. The existing gaps in the current approach will be indicated as well as the economic limitations resulting from limited natural resources.



Economic incentives and instruments



Managing water resources along the Mexico-U.S. border: can we find workable market solutions?

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The Mexico-U.S. border has important clusters of population centers at various locations. The continued growth in these population centers has contributed to increasing the municipal demands for water resources along with the existing demands derived from current agricultural activities. In this paper we focus on two sets of Twin Cities along the U.S.-Mexico border, namely Calexico-Mexicali in California and Baja California respectively, and on Nogales, Arizona and Nogales, Sonora. These two case studies provide interesting insights due to their differences in size and development patterns. The purpose of this research is to develop a model structure of water for surface water use. The intended use of this model is to form the basis for designing a market structure and other policy instruments to more efficiently allocate scarce water resources along the border. Equity issues are also considered. The methodology developed in this paper is directly transferable to other water-stressed regions of this border and elsewhere.

Transboundary water resources allocation using bankruptcy theory; Case study of Euphrates and Tigris Rivers

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One significant problem of trans-boundary rivers, which has been causing various challenges and disputes throughout the world, is that the amount of demand and need of riparian states is larger than the available water. Hence, one of the main challenges in trans-boundary rivers management problems is that how we can allocate the limited and shared available water among riparian states when it is not sufficient to satisfy the claims of all riparian states so that it would be more equitable and reasonable. In this study, we survey the application of bankruptcy theory to solve this problem in trans-boundary rivers. Furthermore, we propose a new bankruptcy rule to help solving conflict in trans-boundary reallocation problems and investigate its application in a real case study. The results reveal that this method is potentially helpful to solve conflict over trans-boundary water resources problems.

Gains from trans-boundary water quality management in linked catchment and coastal socio-ecological systems: a case study for the Minho region

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Sustainable economic development requires balancing of marginal costs from catchment water pollution abatement and associated marginal benefits from freshwater/coastal ecosystem appreciation. Hence we need to differentiate between intra- and trans-boundary catchments because benefactors and beneficiaries from water quality improvement are not one and the same. In trans-boundary catchments, private (national) welfare maximizing rates of water quality improvement differ across nations as benefits from water quality improvement generally accrue to one nation while the costs are paid by multiple nations. In this paper we develop a deterministic optimal control approach to explore private and social welfare maximizing rates of water pollution abatement in linked catchment and freshwater/coastal socio-ecological systems. For a case study of the Minho region (Iberian Peninsula), we estimate nation-specific water pollution abatement cost functions (based on management practice adoption) to determine and compare private (national) and social (trans-national) welfare maximizing rates of water pollution abatement. Results show that some private (national) welfare gains can be obtained through adoption of win-win practices, leading to a 12% reduction in the annual rate of water pollution and a 7% increase in annual regional income. Maximum social (international) welfare gains can, however, be obtained through adoption of win-win and lose-win practices across Spain and Portugal, leading to a 36% reduction in water pollution and a 14% increase in regional income. Non-cooperation in water pollution abatement would only lead to a 16%-32% reduction in water pollution and a 8%-13% increase in regional income. Hence, social (trans-national) welfare losses from non-cooperation between Spain and Portugal would equate to between 16 and 81 m€/yr.

Explaining investments in irrigation wells under increasing groundwater scarcity: panel data analysis for 6 Indian villages

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While groundwater irrigation in India has made a substantial contribution in terms of raising agricultural productivity and farm incomes for poor and marginal farmers, excessive extraction has led to depletion of scarce groundwater resources in many parts of the country. The basic incentive structures that induce overexploitation of groundwater in this context are related to a lack of clearly defined and secure property rights that encourage cooperation. Lack of assurance about the actions of others, and lack of adequate legal and institutional arrangements to regulate users has led to an open access solution, characterized by over-pumping and depletion of the resource.

In this study we use time series data (2001-2005) collected in the framework of the ICRISAT Village Level Studies to capture farmers' decisions to invest in wells. The dataset, which contains information on 367 rural households of 6 villages in the states Andhra Pradesh and Maharashtra, allowed us to use a double hurdle model to determine not only the factors that affect the decision to make investments in wells but also the intensity of the investment. Results show that factors playing a role in these decisions are the land size, whether the irrigated land is owned by the irrigator, the perception on the existing water access, the households financial asset status (indebtedness, savings) and the past investments in wells. Understanding of these decisions can help policy makers to design the policies which are necessary to ensure the sustainability of the groundwater irrigation sector in India.

Adoption of improved farming systems for water quality improvement in heterogeneous sugarcane farming communities; sharing the costs

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There is growing recognition that coastal water quality is interdependent with agricultural management in coastal catchments. Economic incentive-based instruments can be used to internalize the negative externalities from coastal water pollution. In this paper we assess a design-based instrument for promoting the adoption of management practices for water quality improvement in heterogeneous sugarcane farming communities in the Great Barrier Reef (GBR) region, with emphasis on regional income, employment and dissolved inorganic nitrogen (DIN) delivery impacts. We combine financial and environmental analyses of farming systems at the paddock scale with a mathematical modelling approach at the farm scale, differentiating for three farm typologies, aggregated to the catchment scale. Management practice adoption rates are assessed by exploring how different types of farmers are likely to respond to increasing transition cost-sharing ratios (CSR).



Water governance,
institutions and regulations



Flood risk management strategies across boundaries: a research approach

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Floods are the most frequent and damaging of all types of natural disasters and annually affect the lives of millions all over the globe. Against this background, enhanced climate variability and climate change are expected to increase the frequency and intensity of floods. The situation is further complicated by the transboundary nature of water, making transboundary cooperation on integrated flood risk management not only necessary, but highly beneficial as well. Unfortunately, numerous challenges hamper effective transboundary cooperation in general and cooperation on transboundary flood management in particular, thereby increasing vulnerability to floods.

Flood Risk Management Strategies (FRMSs) are designed to make vulnerable urban regions more resilient to flooding. This likely requires changes in their institutional embedding. Insights into this institutional embedding of FRMSs so far is, however, rather limited and fragmented. In this paper we argue that such insights can be created by drawing upon and combining public administration and legal expertise. To make a start with the latter, we introduce the Transboundary Flood Risks Governance Arrangements (TFRGAs) approach. In the EU-funded STARFLOOD-project we will use this approach to carry out comparative research to further elaborate the approach.

Difficulties and challenges regarding institutional processes for transboundary water management

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Cooperation mechanisms for transboundary watercourse, lake or groundwater management are usually set up when riparian countries recognised that cooperation provides more benefit than non-cooperation. Driving forces for cooperation can be the need to improve scientific knowledge for alleviating misunderstanding and impact of the climate change, the need of rules for sharing hydropower, and the will to reduce pollution, to respect an ecological minimum flow or to prevent food damages. The 1992-Dublin conference on Integrated Water Resource Management and the 1997-New-York conference on Transboundary Watercourses provided principles and momentum for international river basin cooperation. Stakeholders' consultation and public participation are promoted for developing a well-accepted policy. New transboundary institutions or cooperation mechanism are created, but the cooperation process is often difficult and costly. Implementation of cross-border activities required rather complex mechanisms of cooperation including local and national representatives from riparian countries. Based on project implementation experience, an analytic approach is proposed. Factors impacting the cooperation and institutions efficiency have been identified for various transboundary areas. Among these factors are a common language and culture, the political climate, the integrity and capacity of local administrations in-charge, donor Agencies influence, etc. However, the process of institution building may sideline issues such as filling improving data quality or local socio-economic development. Analyse of this kind could be useful to quickly identify bottlenecks and better understand, who benefits from transboundary water cooperation, what could be the gains for the local people affected by cross-border water management and what is the overall efficiency of the process.

Sharing the River: implications for local and regional peace and stability in Mali and the Niger basin

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This paper explores the dynamics of shared rivers and local and regional peace and stability, using Mali and the Niger basin as a case study. Mali contains 30% of the Niger River basin and relies heavily on the river for crop irrigation, fishing, and cattle grazing. Mali's capital, Bamako, is situated on the river, and over 8 million of Malians reside in the basin. Thus, the river is an important current and future resource for Mali's human and economic development. Likewise, the health of the Niger's waters is largely dependent upon Mali's use and development of the river. As one of nine countries party to the Niger Basin Authority, Mali has plans to construct at least one major dam within its jurisdictional area of the Niger River within the next few years. Alongside increased development, conflict within Mali has been escalating since rebel groups initiated a coup d'état in early 2012 and began seeking occupation of the north. The situation has become increasingly unstable. Though the conflict is small in scale relative to the Niger basin as a whole, it can affect the resilience of the basin and its governing institutions. Likewise, political stabilization and post-conflict reconstruction in Mali are dependent upon the ability of the Niger to deliver necessary water and services.

Settlement mechanisms of international water disputes

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Water conflicts are forecast to be the typical conflict of the XXI century. This is due to the perception that the competition for water resources shall accrue dramatically in the current century. While it may be doubted that this trend may necessarily materialise into growing conflicts, international cooperation being also a likely alternative, there is no doubt that the looming global and regional water crises of contemporary times render it necessary to reflect on the mechanisms available for handling and settling international water disputes, a major global governance issue of our times. The current article seeks to enlist such mechanisms and characterise them in not only theoretical terms but also in view of the experience gained in the corresponding practice. In particular, an attempt shall be made at assessing the significance of the recent wave of international water cases brought to international courts as well as the case law produced.

