DANUBIUS-PP

Preparatory Phase for the pan-European Research Infrastructure DANUBIUS–RI "The International Centre for advanced studies on river-sea systems"

DANUBIUS-RI masters training programme module

Deliverable 9.5

European Commission

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1 Introduction

This report outlines a Masters-level module content to support the research and educational needs outcomes from the Preparatory Phase for the pan-European Research Infrastructure DANUBIUS–RI “The International Centre for advanced studies on river-sea systems” project (DANUBIUS-PP): This is in fulfilment of Deliverable D9.3. DANUBIUS-RI masters training programme module.

The module materials will be web-based and designed to be incorporated into any new or existing Master’s level course provision that has a focus on the integrated management of river-sea systems spanning traditional disciplinary and geographic boundaries. These materials will be freely available to:

- any teacher who wishes to construct, validate and deliver such a course, or use any part for teaching;
- any person who wishes to learn more about the integrated management of river-sea systems.

Specifically, the course materials are designed to develop an understanding of the management needs from societal and environmental contexts for the integrated understanding of the functioning of river-to-sea systems and address the key societal challenges associated with, and opportunities they provide. The course materials build upon a proposed new education program for the Danube-Black Sea (DBS) region from the FP7 project DANCERS (DANube macroregion: Capacity building and Excellence in River Systems (basin, delta and sea)). The module design allows an implementing institution to ‘front-end’ and ‘conclude’ a taught module with content designed to support the objectives of the DANUBIUS-RI project and provides indicative content for the rest of the module that can reflect the ‘local’ specificity of the geographic locality and/or overall course focus.

Study of the module materials will develop a detailed and critical knowledge for the management of river-sea systems, including:

1. Environmental system dynamics that can be compared across Europe;
2. The implications of catchment/marine pressures on system function;
3. The consequences of human agency; and
4. The importance of conserving or enhancing the ecosystem services that these systems provide for society to ensure future wellbeing.

1.1 Project background

River-Sea Systems (RSS) comprise rivers and their catchments, estuaries, deltas and lagoons, as well as their adjacent coastal seas (Figure 1). As such, River-Sea Systems cover freshwater, transitional and coastal waters, including semi-aquatic and semi-terrestrial environments, such as floodplains. The extent of a River-Sea System is defined by the surface-water (or groundwater) boundary and the marine boundary, which is more variable. It is defined by the extent of riverine influence on individual parameters of interest. RSS are very dynamic and highly complex due to various interfaces and interactions: longitudinally (freshwater to marine), laterally (river to floodplain; coast to sea), and vertically (surface to groundwater) with interrelated processes between physical, chemical, biological components as well as social and economic processes (Figure 1). These processes provide a wide range of valuable ecosystem services to humans that face compounding pressures: from climate change and human drivers, such as urbanisation, energy generation, waterborne transport, agriculture and fisheries at different spatial (local, national and global) and temporal (seasons to centuries) scales. The resulting changes in the structure and the functioning of River-Sea Systems lead to the decrease or loss of ecosystem services. This poses a number of societal challenges, for example, eutrophication, hypoxia, pollution, changes in hydrology, sediment transport and morphology, loss of biodiversity and sea level rise. A diverse range of disciplines have shown interest in exploring various aspects of the water continuum partly reflecting the disciplinary structure and organisation of research but also reflecting the wide range of processes that are part of the RSS. Attempts to understand and manage RRS also are reflected in the diversity of policy instruments that are applied. For instance, in Europe these include the Water Framework Directive 2000; Floods Directive 2007; Marine Strategy