Transboundary river basins planning – a challenge to the implementation of the European Water Framework Directive

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Transboundary river basins pose a significant challenge to the management of shared water resources between riparian countries. The challenge is even more significant in semi-arid Mediterranean environments and under water scarcity circumstances, as is the case for the Guadiana river basin, shared between Portugal and Spain. Albeit the European cooperative context determined by the Water Framework Directive and by the existing bilateral agreement (the Albufeira Convention), Spain has a clearly dominant position in the hydro-diplomatic relations between both countries. Furthermore, the effectiveness of this agreement is undermined by the lack of basic framework conditions, namely the failure to integrate principles of water sharing and territorial planning, to identify an appropriate business model, to promote cross-border public participation and democratically sustain the treaty's entry into force, to implement an operational, empowered and adaptive management structure, as well as mechanisms for monitoring and enforcing compliance. Finally, the existence of two separate, rather different and uncoordinated river basin management plans for the Guadiana contributes significantly to the difficulty of both countries in managing their shared water resources appropriately. To overcome this gap, it will be crucial to ground the Albufeira Convention enforcement on a long foreseen but still inexistent Permanent Secretariat.

Establishment of a guidance framework for cross-border maritime spatial planning

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In the last five years European Union has strongly promoted Maritime Spatial Planning among its Member States as expressed in the Maritime Strategy Framework Directive and the Roadmap for Maritime Spatial Planning. Cross-border cooperation in the marine environment is one of the main principles for successful maritime spatial planning approaches. Transboundary Planning in the European Atlantic is a recently started European Union project, which studies the implementation of maritime spatial planning in cross-border areas. Difficulties arise in these areas as different national frameworks and models of marine planning are being implemented according to Member States own traditions of planning and governance. This paper presents the contribute to a guidance document for Transboundary Planning in the European Atlantic project, reviewing the main existing legal and administrative frameworks at international, regional and at European Union level. Finally, an overview of the lessons learnt in similar projects, in the context of transboundary areas, was also embedded in the overall assessment.

Innovative approaches to the interaction of law, policy, actors and institutions in Water GovernanceGooch, Geoffrey^(a, 1)⁽¹⁾g.d.gooch@dundee.ac.uk • ^(a)University of Dundee

This paper presents an examination of the interactions between law, policy, actors and institutions in the governance of water. The paper claims that law and policy each play important, complementary, yet sometimes competing, roles in water governance.

In many parts of the world there is a potential conflict between the improvement of people's livelihoods and the protection of aquatic and riparian ecosystems. This necessitates an IWRM approach which takes into account both livelihoods and the protection of biodiversity, as at the heart of any potential conflict between livelihoods and the protection of nature lies the question of whether resource use, especially the use of natural resources such as water, leads inevitably to resource depletion and to negative effects on the ecosystem. There is often an inherent acceptance that livelihoods and protection are incompatible. This is of course not always the case, resource users may decide not to destroy the water resource and may decide not to for a variety of reasons. Laws and legal frameworks may be one of these, perhaps best described as formal constraints; however, many other incentives to protect ecosystems are in place in the case areas, as will be shown in this paper.

The major challenge facing the governance of water is not in itself the quality or quantity of legislation or policy; it is the implementation of these laws and policies. Any approach wishing to understand the lack of success of water law and policy in many parts of the world must therefore begin by analysing the processes through which these are implemented. In this respect, while there are in principal differences in levels of potential enforcement between law and policy, in practice both of these forms of influencing behaviour are usually left in the hands of the same institutions and organisations. In many areas these are usually the government authorities, departments of the environment and state or county authorities. The complexities of modern political systems often result in decisions, both legal and policy-orientated, being moved along from the political sphere into the administrative sphere. There are a number of reasons for this, such as limited detailed knowledge of specific issues, the wish to de-fuse sensitive political conflicts by leaving their resolution to the implementation process etc. The process often creates confusion between the politicians who are responsible for making laws and decisions that determine policy, and the civil servants who are responsible for implementing them. This paper therefore also analyses the actor-networks responsible for implementation of the laws and policies, and the interactions between the organisations and institutions that form these networks.

Transboundary riparian watersheds: political conflict and power on the United States – Mexico borderJordan-Werhane, Dian^(a, 1)

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Disputes related to transboundary riparian areas are manifested within international power struggles related to water issues of flow control, flooding, damming, aquifers, pollution, navigation, access, and economic rights to sell. Shared land borders are often a stage for these conflicts. Shared water boundaries increase the complicated matters of dispute along the riparian zone where land meets water. The imbalance of power is fraught on numerous levels including economies, governments, institutions, military strength, international social capital, and the geographic loci of the water sources. This paper will analyze the conflicts and power exhibited in a single revelatory case study of the Mexico-United States transboundary riparian watersheds. Specifically, Ritzer's integrative theory of social analysis will be applied which illuminates the interrelationships of the macro and micro structural orientations that are framed within the conflicts and powers related to the shared water for these two North American countries. The comprehensive data collection contained in the Transboundary Freshwater Dispute Database (TFDD) was utilized for this research. Results infer that Mexico-United States water conflicts range in levels of intensity but are generally resolved with unified cooperation. Subtle shifts in political power are exhibited in periods of quiescence times as well as during events of escalating conflict. In particular, when multiple agency-multiple jurisdictional laws are in disunity, social capital is often employed by actors to strengthen their stated or desired positions. This case study analysis reflects both policy procedures in practice as well as interaction effects of micro-level activities effectuated on the transboundary riparian border waters.

Negotiating transboundary water-sharing policies: conflict, cooperation and governance of international river systems

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Riparians in transboundary river systems negotiate water-sharing policies to promote political stability, regional security, economic prosperity, and environmental sustainability. Yet interstate disputes are occurring within most multistate river systems, and weak riparians are often coerced to agree to water-sharing policies that adversely affect them. This research examines the strategies weak riparians use to assert leverage in international river basins with asymmetrical power, and the success of those strategies in achieving cooperation versus conflict. Grounded in the theoretical framework of hydro hegemony, hard power, and soft power, this study uses cross national analysis to test the effects of geographic, military, political, economic, technological, and external influence on water governance in eight international river systems. The results demonstrate that weak riparians mobilize the assets and capacities of external actors, such as donor countries and the World Bank, to increase their leverage within the river system. The study finds that strategies to balance hard power are largely ineffective; they fail to achieve cooperative water-sharing arrangements and often exacerbate conflict. In contrast, strategies to balance economic power and soft power, such as market access and political legitimacy, are more successful in promoting cooperation and preventing conflict in transboundary river systems.

Structural analysis of a transboundary conflict interests and values in the Rio Bravo Basin

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After a period of water scarcity initiating in 1992, the old 1944 Treaty on Water between Mexico and United States was seriously brought into question to the point of requiring the intervention of both presidents in 2002. In this paper, we use a “structural analysis of conflict” under the assumption that the many actors, speeches and social practices have to be reconstructed and modelled from main actors’ economic and social interests. We stress the difficulty for expertise to avoid “irrationality”, information asymmetry and the pervasiveness of cultural stereotypes.

Integrated coastal management diagnosis for the Coastal Zone Sanitation of San Francisco de Campeche, Mexico

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The contamination of the coastal zone because of the poorly planned urban development is one of the main causes for the alteration of this ecosystem with effects in the human health. The coastal waters of Campeche are contaminated, to attend this problem the state and municipal authorities had developed different initiatives that haven't been consolidated. This study establishes the diagnosis of the Campeche coastal zone problem, looking forward the creation of an integrated coastal management program for its sanitation. With this analysis it was possible to identify that the main problem of the coastal zone contamination was the lack of institutional capacity to coordinate, control, monitor and perform sanitation actions. This study conform the baseline to establish and prioritize the actions for the coastal zone sanitation.

Opportunities for international water governance: the Guadiana Basin experience

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The Albufeira Convention of 1998 signed between Portugal and Spain imposes on both States' Administration the need to produce, compile and organize data bases, ensuring a permanent cooperation which must also be open and participative for all stakeholders and populations, regarding all decision making on the Portuguese-Spanish water resources. This challenge is particularly difficult to address, due to lack of information in many situations, and also to the increased complexity of the planning process required by the implementation of the Water Framework Directive. In the context of the implementation of this Directive in Europe, there is an interesting space for comparison with the principles advocated in both the Helsinki Conventions (Helsinki 1992) and the UN Convention (New York, 1997), and the principles of the Water Framework Directive, in terms of international water governance. In particular, how does international water law and international legal frameworks promote water governance and support national decision-making? This paper will discuss how the principles of 'Good Water Governance' can be implemented in the Guadiana river basin, under the Albufeira Convention and the European Directive, and this process can also benefit from the ongoing UNESCO HELP Program, which has been in place in this basin since 2004.

Key discursive themes for the environmental governance of the Vouga Estuary (Ria de Aveiro)Sumares, David^(a, 1) • Teresa Fidélis^(a)⁽¹⁾david.sumares@ua.pt • ^(a)Dept. Environment and Planning & CESAM, University of Aveiro

Over the past decades, at the same time that traditional activities declined, the Ria de Aveiro (the estuary of the river Vouga) has suffered strong development pressures (urban, agricultural and industrial), which have caused severe environmental problems such as water pollution, eutrophication, habitat destruction, among others. In particular, changes in the estuary's hydrodynamics are being increasingly seen as especially damaging to the Ria's ecosystems, protected under the Natura 2000 Network. The dispersion of decision-making across 10 municipalities and various entities that have overlapping jurisdictions over the area has led to constant difficulties in finding coherent and articulated management solutions for the estuary's ecosystem as a whole. The Polis Coastline Programme — a governmental initiative of “integrated redevelopment and enhancement operations” in coastal areas — intended to address some of Ria's most urgent problems with an integrated “requalification” strategy. However, as it becomes evident from the opinions submitted during the consultations carried out in the context of the respective Strategic Environmental Assessment (SEA), the concrete meaning of sustainability in this complex semi-natural system is far from consensual among the different participants, and is often in tension with the vision behind the planned interventions. In particular, the role that the port is seen to occupy in a sustainable future constitutes an important focus of dispute. In this paper, through the analysis of written opinions submitted during the SEA consultation procedures, we shall explore how key-themes in local discourses dialectically interrelate in ways that ought to be considered by this territory's environmental governance.