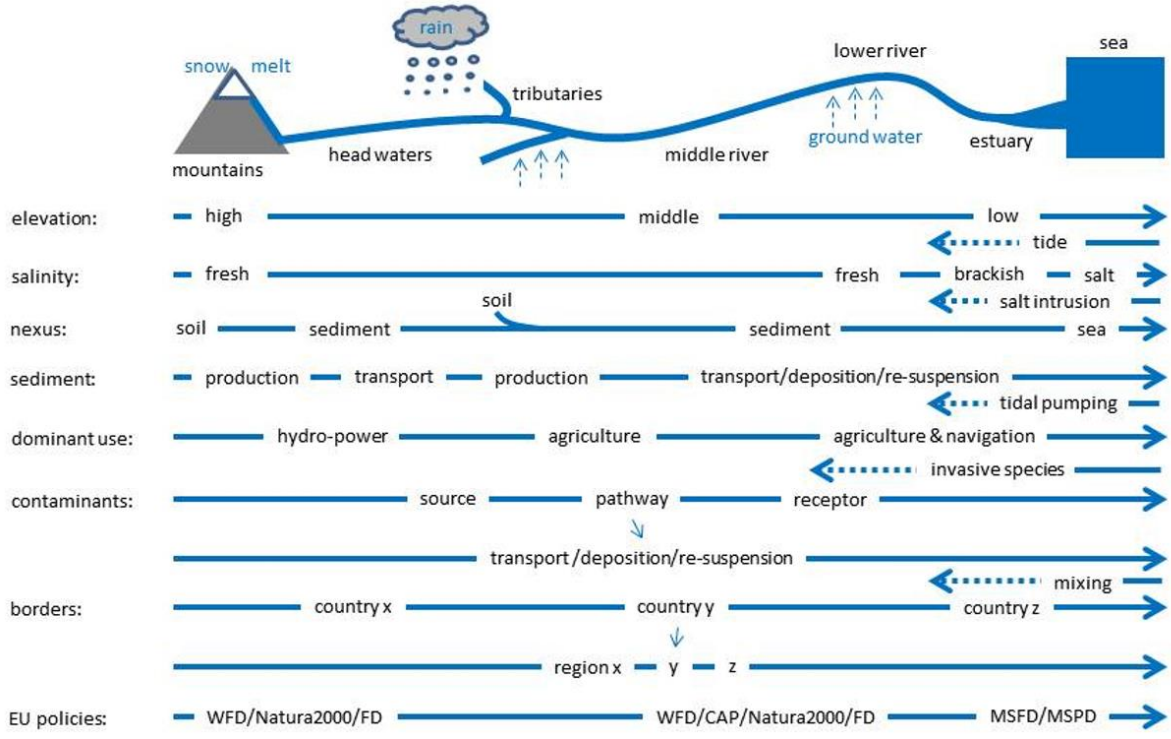

Figure 1. River-sea continuum (extremely simplified; by Brils, Deltares).

Framework Directive 2008; Natura 2000, and there is no Sustainable Development Goal that does not have some connection to RSS. Analysis of the current research space pertaining to the RSS has recognised that the current situation leads to distinct gaps in terms of geography, disciplines and policy that means the RSS is not addressed as a continuum but rather as a series of disconnected fragments.

To address the current fragmentation, Integrated water resource management (IWRM) has been proposed by the DANCERS FP7 project (Habersack *et* al. 2015) as a means to overcome the interconnectedness of social, economic, hydrological and ecological needs in river basins and associated coastal zones. The IWRM approach uses the basin as the managed unit, and recognizes the dynamic relationships between stakeholders and central governments who must work together (the Danube catchment includes 19 countries) to meet sustainable development goals. Thus, IWRM aims to balance the needs of stakeholders while balancing the needs of the environment. In principle, it achieves this through the coordination of management across sectors and the active engagement of stakeholders and policy-makers at multiple scales, including local, national, and international. The knowledge skills required to overcome the current challenges to break down the traditional silos of research disciplines was identified as a priority to develop an integrated and more holistic understanding of the Danube river-delta-sea system, including:

- Application of pure and applied research spanning and integrating across the disciplines in the science and humanities;
- Understanding of environmental, ecosystem and natural resource management and governance and planning from the local to the international level;
- Addressing the needs of industry that sustainably builds on the ecosystem goods and services of river-delta-sea systems; and
- The relevance of environmental policy, law and regulation.

1.2 DANUBIUS assessment of needs

The DANUBIUS project has identified that current gaps centre on approaches that span traditional disciplinary and geographic boundaries, and be implemented in a consistent and quality assured framework, particularly at the freshwater-marine interface. These approaches need to integrate the biological, chemical and physical sciences, and recognize the significance of interacting social and economic processes, to better understand a complex set of biogeochemical and socioeconomic interrelationships and feedbacks. Four overarching and interrelated challenges in River-Sea Systems have been identified: (i) Climate Change and extreme events, (ii) Water Sufficiency, (ii) Sediments and their Management, and (iv) Ecosystem Health (Figure 2).