Stakeholder engagement



Using participatory methods for coastal lagoon management and climate change

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The underlying concept of the LAGOONS project is that knowledge produced by different scientific disciplines needs to be combined together with local knowledge and stakeholders' views in order to produce integrated, participatory scenarios of possible future trends and conditions in coastal lagoons. During the project this aim will be reached through active engagement of stakeholders (and policymakers) via a three stage participatory process using three different forms of engagement (focus groups; citizens' juries; scenario workshops) in each of the four case study areas. This paper concentrates on the first step of this project's participatory process where focus groups were used as the initial method of engaging stakeholders to identify key issues in each of the lagoons, from the perspective of various groups (e.g. farmers, fishermen, local businesses). Between six and eight focus groups were conducted in each study area, led by the case study partners following a training session conducted for these partners. The outputs of these focus groups were summarised by the partners and then further analysed by the University of Dundee team, who led the stakeholder work, for the preliminary identification of the main drivers, issues and concerns per lagoon from the stakeholders' perspective. These focus group outputs are to be used to help decide the inputs required for the next phase of the participatory process, citizen juries. In addition, the training provided to the case study partners, who are not social scientists, through the University of Dundee team, contributes to an interdisciplinary understanding which is increasingly important in water and environmental management.

Sharing stakeholder knowledge in water resource management across boundaries and interfaces: experiences from Australian and New Zealand UNESCO HELP basins

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“Nurturing the opportunities for cooperation in water management among all stakeholders and improving the comprehension of the challenges and benefits of water cooperation can help build mutual respect, understanding and trust among countries and promote peace, security and sustainable economic growth.” (UN Water 2012). This paper discusses experiences from three UNESCO-IHP HELP program basins. At the Ord HELP Basin, northwestern Australia, an irrigation expansion project and investment in regional social infrastructure is driving the need for comprehensive water and development planning processes that incorporate new knowledge and a new set of economic, social and ecological values. In the lower Burdekin HELP Basin, northeastern Australia, sugar cane farming predominates and irrigators are looking to address current and future pressure to reduce their impact on adjacent wetlands and the Great Barrier Reef. And in the Motueka HELP Basin, on the south island of New Zealand, an 11 year Integrated Catchment Management program was seeking solutions to the impacts of upstream land use on downstream water quality, with very positive results. While none of these rivers cross international boundaries, it is clear that many of the challenges experienced at the international scale are replicated at other scales: across internal jurisdictional borders, through institutional confines, across environmental interfaces, between economic sectors and around a range of social norms. Through the lens of three HELP basins, this paper draws lessons from some recent approaches aimed at harnessing stakeholder knowledge as a critical input at the policy-stakeholder-science interface for improved management of transboundary waters.

Water-related citizen' complaints on a coastal wet land area: exploring the influence of local administrative boundaries

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This paper explores the water-related citizen' complaints submitted to the municipalities surrounding "Ria de Aveiro", a natural lagoon located in the central section of Portugal's Atlantic coast, and is aimed at analyzing how local administrative boundaries might influence the frequency, typologies and territorial pattern of complaints. It also analyzes the frequency of water-related complaints in relation to other environmental problems raised by local population. The proposed analysis assesses how the existence of such a large water territory that Ria de Aveiro is, influences the typologies of water-related complaints and the propensity of the population to complain about problems specifically related to the quality of this area. It is also analyzed the relationship between the extent of the water body of Ria the Aveiro within each municipality and the typologies of water-related complaints. The paper is organized into four sections. The first presents a brief literature review about citizen environmental complaints and their relevance for environmental and water resources governance, highlighting the role played by different sorts of stakeholders involved. The second section describes the case study and the methodology adopted. The results of the empirical study are presented in the third section with emphases given on the actors involved, the typologies of water-related problems referred to in the complaints, as well as, their territorial pattern. The final section critically analyses these results and questions the actual relevance of local administrative boundaries in the perception of water-resources related values as interpreted and communicated by citizens' complaints.

Success and failure in cooperative water resource management: case studies at the local and regional level

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This paper argues that the key to developing resilience to reduced water supplies, due to climate change or resource depletion, is cooperation between stakeholders at the local and international level. Using case studies at two different levels of analysis, the paper also holds that the lack of participatory methods of water management at the local level often feeds trans-boundary disputes and friction. It argues that the solution lies not in the withdrawal of the state from agriculture but in an involved state that transparently interacts with its farming communities.

Stakeholder collaboration for water governance in North Sea coastal regions

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Communities living in coastal lowlands and estuaries have to deal with constant environmental and societal change and increasing competition concerning space and resources. The southern North Sea region provides prominent examples for increasing numbers of spatial activities. Scarcity of space and impacts of climate change are becoming major drivers of land use and adaption management today. Focusing the water management in the low lying areas of the Dutch and German coastal zones, the status and the future needs of the drainage systems will cause considerable problems. Here, spatially integrated water management approaches need to be developed and harmonized, delivering adaptive strategies for a more sustainable development and focusing on human well-being to meet the future challenges. The Ems-Dollart region (German-Dutch transboundary region) is of significant ecological and socio-economic interest and part of international and cross-sectoral projects. Results of the study will be included in the integrated management plan (IBP) as instrument for mainstreaming different interests including the common objectives for sustainable development in accordance to the European Spatial Development Perspective.

However, changes in land use management may lead to beneficial and adverse effects on both human well-being and ecosystem health of a region. In current coastal and water management practices there is more emphasis on understanding the direct cost of human interventions for ecosystems, while a combined consideration of supplementary changes in benefits is generally missing. Development and management processes have to take into account that interventions cause environmental and social consequences which influence each other.

When decision-makers and stakeholders together with scientists deal with the challenges of an integrative approach inherently the question arises, how to develop participatory and adaptive strategies for sustainable development including the ecosystem services (ESS) and social needs? Related informal processes have started in the area of Krummhörn (North-West Germany). Stakeholders, engaged in sectors of agriculture, nature conservation, tourism, policy, spatial planning and water management, collaborate in inter-sectoral dialogues to develop holistic, long-term and anticipatory spatially explicit courses of action.

We developed and applied an integrated methodical approach to participative land use planning merging decisive elements of two powerful concepts (i) the ESS approach and (ii) the social impact assessment. Both concepts constitute the foundation to analyze complex socio-ecological systems and activities within the regional society and support land use management. The method contributes to optimize decision-making by improving the inclusion of ESS in planning processes focusing on the linkages with social impacts. Interactions with practitioners demonstrated that local decision-making cannot be based on the ESS approach directly. From a management point of view, thinking and acting is located within social units. Putting the method into practice, stakeholders express their experiences and needs in social terms without the need to understand the scientific background of the ESS approach which is often not easy to communicate.

It is argued that scientific and practical implications of this integrated assessment offer an improved understanding of human well-being, focus on multi-functional options and contribute to more sustainable practices in land use planning. The method operationalizes the ESS approach and social impact analysis and demonstrates that social demands and provision of ESS are inherently connected. It combines scientific driven and stakeholder driven decision-support gaining a holistic view including the ESS approach into the sphere of planning due to the interests and needs of the society and considers feedback mechanisms promoting courses of actions within planning activities.

A trans-disciplinary approach for refining water quality objectives in the Wet Tropics, Australia

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The Wet Tropics region contains the highest biological diversity in Australia, has outstanding environmental values, is economically important, and is located close to the Great Barrier Reef (GBR). Increasing urban development and agricultural intensification in the Wet Tropics has raised water quality concerns. This paper focuses on a three month pilot water quality monitoring program for a tropical basin in north-eastern Australia. This pilot program was implemented using a trans-disciplinary approach, including the results of personal interviews, community workshops and biophysical information, to provide guidance in developing a long-term community driven water quality monitoring program to refine water quality objectives. Indigenous Rangers from Giringun Aboriginal Corporation (a legally incorporated organisation representing the interests of Traditional Owners from tribal groups in the basin) assisted with both the personal interviews and the pilot water quality monitoring program. The pilot program helped verify whether a monitoring plan could be feasibly undertaken by a local community group such as the Giringun Indigenous Ranger Unit. The Corporation has expressed a desire to continue water quality sampling for this basin, and has recently applied for Queensland State grant funding to continue monitoring over the next three years. Results of this study are expected to provide a successful community-based framework to refine water quality objectives in a tropical basin. Additionally, this strategy may encourage greater acceptance and compliance of future management actions, and provide a template for use in other basins worldwide.

Scientists and stakeholders: can two separate worlds be joined for sustainable water management?

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According to the International Council for Science, science should be developed for the benefit of all. In face of complex environmental problems and of a need for the sustainable management of water, answers are increasingly requested from science. A science that can face such challenge must be constructed in cooperation with policy makers and society (hence enlarging the traditional scientific sphere), and its product must be effectively linked to policy. However, these new forms of science production always raise a number of obstacles: differences in interests, incentives and languages among these actors. These obstacles are further increased when the scientific issues are of low social relevance, which is the case with climate change.

This paper focuses a set of scientific projects financed by Circle-Med programme which dealt with management of hydrological resources in the Mediterranean region in a context of climate change. In this call, a strong appeal was made for research to be pursued in collaboration with local stakeholders and for the interdisciplinary of teams, as to include social science researchers. After the analysis of research projects' documents and interviews to coordinators, we conclude that the liaison to stakeholders has a very secondary role (and is often not even considered) in the scientific outputs. The current organization of science and public administration, as well as its under financing and focus on short term goals, was unanimously considered to be strong deterrents of the collaboration of science and society.

A decorative graphic consisting of a series of blue water droplets of varying sizes, arranged in a curved path from the bottom left towards the center. Below the droplets is a light blue wavy line that extends across the bottom of the page.

Planning water resources and land use

Integration of Coastal Changes trends in Coastal Management Plans: the short and medium term perspective of the spatial planning process

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Spatial planning can be seen as an interdisciplinary science that ensure to the sustainable development and land use, since integrates policy, social, cultural, economic and environmental management. Marine and coastal spatial planning is particularly challenging due to their vulnerable and dynamic nature and to the problems of sea level rising, erosion processes and land-use pressures in the coastal zone. Based on these challenges spatial planning processes in the coastal areas should address the potential impacts of climate change on coastal ecosystem, settlements and development, and develop policies/measures to minimize these impacts.

Coastal erosion, flooding and shoreline retreat are serious problems along the coast of Portuguese mainland. Past human impacts, inappropriate management interventions, climate variability and coastal dynamic have been identified as major contributory factors.

The study developed for the Portuguese central region (stretch Ovar - Marinha Grande) is integrated in the Coastal Management Plan and uses an innovative approach on coastal zone spatial planning. In order to address the problems regarding climate change, and considering the dynamic and complex nature of coastal environments, alternative planning policies were developed. The study also revealed the need of incorporate in spatial planning the socio-economic analysis and the identification and valuation of ecosystems services and land use, in order to ensure the sustainable development, but also to support de decision-makers.

According to this approaches the Coastal Plan was developed considering three environmental scenarios to respond to the coastal erosion trends, based on a development model for the coastal region. In addition, the scenarios consider the public investments constraints (national budget) expected to the next decade and the short and medium term of the Plan.

Assessing the impact of historical urbanization evolution patterns on surface water quality - the case of the Cértima catchment in central Portugal

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As urbanization around the world continues to grow, concerns over degradation of water resources have arisen in the experts' discourse in the areas of planning, ecology, economics and biology – leading to the study of land use planning beneficial to improvement and maintenance of water quality. The urbanization process in Portugal started later than in other parts of Europe – in particular as of the mid 70's and took heaviest toll in coastal areas that, in some cases, are severely threatened by increased levels of pollution affecting ecosystems processes, economic development and quality of life. Located in the Vouga cathment (central Portugal), the Cértima catchment is the most polluted catchment in Portugal and amongst the top-ten of most polluted catchments in Europe. The Cértima flows into the Pateira de Fermentelos, a shallow and natural freshwater lagoon that hosts an important wetland area and corresponding vulnerable ecosystem. Using the Soil and Water Assessment Tool (SWAT), we assess the extent to which historical urbanization patterns impacted surface water quality in the Pateira de Fermentelos. Results show that while urban land use increased from 5% to 8% over the period 1975 to 2006, nitrogen water pollution increased 25%. By 2006, more than half of nitrogen loads originated from urban areas – largely explaining eutrophication issues in the Pateira de Fermentelos. We show the potential benefits of crossing data outputs of a calibrated SWAT model with inter-temporal land use cartography, as to assess the impacts of historical urbanization patterns on water quality.

Estuary planning and management in Portugal - sharing local boundaries for water resources management

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Estuaries concentrate complex and often conflicting sets of natural, economic and social resources and activities bringing multiple challenges to institutional frameworks, planning and management approaches as well as governance practices dedicated to their protection, maintenance and resilience. Portugal has recently adopted a new set of estuary plans of regulatory nature, which combine the perspective of water resources management with that of land-use management. This paper explores the conceptual specificities of estuary plans in Portugal and their potential role in contexts of multiple resources, users, instruments and institutions. Given the mentioned complexity and vulnerability to global change, these plans may be crucial for seeking better environmental governance and greater resilience. The paper is structured in three parts. The first one through a literature review summarises some of the main conclusions about the role and specificities of estuary plans. The second part presents the legal and procedural features of estuary plans in Portugal and their integration within the water resources and land-use planning systems. The third part concentrates on the specificities of the River Vouga Estuary (Ria de Aveiro), a Natura 2000 area that needs to deal with different, and potentially conflicting, socioeconomic sectors. Departing from a SWOT analysis of the main environmental, socioeconomic and institutional features, the paper argues for the relevance of an innovative planning and management instrument - capable of reducing the tensions inherent to local administrative boundaries and of contributing to a collective vision of the territory through the articulation of values, targets, instruments and means.

Land-use and water resources planning systems in Portugal – driving from conceptual boundaries into real synergies?

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Spatial planning and development are critical components in maintaining and restoring water quality in streams, lakes, wetlands, estuaries and aquifers, as well as, crucial to prevent water-associated risks and to adapt to global change. An effective articulation between spatial planning, development control and water resources planning and management measures can contribute to the successful implementation of the Water Framework Directive 'basic measures' and can, consequently, help to encourage the sustainable management and protection of water resources. The way land use and water resources planning systems are tied and articulated, is a key issue for the deployment of the above mentioned potential. This article develops a critical analysis of the integration of the spatial planning and water resources planning systems in Portugal, and reveals new insights and conditionings for more productive synergies between these systems. Firstly it presents a literature review on spatial planning and water resources planning, with particular focus on arguments and the appeal for stronger ties. Secondly it concentrates on the Portuguese planning systems, questioning: i) how the Law on Spatial Planning and Urban Development establishes the main features of the spatial planning procedures and plan contents regarding water resources, and ii) how it brings new expectations for the adoption of more environmentally sustainable planning and water resources management practices. In addition, it analyses how the WFD and the Portuguese Water Law have introduced new challenges for the integration of water resources management concerns into spatial planning and, especially, urban development determinants.

Challenges in developing the first Portuguese marine spatial plan

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The European Commission recognizes the importance of marine spatial planning (MSP) as a key instrument to implement the goals of the European Integrated Maritime Policy and of the Marine Strategy Directive, while reaffirming ecosystem-based management and sustainable development as MSP overarching principles. This study describes the Portuguese MSP process, presents its legal framework and, finally, highlights some major challenges to its long-term adequacy regarding (1) transboundary issues and (2) adaptive management. The first Portuguese attempt at developing a marine spatial plan started in 2008 with the “Plano de Ordenamento do Espaço Marítimo” (POEM). A multidisciplinary team with representatives from various ministries was established and made responsible for developing POEM. Between 2010 and 2011, POEM’s public consultation process took place, and in 2012 a final version of POEM documents was completed and published. In order to ensure MSP sustainability there must be a close connection between marine spatial plans and other programs/policies, and decision making must account transboundary effects. This is especially important regarding the sea-land interface (POEM must be properly connected to coastal zone management), and cross-border effects with the Spanish EEZ and with international waters in the Atlantic Ocean. Moreover, a true adaptive management approach is essential in MSP and, thus, POEM must be revised/redesigned whenever necessary due to lessons learned and/or changes in initial conditions. Although the development and implementation of a proper marine spatial plan for Portugal poses a national challenge, it is viewed as a major contribute to attain a truly integrated and sustainable coastal/ocean management.

A novel concept: use of saline water in the water cycle of coastal cities

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Direct saline water, seawater or brackish water, usage for toilet flushing could alleviate the freshwater shortage, but its worldwide application was hindered due to several issues and challenges. Over the last decade a group of researchers from Hong Kong, The Netherlands and South-Africa developed, tested and applied a novel approach to water management in coastal cities, where saline water is used as secondary quality water. This approach addresses traditional issues such as the need for a dual water system, requirement for use of non-corrosive materials, issues with H₂S formation, impact of increased salinity on biological wastewater treatment, reduced reuse options due to saline effluent, and lack of proper cost-benefit analysis of different options, in a holistic fashion and introduces novel technological interventions and developments at various parts of the urban water infrastructure system. Direct use of saline water replaces a substantial part of freshwater usage, exploits sewerage as a bioreactor and introduces new Sulphate reduction, Autotrophic denitrification and Nitrification Integrated (SANI) process technology for treatment of sulphate-rich wastewaters. This paper outlines the concept that has been evolved over the last 50 years in Hong Kong and has recently matured to the degree that can be applied at full scale in coastal cities.

Linking Water management to Spatial Development; impact from EU to local level

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The co-operation between water managers and spatial planners depends heavily on its basic element: competing interests. Aspects that shapes the co-operation and define its effectiveness are language (discipline related jargon), contracts, trust, personal competences, policy tuning & policy instruments, institutional innovations, instrumental innovations and mental innovations. This co-operation is mainly informal of character. These aspects will be discussed based on a comparison of two case studies around water management and spatial planning. Another aspect are the recent evaluations of the European Commission that show that implementation of environmental directives proves to be a challenging task for the responsible authorities. This paper discusses also the relation between the implementation of the Water Framework Directive and the Birds and Habitats Directives with a focus on the Netherlands. Studies show that legal and procedural aspects of planning and decision making gain the most attention at the EU level (the formal side) and that environmental goals, e.g. around water and nature, are fading into the background, especially on the EU level. The difficulties that arise in the implementation process on a local and regional level are discussed and also the integration of both directives from a policy and practice perspective are presented.