The effects of *climate change and extreme events* will be particularly marked for the water cycle in general and in River-Sea Systems with considerable socio-economic impacts, requiring long-term mitigation and adaptation for human well-being. *Water Sufficiency* relates to ensuring continued water availability for both anthropogenic and environmental needs. It includes water of sufficient quantity as well as quality of both surface waters and groundwater along the freshwater-marine continuum to maintain ecosystem functioning and to provide ecosystem services. *Sediments and their Management* is also a cross-cutting issue, with links

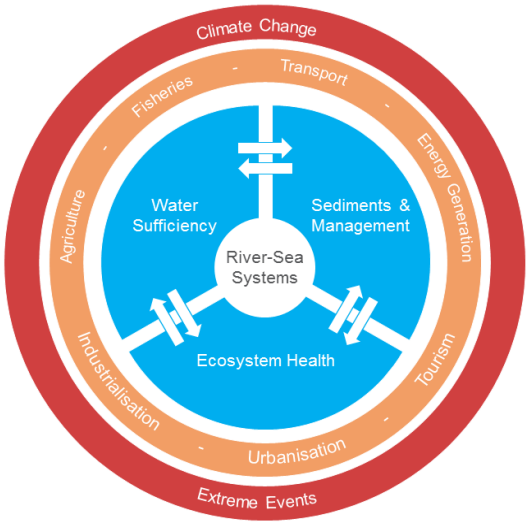

Figure 2.External (Climate Change and Extreme Events) and internal drivers (Fisheries, Transport, etc.) resulting from basic human needs cause cumulative effects on River-Sea Systems. DANUBIUS-RI identified overarching challenges related to Water Sufficiency, Sediments and their Management, and Ecosystem Health.

to, and possible consequences for, many different sectors, regulatory interests and management requirements. *Ecosystem Health* links the biophysical understanding of how natural River-Sea Systems function with societal goals and human values.

1.3 Knowledge gaps

Deliverable 2.3: "Review report on environmental, societal and policy challenges in RSS and emerging research and legislation needs" has identified the knowledge areas required for sustainably managing river-sea systems as those that inform:

i. The sustainable use of the key ecosystem services provided by river-sea systems;

ii. Opportunities for Knowledge Exchange and Transfer with business and society; and

iii. Environmental policy development, regulation, societal well-being, economic growth and river-sea system management.

Such knowledge is necessary to evolve a holistic understanding and management of interacting environmental and socio-economic processes. A central nexus that frames environment and socio-economic interactions is the material fluxes arising from movement of water, sediment, contaminants, through the RSS from source to sink. These material fluxes are highly variable, both in time and space; and affected by socio-economic activities such as agricultural practices, urbanisation and river regulation (e.g. for hydropower and navigation) and coastal engineering works. The four challenges identified above represent the research areas that provide the information base to address the three knowledge areas.

2 Content and Target Audience

The Masters-level module is designed to develop capacity to understand how current research methods and results can contribute towards sustainable development of RSS, protecting the environment whilst also realising social and economic expectations. Such developed capacity will be better able to realise and manage inter-disciplinary research to address current and emerging environmental problems to deliver sustainable and innovative solutions to major societal challenges, including environmental protection and job creation. The module is

designed as a Masters level module, corresponding to European Qualification Framework (EQF) level 7 with 125-150 study hours corresponding to 5 European Credit Transfer Framework (ECTF) credits.

The main focus of this module is on knowledge. So far as this is concerned, EQF level 7 specifies (European Commission, 2008) that the content shall be of “highly specialised knowledge, some of which is at the forefront of knowledge [about the topic], as basis for original thinking and/or research" and that the level requires “critical awareness of knowledge issues within the [topic] and at the interface between fields [of knowledge]".

Finally, the material in this module draws on multiple academic disciplines, including those of economics, ecology, planning and social sciences. It is assumed that someone using it for teaching purposes will have an advanced qualification in at least one of these academic disciplines. The content is intellectually demanding and will require students to have an educational level equivalent to an honours degree (EQF level 6).

2.1 Module learning outcomes

The ***aim*** of Danubius Task 9.3 – Develop scientific training programmes for river-sea systems is to produce module content that builds understanding for the holistic and integrated management of RSS with specific skill development for 1) problem identification and structuring; 2) problem investigation; and 3) implementation of the results to address the four identified RSS challenges.

The intended ***learning outcome*** from the module content is that participants develop a deeper understanding of the functioning of River-Sea Systems (RSS) in order to address the key societal challenges associated with, and opportunities from, RSS, specifically;

- To be able to determine how sustainable RSS management can be undertaken in an integrated manner such that the competing needs of the multiple stakeholders in a basin can be rationalized across conflicting objectives of economic efficiency, social equity and environmental sustainability.
- To understand how sustainable management of a RSS is affected and influenced by the four overarching and interrelated challenges in RSS: (i) Climate Change and extreme events, (ii) Water Sufficiency, (ii) Sediments and their Management, and (iv) Ecosystem Health.
- To provide an opportunity for students to assess problems in a major international RSS, and to propose agendas for sustainable RSS management.