Planning regional wastewater systems across borders

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Regional wastewater systems are aimed at guaranteeing surface water quality by properly collecting and treating the wastewater generated in the population centres of a region. But the most suitable planning regions are often divided by political or social boundaries and may include upstream-downstream surface water quality conflicts. A cross-border planning approach allows the coordination of pollution control and can embrace both economic and environmental considerations. In this paper, an optimization model for regional wastewater system planning across borders is presented to identify reference solutions for negotiation between parties, for the layout of the infrastructure to be included in the system. The model takes into account costs and the water quality in the receiving body, and is therefore able to meet the surface water quality standards in the shared waterway. The model is solved through a heuristic method based on a simulated annealing algorithm enhanced with a local improvement procedure. A region designed to replicate a real-world problem containing two countries is used as a case study. The transboundary wastewater system planning approach is compared with the consideration of separate systems for each country. The features of the transboundary solutions are discussed, with particular focus on the basis of the asymmetries in the willingness to pay. Two possibilities for cost allocation are analysed.



Integrated assessment and decision support tools



Study of Water Quality Classifier

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Over large parts of the world, humans have inadequate access to drinking water and so, have to use sources contaminated with disease vectors, pathogens or unacceptable levels of toxins or suspended solids that contribute to the spread of diseases. The control and monitoring of the drinking water quality is an open field and has become of prominent concern during the recent decades. This has resulted in the formulation of national and also international regulations for drinking water quality as this is a very important issue both in the first and in the third world. Each member state adjusts the required policing measures to ensure that the legislation is implemented. However, the scientific community has sought to find ways simpler and less costly to classify the water. The most used method of water quality evaluation is to generate a Water Quality Index (WQI) representing a single number based on a reduced number of parameters. This type of water quality assessment is useful not only for its ability to generate understandable classifications, but also for its potential to facilitate behaviour studies over time and also to feed machine learning classifiers for drinking water. In the present work some WQI methods will be studied and compared to finds new classifications approaches using only parameters measured in real time which will provide starting points for machine learning algorithms.

Challenges in the definition of transboundary indicators for Maritime Spatial Planning in Europe: the Portuguese example

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Maritime spatial planning (MSP) has a number of specificities that differentiate it from traditional planning efforts/products on land, i.e., the fluid/dynamic nature of the marine environment, the degree of interconnectedness of its components, and the complicated logistics of its monitoring, coupled to a still limited knowledge about its components and processes. Also, in order to increase its practical interest and chances of success, MSP initiatives should be articulated within neighboring spaces/territories and with planning efforts that apply to such spaces. This includes crossing political borders (intra and international), and physical interfaces, namely the coastal zone, where sea/land/air come in contact, or different ocean zones or layers.

Particularly relevant in planning/management processes is their evaluation, including the definition of a good system of indicators pertaining to its implementation, namely indicators of efficiency (governance) and of efficacy (environmental and socio-economic effects of the process' implementation). Appropriate indicators should fulfill a number of important requisites, i.e. being scientifically credible, easily measurable and understandable and sensitive to changes.

Development of evaluation mechanisms (including indicators) of transboundary effects of MSP needs to focus on common governance objectives of neighboring/overlapping initiatives and poses a number of other particular challenges, still relatively untapped: 1) focusing on aspects generated by maritime activities; 2) establishing a clear link between a given activity and its impacts; 3) pinpointing those aspects which may have an impact across the borders of a given plan, and 4) ensuring cross-border comparability of results (establishment of standardized methodological procedures). Different pressures (maritime and coastal activities) and differences in governance among coastal and maritime nations, complicate the definition and selection of transboundary indicators for MSP. However, an exercise of transboundary coordination is imperative from a cost and resource effectiveness standpoint (within and between countries), promoting greater efficacy of the monitoring/evaluation systems to be implemented.

We discuss the challenges and approaches to tackle transboundary indicators for MSP (including CZM) initiatives, using Portugal as a particularly interesting case-study: Portugal's maritime area, comprehending the Exclusive Economic Zones of mainland Portugal and of the Archipelagos of Madeira and Azores, and the area of extended continental platform, covers approximately 4 000 000 km², being one of the largest maritime areas in Europe. Portugal's maritime space has a number of (intra)national frontiers, and international borders with countries from inside and outside the EU (respectively, Spain and Morocco).

Among the various international and national instruments relevant for MSP that Portugal has to implement, broad transversal/common objectives are related to environmental protection and maintenance of ecosystem health. Relevant indicators proposed in such instruments can be broadly grouped in three themes: biodiversity, fisheries, and water quality and pollution. Each theme is discussed in terms of its adequacy to evaluate crossboundary MSP initiatives and of its relation to specific sectors, including those more pertinent to the Portuguese maritime space, namely, fisheries/aquaculture, nature protection, shipping, and off-shore renewable energy production.. We propose a set of recommendations for the development and implementation of indicator sets for transboundary MSP initiatives, which includes: starting with a reduced set of indicators that will set the stage for the construction on a common denominator acrossboundaries, and; building upon transboundary participation – both institutional, covering both sides of the “border” at stake, and public, opened to relevant stakeholders across the boundary.

Calibration and validation of a SWMM applied to Caneiro de Alcântara in Lisbon

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In 2005 SIMTEJO, the company responsible for the integrated sanitation of municipalities belonging to Tejo and Trancão basins (Lisbon, Portugal), in the framework of the Alcântara Waste Water Treatment Plant expansion project, implemented a partial model in Alcântara sub-basin on the software SWMM - Storm Water Management Model. SIMTEJO intends to have a decision support-tool on predicting volumes of waste water to treat during wet weather and corresponding discharges on the receiving environment. SWMM simulates hydrologic processes under unsteady conditions. The recent implementation of a real time flow measuring system upstream WWTPA, associated to two real time acquisition rain gauges, allowed a proper calibration of hydrological processes and subsequent validation of the mathematical model. Herein results of this calibration and validation process applied specifically to Caneiro de Alcântara, a critical section of Lisbon drainage system comprised by a closed conduit concentrating the flow drained over a 2717 ha basin, are shown and discussed. Calibration was made by using two flood events while validation was made using one event. Generally, errors on the prediction of total flow volume of flood events are within 10% to 20% whereas errors on the prediction of peak discharges are within 15% to 25%. The mathematical model applied to Caneiro de Alcântara is thus considered reliable and constitutes a useful management model at the service of SIMTEJO, allowing discharges prediction during extreme precipitation periods at critical sections. A continuous updating calibration procedure is envisaged in order to reduce errors while cumulative data is being gathered.

A participative ecosystem service mapping of four industrialized estuaries

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The TIDE project (Tidal River Development, EU - INTERREG IVB North Sea Region Programme) aimed at developing an integrated management vision and scientific inter-estuarine comparison, based on data and expertise from four intensively used NW European estuaries: the Scheldt (Belgium), the Elbe (Germany), the Weser (Germany) and the Humber (UK). As a first step, a screening of ecosystem services was performed, using expert surveys. The surveys provide an inventory of local demand and supply maps of ecosystem services in each estuary, distinguishing salinity zones and main habitats.

The assessment allowed to determine trade-off risks and synergy opportunities between ecosystem services. Internal consistency and accordance tests suggest that the supply data as well as the general assessment methodology are applicable in similar estuaries.

Performing an ecosystem service assessment with scientists and participation of a broad stakeholder group yielded a complete overview of ecosystem services, rose awareness on the importance of regulating and supporting services among estuarine managers, and was effective in setting the starting point for integrated assessment and management of estuaries.

Challenges for integrated assessment and Cost-Effectiveness analysis of mitigation measures for controlling water pollution

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Identification of challenges for integrated assessment of mitigation measures proposed to improve the ecological and chemical status of water bodies is explored in this paper. These challenges are addressed within a framework proposed for a spatially-distributed cost and effectiveness analysis. Resulting environmental and economic impacts of the implementation of measures are assessed using agro-hydrological and bio-economic modelling with effectiveness and costs calculated at each sub basin level. Cost-effectiveness ratios calculated over a long period of measures implementation depend on the location where measures are applied. Mapping costs and effectiveness at the basin sub-level reveals the locations where implementing a measure (within interval confidence) would be the most cost-effective. To compare measures between themselves, cost-effectiveness ratios can also be calculated for the whole catchment by adding up sub basin total costs, and by assessing effectiveness at the watershed outlet. Advantages and shortcoming of the integrated approach are discussed with challenges to investigate all the uncertainties related to mitigation programmes of agro environmental policies for reducing water pollution.

LAGOONS project - Integrated water resources and coastal zone management in European lagoons in the context of climate change

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The main objective of the LAGOONS project is to develop science-based strategies and a decision support framework for the integrated management of lagoons in the context of climate change. The LAGOONS methodology is based on an increased understanding of land-sea linkages processes and the science-policy-stakeholder interface. This approach combines knowledge and insights from an interdisciplinary team, working together to apply dynamic models of drainage basins for a range of scenarios and quantitative models of lagoons. In management terms, the project will seek to contribute to interface between the EU WFD, the Habitat Directive, the EU's ICZM, and the EU MSD. In addition, LAGOONS will propose actions foreseen in the goals of the Europe 2020 strategy. To fulfil the proposed objectives, 4 "hot spot" case study lagoons have been selected. These lagoons will provide a support for Pan-European integration through a bottom-up approach, showing that it is possible to enhance connectivity between research and policy-making in a lagoon's context using a proactive approach to water issues, which assures more efficient use of existing research results. Moreover, integrated scenarios will be formulated using also a participative approach to develop strategies and methodologies for integrated decision support for stakeholders, as well as with a special focus on recommendations of suitable use of ecosystem services.

In this paper, we introduce the main challenges and objectives of LAGOONS, which is one of two EU-FP7 funded projects on issues related to coastal lagoons. We will also present the current knowledge followed by a knowledge gap analysis.

Modelling and Scenario Analysis in the Management of the Trophic Status of Torrão Reservoir, Portugal

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Torrão reservoir is located in the river Tâmega, one of the most important tributaries of the river Douro. The watershed is characterized by a variety of land uses and there are several urban areas in the watershed, with some major urban poles along the river, accounting for a total Waste Water Treatment Plants (WWTP) discharge of ~100,000 p.e. The geometric mean of surface chlorophyll-a field data from April to September (1996 to 2009) was above the threshold of 10 µg/l (10.6 µg/l), thus making the Torrão reservoir a eutrophic system according to the criteria defined by the National Water Institute based on the implementation of the WWTP directive. An integrated watershed-reservoir modelling approach was implemented in this study. The SWAT model was implemented to estimate the input loads (flows and concentrations) from the watershed, and the output was used afterwards as boundary conditions to the reservoir model, CE-QUAL-W2. Load reduction scenarios were performed to quantify the total maximum input load that allows the reservoir to be classified as mesotrophic, it was estimated that a load reduction of 10% of the reference situation load would allow that the geometric mean for surface chlorophyll-a in dam wall could reduce to 9.2 µg/l. In conclusion, actions should target primarily the effluent water quality in some WWTP, but also diffuse source reduction in order to achieve the total maximum input load and mesotrophic level.

Support methodologies for oil spill prevention and response in a coastal lagoon (Portugal) integration of physical, environmental and socioeconomic dimensions

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Oil spill accidents can be caused by several risk factors associated to maritime transport and port activities, which cannot always be predictable or controllable. Therefore, it is essential to support prevention and contingency plans, which effectiveness is crucial to produce adequate responses and minimize resulting impacts.

The Ria de Aveiro (Portugal) is a wide coastal lagoon ecologically diversified, conjoined with a densely populated pole with several economic activities concentrated. One of the main objectives of this work is to construct a geographic information system database with crucial data, to contribute as an important support tool for the optimization of civil protection assets in the occurrence of an oil spill event.

The presented methodologies are based on: i) the Environmental Sensitivity Index developed by the North American National Oceanic And Atmospheric Administration (USA), with special focus on ecologic and geomorphologic domains – habitats and shoreline, respectively; and ii) the Global Vulnerability Index applied for the Bay of Biscay (Spain), that, adds a socioeconomical factor related to oil spills. However, during the development of present work, none of these methodologies, was considered to be able to entirely assess the study area, which leads to the necessity to adapt to an own approach. The introduced changes include extra categories in shoreline classification, considerations for the lagoon specifications, an adapted physical vulnerability index for lagoons, differentiated aspects for highly protection status areas, qualitative assessment of socioeconomic features and an access and operability index for contingency means deployment.

Spatial & temporal modelling of nutrient flows in Australian dairy catchments: Implications for water quality impact assessments in complex landuse mosaics

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Considerable resources have recently been invested in projects that have investigated the actual and potential economic, social and, particularly, environmental impacts of land management activities in a “catchment context”. These activities have resulted in the development of a much-improved understanding of the likely impacts of changed management practices within the farms and regions in which they were investigated, as well as the development of a number of conceptual models which place individual land uses within this catchment context. The research reported here has transformed conceptual models of dairy farm nutrient management and transport processes into a more temporally and spatially dynamic model. This has been loaded with catchment-specific data and used as a “policy support tool” to allow examination of the potential farm and catchment-scale impacts of varying dairy farm management practices, and of changing the landuse mosaic within some key Australian farming regions. Scenarios were examined ranging from simple, on-farm riparian management and changes in fertiliser use, to gross changes in land use. The results indicate that whilst implementation of environmental best practices can go some way towards reaching water quality targets, the effectiveness of most of these practices is limited. Changes to actual nutrient input rates have the most impact at both the farm and catchment scales, but these improvements come at a considerable cost to dairy productivity. Furthermore, because dairying occupies only a small percentage of the catchments investigated, changes to other land uses within the catchment, or changes to the regional landuse mosaic affect downstream water quality response much more than can be achieved by changes to dairy farm management practices alone.

Integrated modelling of goods and services provided by aquaculture to coastal systems

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Modelling coastal systems is a complex task as coastal areas are flooded by various water resources from both terrestrial and marine systems and because they are subject to numerous human pressures (e.g. pollution, overexploitation). One European task is to manage in a sustainable manner the use of the coastal system from a growing demand of space from various activities and the exploitation of coastal resources. Tools such as integrated assessment using ecosystem approach and Marine Spatial Planning (MSP) are developed to help decision makers in managing the coastal areas.

The ecosystem approach for aquaculture was applied in the FORWARD project (polislitoralriaformosa.pt/forward.php) to encourage sustainable development of renewable resources in the Ria Formosa (Portugal). Bivalve aquaculture is a good example of activity that can provide goods and services for coastal systems by reducing the eutrophication symptoms, offering seafood as an alternative to wild fish capture and hence as a measure to reduce the fishing pressure, and through the creation of jobs linked to the industry.

The project aimed to deliver management guidelines based on an interdisciplinary research at local and system scales, including hydrodynamics, watershed discharges, ecological processes occurring in the coastal areas and economics. The research approach was based on developing and adapting tools both to analyse and optimise carrying capacity of the Ria Formosa. These tools were integrated into a modelling framework including models for terrestrial water and nutrient balance, coastal hydrodynamics, coastal ecosystems and aquaculture production. In addition, best environmental practices (BMPs) and product certification were also reviewed.

The results from the modelling framework matched observed data from the Ria Formosa, including current aquaculture production. Social aspects and governance cannot be simulated with mathematical models but are indispensable for sustainable development of aquaculture. The interdisciplinary nature of the FORWARD project also revealed challenges with large potential impacts for aquaculture, especially groundwater nutrient inputs and biosecurity risks, which should be addressed by further research. The modelling framework proved useful for testing different management scenarios, and to help engage stakeholders in the application of decision support tools.

Combined assessment of climate change and socio-economic development as drivers of freshwater availability in the South of Portugal

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A combined assessment of the potential impacts from climate change (CC) and socio-economic development (SED) on water resources is presented for a large aquifer in the south of Portugal, under large pressures from water consuming and contaminating activities. We aim to understand how this may further be aggravated by CC and SED, particularly for agriculture, the largest water consumer in the region. Short-term (2020-2050) and long-term (2070-2100) CC scenarios were developed and used to build aquifer recharge and crop water demand scenarios, using different models and methods to account for uncertainty. SED scenarios were developed using a number of techniques, and discussed at workshops with farmers and institutional stakeholders in the water sector. Groundwater use was quantified for each scenario and then integrated with the CC scenarios. They were run through a calibrated groundwater flow model, to study their individual and joint impacts on water levels and discharge rates into the bordering coastal estuary where relevant freshwater dependent wetlands exist. Recharge scenarios show clearly negative long-term trends, but high uncertainties in the short-term. Scenario SED1 predicting intensification and decline of small farms, considered by stakeholders to be most likely, shows a large drop in agricultural area and water demand. SED2, the most desired scenario, foresees growth and modernization of agriculture, but could be unsustainable in combination with CC. The joint analysis of CC and SED revealed to be challenging but useful. It involved the use of different methods across the border between natural and social sciences, aiming to contribute to transdisciplinary water management.

Proposing an integrated assessment methodology to analyse the economic impacts of climate change on the renewable energy sector in Portugal

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Climate change is a major challenge faced by mankind. It results to a large extent from human action through the emission of greenhouse gases (GHGs), particularly from the energy sector. As concerns about the consequences of economic activity on the environment increase, studies about the economy-energy-environment system thrive, and integrated assessment approaches, which combine economic and climatic/biophysical components, emerge. Few studies focus on the renewable energy sector in the face of climate change – even less so for Portugal. This constitutes a gap in scientific research that hampers the formulation of informed environmental-economic policies for climate change mitigation and sustainability. Thus, our aim is to perform an integrated assessment of the impacts and feedbacks between climate change, natural resource availability (mainly water), the energy sector (namely hydropower) and the Portuguese economy, applying climate change and catchment modelling approaches to analyse the physical impacts of climate change, and partial and general equilibrium models to evaluate their economic consequences.

Optimal operation of multisource water supply systems including water transfers

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This paper describes the application of a simulation-optimization model aimed at helping water utilities determine the best way to operate large-scale multisource water supply systems that depend on surface water and groundwater resources. The model includes a detailed simulation of the water storage in reservoirs, the groundwater flow in aquifers and the water transport in terms of quantity and quality in a discretized distribution network. The operation of the water systems is optimized in terms of reducing operating costs, satisfying demand and water quality. When applied here to the Barlavento Water System (Algarve-Portugal) the model considers the possibility of expanding the capacity of the current water system through an inter-basin transfer of surface water. Water transfers are often used for meeting growing demand and for managing the impact of drought on urban water supply systems. The results presented here highlight the potential of the envisaged inter-basin water transfer as an effective supply-side option for expanding the capacity of the Barlavento Water System, as long as interannual management of the water resources is implemented.

Poster Sessions





Transboundary Spatial Planning between Extremadura (Spain) and Alentejo-Centro (Portugal)

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The “General Direction of Transports, Spatial Planning and Urbanism” from the “Regional Government of Extremadura” has developed three projects involving transboundary watersheds of Tajo and Guadiana rivers, both of them are developed around Alqueva Reservoir in Guadiana River (PEGSA and PUGLA) and the third one is developed around the Tajo River (EDTAFTI).

Both EDAFTI and PEGSA are configured as a summary to aid understanding and joint management of a territory with several territorial regulations. PUGLA is to encourage reflection on the rules of water uses in the Spanish area in accordance with POAAP in the Portuguese one.