2.2 Module structure

The proposed module content is not intended to replicate any existing courses or content structure already offered by DANUBIUS participating organisations, but draws on existing course content offered by them to compile a module to specifically addresses the knowledge gaps identified by the DANUBIUS project to enhance capacity to address the environmental, societal and policy challenges confronting RSS.

The module structure is designed to provide 5 ECTS (European Credit Transfer System) credit points (equivalent to 100 – 125 study hours)[1] centred on a 12 lecture course (Table 1). The course content will be available on the DANUBIUS-RI website and will consist for each lecture a PowerPoint presentation and accompanying lecture notes. It will be up to individual organisations to decide on how to embed the lectures within their existing course/module provision and the details of accompanying teaching activities to complement the lectures to build-up full module provision: only the lecture outlines are included in this report.

2.2.1 Outline of syllabus

Lectures will cover the full spectrum of the four identified challenges of climate change and extreme events, water sufficiency, sediments and their management, and ecosystem health as well as socio-economic principles. These challenges can be placed into a locally specific context to reflect the locality and pedagogy of the course in which the module is embedded. To place these challenges into context the module will commence with a lecture outlining the context of RSS and how demand placed on RSS by increasing populations and economic activity lead to the need for a sustainable integrated approach to river basin management has become ever more pressing. The module will conclude with a lecture that revisits the first lecture to revise how an improved knowledge of the challenges can mitigate current and future management challenges. There will be a major emphasis on the integration of technical and socio-economic knowledge in attempting to balance the conflicting objectives of economic efficiency, social equity and environmental sustainability defined by the internationally accepted Integrated Water Resources Management (IWRM) approach. The suggested outlined lecture syllabus is:

Lecture 1: Introduction to Integrated River Basin Management.

Lecture 2: Institutional frameworks and the EU Water Framework Directive.

Lecture 3: Managing RSS: human activity and ecosystem disruption.

Lecture 4: Introduction to RSS cycles: the hydrologic cycle and biogeochemical nutrient cycle.

Lecture 5: Climate change, extreme events and water resources

Lecture 6: Water sufficiency to meet anthropogenic and environmental needs.

Lecture 7: The dynamics of RSS sediment flows.

Lecture 8: Ecosystem services and ecosystem-based approaches.

Lecture 9: Economic evaluation of environmental goods environmental and social cost-benefit analysis.

Lecture 10: Sustainability and Sustainable Development for RSS.

Lecture 11: Tools and frameworks for IRBM for RSS.

Lecture 12: Conclusion: Creating an Agenda for IRBM for RSS.

[1] Note that the actual award of credit will require the course to be validated and examined by a university.

2.2.2 Teaching activities

With the accelerating growth in population and economic development around the world, and the developing food crisis, the pressures on river basins and their water resources are becoming unsustainable. The need for an integrated, sustainable approach to river basin management has never been more pressing. Students gain the required wide base of technical and socio-economic knowledge through lectures and computer practicals, and guest speakers from industry reinforce the learning experience. Most importantly, students are also given the opportunity to put this knowledge into action through the group coursework in which they are required to assess the current states of a number of stressed international river basins, and to come up with an agenda for sustainable river basin management in each. They are thus well prepared to tackle such challenging problems in the real world after they leave.

Table 1. Example of suite of teaching activities including lectures outlined in this report that could constitute a 5 ECTS credit module.

Category	Activity	Number	Length	Student Hours	Comment
Scheduled Learning And Teaching Activities	Lecture	12	1:00	12:00	N/A
Guided Independent Study	Assessment preparation and completion	1	5:00	5:00	Preparation of reports for assessment after tutorials
Guided Independent Study	Assessment preparation and completion	1	5:00	5:00	Preparation and completion of online tests
Guided Independent Study	Assessment preparation and completion	1	30:00	30:00	Examination and revision of taught materials (lectures, tutorials, practicals)
Guided Independent Study	Directed research and reading	1	6:00	6:00	Tutorial preparation
Scheduled Learning And Teaching Activities	Small group teaching	3	1:00	3:00	Tutorials to evaluate research and or carry out problem solving exercises
Guided Independent Study	Independent study	1	60:00	60:00	Lecture follow up and background reading
Total				**121:00**	

3 Licence and Attribution

[2] https://creativecommons.org/licenses/by-sa/4.0/

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