Improving of drinking water quality in small rural municipalities in the Czech Republic

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In the Czech Republic there are current problems with improving quality of drinking water from small water resources. Water quality in smaller water-supply systems (mainly in municipalities to 1000 inhabitants exploiting own water resources) is long-term statistically worse than drinking water from large water-supply networks. The current solutions usually reflect mainly the situation of large settlements and large water supply companies. As a result of this situation, the rural population has drinking water of worse quality, although mostly within the required drinking water standard. The solved project aims to address the situation comprehensively in the form of a systematic and professional approach to the management of small water resources in order to achieve optimal quality of drinking water for common situations as well in emergency situations.



A multilevel approach to monitor and help manage the development of cyanobacterial blooms in lakes and reservoirs

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Climate changes are enhancing the frequency of cyanobacterial massive growth in freshwaters. Most of these blooms are toxic and put at risk the water quality and human health. Moreover, the persistence of a bloom throughout a same River Basin is often recorded, which highlights the need for integrated water management plans, namely across borders. Therefore, effective management strategies to predict and control cyanobacterial blooms in “hotspots” along the Hydrographic Basin are preferable to large investments for the mitigation of the blooms’ consequences. The World Health Organization has proposed alert levels based on chlorophyll a concentration and cyanobacterial cell density. Yet, cyanobacteria-specific pigments (phycocyanin) can rapidly indicate a more specific alert level. This study proposes a stepwise monitoring approach primarily based on fluorometry (phycocyanin levels for a real-time screening of cyanobacterial blooms). However, fluorometry does not give information about dominant species and its (their) toxic potential. Consequently, other methodologies are proposed sequentially: 1) microscopic identification and cell counting (only when phycocyanin levels rise above the thresholds defined for a bloom); 2) molecular approaches (16SrDNA-DGGE and sequencing will aid in the assessment of spatial hotspots and identification of dominant cyanobacteria); 3) PCR-based approaches (to assess the potential for microcystin, nodularin and cylindrospermopsin production); 4) ELISA assays (when justified, cyanotoxins will be analytically quantified). This chain of results gives alert levels with a higher level of confidence and may provide the necessary information for triggering contingency actions and, most importantly, for planning management strategies by the different stakeholders.

Combine use of nanofiltration and electro dialysis for eutrophized water phosphorus recovery

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Phosphorus (P) inputs in surface waters from point and non-point sources are considered the main cause of eutrophication. The best approach is to effectively treat water in order to clean it but, at the same time, use the waste produced that is rich in P, to recover this valuable nutrient for further re-use, namely in agriculture. Nanofiltration (NF) applied to water reservoirs produces a clean stream and a concentrate stream that contains contaminants but also P. The application of the electro dialytic (ED) process to this concentrate stream promotes the movement of species out of this matrix, towards one of the electrode compartments, where they concentrate and may be removed. The present project aims to survey optimized conditions for NF coupled with ED in order to search for an integrated solution.



Protected zones of surface water and groundwater for human consumption - evaluation of raw water and its application in practice

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Groundwater and surface raw water is a basic source for drinking water supply. These water resources are protected by various types of protected areas. It is inevitable to protect not only water quantity but also to secure its quality. On the territory of the Czech Republic there are nowadays only for drinking water-supply more than 1700 registered water intakes of groundwater and 170 water intakes of surface water. Results of their chemical analyses are evaluated by water-supply operators, and then they are transferred to water management authorities. The project has a purpose to mediate evaluated data of raw water quality to water authorities, which take it into account during their decision making processes.

Evaluation of physico-chemical and microbiological parameters of the estuarine waters of the Baía do Iguape, Conservation Unit in the Bahia state, Brazil

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The aim of the present study was to assess the water quality of the estuary of the Federal Conservation Unit called the Reserva Extrativista Marinha Baía do Iguape, located in the State of Bahia, Brazil. To carry out the physical, chemical and microbiological analyses four water samples were collected on December 15, 2011, in areas most involved with extractive activities and dealing in some way with anthropical influences due to the proximity to settlements surveyed. In this perspective, the physical parameters analyzed were: total solids, temperature and Turbidity. The chemical variables were the Hydrogenic Potential (pH), conductivity, dissolved oxygen (DO), total Phosphates, nitrates and biochemical oxygen demand (BOD). The microbiological analysis were the percent of faecal coliforms and totalcoliforms. Heavy Metals analysis measured the percents of zinc, Cadmium, copper, lead and manganese. The data obtained were confronted with legal standards laid down by the Conselho Nacional de Meio Ambiente (CONAMA), as Resolution 357/2005 and specific literature. From the above, the findings in which the variables presented levels above the limits set by the current laws (CONAMA 357/2005) were: pH, nitrate, Phosphates, coliform (fecal and total) and the heavy metals cadmium, copper, lead and zinc. As seen, more studies are needed in order to diagnose more specifically the possible sources of contamination in this environment, as well mitigating measures are most necessary to confront this problem that affects this estuarine ecosystem of great ecological and socioenvironmental relevance.



Finding proper scales for a statewide SWAT modelling in case of Estonia

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Selecting proper scale for statewide hydrological modelling implementing swat model and covering the major part of the territory Estonian republic (45,227 km²) has been investigated at the first stage of the Estkliima project. The Estonian base map corresponds to the scale 1:50 000 which has been often considered to be sufficient for statewide analysis. It was found that it is not sufficient for accurate watershed delineation and LIDAR based DEM should be preferred. However, the LIDAR-measured dataset is tremendous and needs substantial computer workload for DEM generation. CORINE Landcover often used for EU-wide and statewide analysis is too coarse for small watersheds. The Estonian base map and Estonian basic map, (1:50,000 and 1:10,000, respectively) are more suitable, the first one is too general (e.g. too broad type 'natural area') and the second one is even too detailed in case of man-made objects and should be upscaled. The Estonian soil map is available with different scales (1:1,500,00, 1:1,000,000, 1:200,000 and 1:10,000). The last one is the most accurate, however it is even too detailed, lacking hydrological parameters for all specified soil types. The need for downscaling and upscaling is analyzed in the present study.

Environmental management strategies for a region of contrasts: a case study on the coast of Alagoas – Brazil

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The ecological, economic and cultural transformations in the last three decades in the study area in the municipal district of Marechal Deodoro, State of Alagoas, occurred through exempt actions from a sensitive and respectful vision to the environment by showing one of the greatest examples of distortion and dismantling of local ecosystems. The lack of effective actions by the local political and economic powers has compromised the environment and its resources, basis of current and future activities, invalidating the possibility of recovery of this area. On the one hand, there is a lack of public and human resources, and, on the other hand, a political will for decision making and for the accomplishment of education and awareness work, directed to sustainable ways of environmental resources uses.



The ÁGUEDA project: a supporting tool to a transboundary watershed's management

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The Águeda's project is an ongoing work in the framework of the POCTEP program funding by FEDER. The research team includes the European University of Miguel de Cervantes (Spain), the Research Center of Natural Resources and Agrobiological of Salamanca (Spain) and the Polytechnic Institute of Castelo Branco (Portugal). The main core of this project is the construction of methodological body to be used as a generic and flexible tool. The first step was the watershed's environmental characterization aiming a dynamic risk analysis and the its spatial-temporal planning as a leverage to a better land use, specifically when shared management has still some issues to overcome between the two countries. A geographical information system (GIS) will merge all information allowing a spatio-temporal visualization and a dynamic model's fit.

Evaluation of the impacts of the climate change on the crop water demand, water resources and water quality in the Jalón River basin (Northeastern Spain)

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Most of the climatic models predict the rise of temperature and the reduction of precipitation in the Ebre River basin for the last decades of the 21st Century. The most probable effect will be a significant decrease in the water resources, especially in some sub-basins located in the right margin of the Ebre River, such as the Jalón River basin. The Jalón basin (10187 km²) accounts for the 12% of the whole area of the Ebre basin and it is located in the southern region.

A water balance model has been constructed and calibrated to reevaluate and extend the provisions of the Water Plan. The semi-distributed model was implemented using the program VISUAL-BALAN. Changes in water resources and in crop water demand were evaluated for climatic scenarios A2 and B2 of the IPCC and for the period 2071-2100.

Besides the water balance, a chloride mass balance was calculated in order to assess the evolution of the water quality due to the effects of the climate change.

Significant impacts of the climate change on the water resources are expected in the Jalón River basin. However, a proper management of the water resources, based on reasonably accurate predictions, can help minimize the negative impacts.



SWAT based multiscale modelling in the Vouga catchment

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Aquatic and terrestrial ecosystems are increasingly affected by water pollution as a consequence of unplanned and unsustainable human activities along the river banks and on the linked catchments.

Water quality assessment and management are a crucial part of an overall integrated water resources management aiming the reduction of water pollution. Point and diffuse source pollution may have a potential environmental negative impact on the catchments and associated ecosystems services and values.

Water quality assessment impact requires a multi-scale ambient-focused approach varying from the micro and local modelling scale to the macro and regional modelling scale.

In this study we merge the outputs from “different” SWAT models which, in turn, were focused on a wide range of sub-basins analysis on the Vouga catchment. Different analyses were carried out by different research groups aiming at the assessment of agricultural management scenarios and best practices, water quality calibration and assessment, soil analyses, flow calibration, historic climate changes and future climate change scenario forecast.

In this work we intend to debate the way in which a micro scale SWAT modelling can be used and combined to create a solid and calibrated range of parameters and scenarios to improve the overall SWAT model accuracy and results for water quality on a regional catchment scale, for all the Vouga river basin.

Analysing the influence of different monitoring strategies on nutrient yield estimation from a small rural catchment in NW Spain

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Accurate estimation of nutrient loads in streams is essential for making decisions and formulating management plans at local, national and transboundary scales. Inaccuracy or imprecision of load estimation limits its use in environmental assessment and management, trend detection, and catchment simulation. This study investigates the influence of the sampling strategies on nutrient load estimation and its effect on SWAT (Soil and Water Assessment Tool) model calibration. The study was carried out in the Corbeira catchment, a mixed land use catchment representative of the rural environment of NW Spain. The nutrients evaluated were nitrate (NO₃) and phosphorus particulate (PP). The results showed that nutrient load estimations differed depending on sampling strategy, especially for PP. The data demonstrated that monthly and biweekly sampling strategies may be used to estimate adequately annual NO₃-N load in this catchment. However, it is necessary a runoff event monitoring program to achieve accurate PP load estimations. The selected sampling strategy affects the model calibration and leads to different parameter settings to describe the same processes within the catchment. This highlights the importance of the selected sampling strategy for modelling nutrients in rural catchments.



Modelling nitrate transport in a rural catchment in NW Spain using the SWAT model

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Diffuse-source pollution of the aquatic environment has become one of the most crucial environmental problems in the world. The assessment of spatial and temporal variations of water quality influenced by diffuse source pollution is necessary to manage the environment sustainably and should be studied at catchment scale. The objectives of this study were to assess the utility of the SWAT (Soil and Water Assessment Tool) model to simulate nitrate (NO₃-N) load and to determine the contribution of different land uses to NO₃-N load. The performance of the model was tested on the Corbeira catchment, a small (16 km²) catchment representative of the rural environment in NW Spain. The results showed that SWAT is an appropriate tool for simulating monthly NO₃-N load under the prevailing conditions in the Corbeira catchment and can provide a useful tool for further eco-hydrologic research in the region.

The model results also indicated that agricultural lands were the largest contributors of NO₃-N in the catchment because the N-fertilisers applied to the fields are the major source of NO₃-N. Furthermore, groundwater was the major nitrate transport pathway to the stream, accounting for 63% of the total NO₃-N load. Based on these results, appropriate management of fertiliser application, reducing NO₃-N leaching, will be a key factor in reducing loads in this area and in catchments with similar characteristics.

Open source and public domain GIS embedded hydrological modeling: and case studies and software application

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Sustainable water management and planning needs basically data on the availability and evolution of the water resource in space and time, but also tools and methods to analyse such data and to provide forecasting simulations. The SID&GRID project, funded by Regione Toscana (Italy) under the POR FSE 2007-2013, developed a hydrological model based on open source and public domain solutions embedded in a GIS interface, applications and library, where all the input and output data are managed by means of DBMS. The resulting implemented code is fully distributed and physically-based and it couples 3D existing and newly developed surface- and ground-water and unsaturated zone modeling codes.

A GUI, thought as a “master control panel”, has been developed to guide the user from pre-processing spatial and temporal data, running the hydrological model, and analyzing the outputs within the gvSIG GIS framework. Aside from views and tables, a new gvSIG “model” project object, having its own dashboard controller and property setting, has been implemented. Several codes were reviewed to get information on the potentiality, flexibility and weakness of each of them. The following codes have been selected and are integrated: 1. Postgresql/PostGIS for the GeoDatabase Management System; 2. gvSIG with Sextante geo-algorithm library capabilities and Grass tools for the desktop GIS; 3. Geoserver to share and discover spatial data on the web; 4. new SID&GRID tools based on the Sextante GeoAlgorithm framework; 5. MODFLOW-LGR for local grid refinement; 6. VSF for the variable saturated flow component; 7. new developed routines for overland flow; 8. new algorithms to compute the net rainfall rate, as input for the unsaturated/saturated flow model.

Concerning the groundwater part of the code, the LGR capability has been extended to the 3D solution of the Richards' equation in order to solve in detail the unsaturated zone where required, as, i.e., in irrigation areas or around wellhead protection zones. Test and case studies, ranging from synthetic to real world examples, have been implemented to demonstrate code applicability. Results may be used to perform water management relying on distributed and time-dependant water budgets, avoiding averaging calculations on yearly basis. Further code development will include solute transport and flood simulations capabilities.



Transboundary water management in the Vistula Lagoon – regulations, problems and conflicts

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Laws, environmental and economic problems and conflicts in the Vistula Lagoon are discussed. Being one of the largest European inner marine basins it belongs to an EU member Poland and non EU Russia's Kaliningrad Oblast. The direct connection with the sea through the Baltiysk Strait is in the Russian part. The access through Vistula River branches is available to small vessels only, so the isolation of Polish part is a key problem. Despite a visa-waiver between the Kaliningrad Oblast and Pomeranian Province the navigation still requires a permit a month before the arrival. The Strait is also a source of saltwater transport into the lagoon and upstream the Pregola River, affecting fresh water intakes there.

The Polish and EU laws are consistent including the pan-Baltic treaties. The Russian law incorporates Baltic-wide conventions. Two different legal systems hamper effective management of water quality and fishery in the lagoon.

The Polish part pertains to two provinces. The northern Vistula Lagoon Spit offers nice sandy beaches. Fisheries and tourism are the remaining activities. The southern part faces very high unemployment, but both provinces seek little joint efforts; indifference between the Spit and the south continues.

The Polish part of the Lagoon is under NATURA 2000, restricting fishermen and developers' activities. Fishery loses resources due to the growing population of cormorants. The hottest problems are: eutrophication, overfishing and the absence of joint monitoring program.

There is a need for joint harmonization of economic plans, intentions and legislation on coastal zone management and nature preservation.

On-going projects on interdisciplinary research approaches and multi-scale analyses of Ria de Aveiro coastal lagoon and linked interfaces

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The Aveiro lagoon area has been the focus of considerable research work gathering different specialists and thematic perspectives. These projects together handle a multi-scale territorial analysis of Ria de Aveiro, varying from the entire Vouga River basin, to small subcatchments and linking these to the downstream coastal ecosystems.

Issues of concern of these projects involve a wide range of topics and methodologies, being some of them multidisciplinary – including integrated water management, water resources modelling, spatial planning, stakeholder engagement and water quality status, among others.



Sea level rise impact in Lagrangean transport at Tagus estuary and Ria de Aveiro lagoon

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The main aim of this research is to assess the sea level rise impact in the Lagrangean transport in two Portuguese coastal systems (Tagus estuary and Ria de Aveiro lagoon), namely in their salt marshes, throughout the application of the 2D hydrodynamic numerical model MOHID, coupled with a Lagrangean particle-tracking module. The hydrodynamic model was previously implemented and validated to Tagus estuary and Ria de Aveiro lagoon. The models were used to determine the Lagrangean paths of passive particles released in selected areas of both estuaries. In order to determinate the sea level rise impact in particles transport two scenarios were adopted: actual sea level and local sea level rise projection.

The results indicate that Lagrangean trajectories are changed by sea level rise, revealing that nutrient and cohesive sediments dispersion might be affected in the future scenario, both in the Tagus estuary and in the Ria de Aveiro lagoon. Consequently, changes in hydrodynamics could influence the actual equilibrium of the systems behaviour and affect the normal state of the contingent biological communities, namely salt marshes.

Salinity patterns adjustment of a mesotidal lagoon induced by climate change

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Climate change impacts evaluation in transitional environments is essential for the definition of effective adaptation strategies. Ria de Aveiro lagoon, a complex shallow water system located in the northern coast of Portugal, is a highly productive ecosystem susceptible to ecological stress as a consequence of salinity patterns adjustment in the scope of climate change scenarios. Ria de Aveiro is a typically estuarine environment as longitudinal salinity gradients occur during most of an average year due to the interaction between tides and river flow.

The Ria de Aveiro seasonal salinity patterns adjustment to projected changes in mean sea level and river flow regimes for the end of the XXI century according to IPCC scenarios is investigated by means of numerical modelling with MOHID 2D. The hydrodynamic and the salt transport models were calibrated so that the model is able to reproduce salt transport processes with relative accuracy. The MOHID 2D numerical model was then applied in the simulation of reference and future scenarios combining local MSL rise and projected river flow.

The results obtained, in particular: the salinity concentration increase and the salt inland intrusion; the upstream saline increase as consequence of river flow projected reduction; and the larger salinity increase in upper lagoon regions, are in accordance with the ones achieved in the majority of the studies related to SLR impact in estuaries salinity, found in literature.



Applications of artificial intelligence based tools to distinct problems related to different aspects of the water sector

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The present work describes 2 (two) applications based on Artificial Intelligence based tools for problem solving in the water sector. The former describes the use of Artificial Neural Networks (ANNs) to forecast the water quality of the Odivelas reservoir. The latter is concerned with the development of clustering models applied to the public water supply system. In this case unsupervised learning was used to find water clutches with similar physical and chemical properties. Decision Trees (DTs) were used in order to generate explanatory models of the envisage clusters. The model of the 3 (three) clusters that is shown seems to be the most adequate since it allows one to discern among the waters taken from different sources.





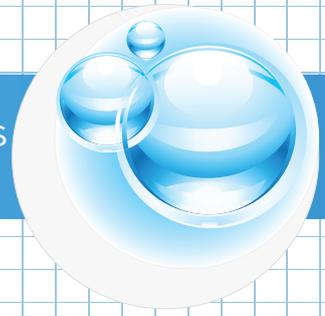
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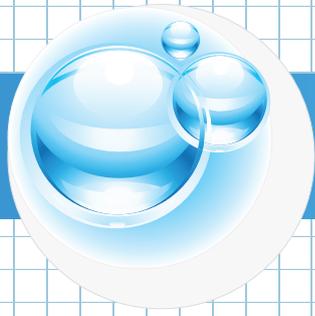
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