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Key messages from a two year EU funded project for the future development of science and ecosystem management in aquatic ecosystems – the DANCERS Project

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This paper summarises the main outputs of the project DANube macroregion: Capacity building and Excellence in River Systems (basin, delta and sea)' (DANCERS) which aims at developing new instruments and tools for environmental research in the Danube Region.

The project objectives were to:

Critically analyse achievements in integrated river – delta – sea management in the Danube – Black Sea region placing them within the wider international context;
Identify strong and weak areas of regional environmental research;
Derive a set of instruments to enhance environmental research and innovation in the region.

Since its start DANCERS has produced:

A Strategic Research and Innovation Agenda (SRIA) to 2020 and beyond;
A concept and a detailed plan for two existing distributed research infrastructures in the region which can implement the SRIA;
Proposals for an integrated educational programme (EDU).

Scientifically coherent solutions for integrated river-basin-sea management require an interdisciplinary approach that informs about decisions by society, industry and government. The SRIA addresses these research priorities in the context of the EU Strategy for the Danube.

Proposed Research Priorities for the Danube – Black Sea System

Restoring Ecosystem continuity throughout the DBS System

Two centuries of engineering work have heavily impacted ecosystems in the Danube River – Danube Delta – NW Black Sea continuum. Science must contribute to restoring longitudinal and lateral connectivity by implementing solutions to work with, rather than against, Nature.

Pathways of transport and accumulation of litter (especially plastic) and pollutants (including emerging pollutants) in the DBS System

We have to understand the transport and fate of key pollutants including microplastics and emerging pollutants.

Ensuring safe and continuous navigation while restoring the Danube green corridors

We need to reconcile the demands of navigation with the challenges of environmental restoration in the Lower Danube. Smart and innovative "nature based" solutions shall involve integrated sediment management and maximize ecosystem services, which are key prerequisite to ensure continuous navigation and the development of green corridors alike.

Mutual ecological and economic benefits from ecosystem restoration of eutrophicated ecosystems in the Danube – Black Sea interaction zone

We need a better understanding of the environmental benefits of ecosystem restoration.

Dealing with Eutrophication in the Danube – Black Sea interaction zone by using algae as 2nd Generation Biofuels

Efficient use of algae as raw materials for biofuel refineries requires understanding of freshwater – marine water interactions, variation of nutrient loads supplied by the Danube to the Black Sea, life cycle of algae development and blooming, as well as forecasting of dynamics of the marine area where algal blooms evolve.

Using latest Earth observation (EO) technologies coupled with in situ measurements for an upgraded DBS System environmental monitoring scheme

We need long-term research sites to capitalize on ESA's next generation EO capabilities and advances in sensor technologies, to develop innovative observation systems for transboundary basin scale water management in the Danube system.

Developing sustainable agricultural practices (crops, husbandry) for obtaining good water quality in the DBS System

Innovative methods are needed to ensure sustainable food production whilst ensuring good water quality in the Danube River – Danube Delta – NW Black Sea.

Understanding river-sea interaction processes in the Danube Delta transitional environments

A fundamental understanding of the functioning of complex, dynamic and vulnerable transitional environments and their relationship to social and economic pressures and global change, is a prerequisite for effective management.

Managing dams and reservoir lakes as critical sediment traps and bottlenecks for river habitats continuity in the DBS System

Dams act as traps, interrupting the natural flow and continuum of water, sediments and biota. As a result they contribute to ecosystem change and sediment accumulation in associated impoundments.

Restoring natural habitats in the Danube floodplains – Danube Delta and lagoon systems as support for fisheries revival.

Plans to support fisheries revival and sustainable aquaculture must include actions to restore spawning grounds and nursery habitats for native fish and other aquatic species.

Understanding Climate change impacts on the DBS System by applying the latest generation of models

Climate change will have differing impacts throughout the Danube River – Danube Delta – Black Sea system. Records of the thermal dynamics of lakes, lagoons and flowing waters are required to understand the effects of climate change.

Managing water resources by implementing new technologies for water abstraction, purification, distribution, collection, treatment and reuse in the DBS System

Fluxes of dissolved organic matter (DOM) from wetlands are the largest and most bioavailable pool of fluvial DOM. However, the subsequent transformation of DOM in the freshwater – marine transitional zone within the Delta is uncertain, yet this knowledge is fundamental to closing the carbon cycle.

Harmonising scientific data and monitoring protocols in the DBS System

Integrated management of the DBS system can be successfully implemented only by fully understanding the upstream – sea continuum and by having compatible indicators of the state of the environment. This requires a harmonisation of monitoring protocols in freshwater, transitional and marine systems.

Unfolding the cultural heritage potential of the DBS System by using scientific tools

The cultural resource of the DBS is threatened by land use change, development and climate change. Remote sensing coupled with geo-archaeology has the potential to uncover cultural heritage sites. Such approaches can inform management of these cultural landscapes to ensure their continued preservation.

Reducing future risks of invasive species in the DBS System

The impacts of invasive species on the DBS system must be reduced by (i) exhaustive risk management plans dealing with all human activities that may represent future routes of introduction and transmission and (ii) by identifying the attributes of native communities that promote resilience to invasion.

Interdisciplinary scientific support for the successful implementation of the Sturgeon 2020 Flagship Project in the DBS System

Existing projects and programmes must be coordinated to focus on solving the most important uncertainties and critical questions related to the restoration of the sturgeon populations.

Innovative means to harness water energy in the DBS System

Harnessing energy from water and other renewable sources in a way that does not significantly affect ecosystems is a major issue for the DBS system. Innovative engineering schemes are needed for sustainble energy generation, from the river water flow to the marine waves and currents.

Promoting Cross Border Environmental Stewardship in the DBS System through Citizen Science

Systematic and timely monitoring of large river-sea systems with complex geopolitical histories remains challenging. A number of emerging technologies, including smart-phones and inexpensive sensors which can be widely distributed now provide the framework for effective monitoring of water quality.

Detailed plans and concepts for a new regional research infrastructure in the field of integrated river – delta – sea management in the Danube – Black Sea area are in preparation.

This is an opportune time to address the challenges, identified above, by a cross-disciplinary distributed Research Infrastructure (RI) on freshwater – marine systems. The RI can build upon the world- leading capabilities of the European environmental science community to deliver a step-change in our understanding.

The initiative to develop RI in DBS is further enhanced by the coincidence of:

- Political framework including EUSDR and ESFRI.
- Timeliness of technical advances
- Resource exploitation
- European e-infrastructures initiatives (Geant & PRACE)
- Existence of the GEOSS and the COPERNICUS programmes

It is important to look forward and consider the degree to which the research needs can be addressed by the two new EUSDR flagship research initiatives in the Danube – Black Sea system (River, Delta and Sea). Together these initiatives (DREAM and DANUBIUS-RI) have the potential to provide world-leading facilities that will facilitate inter-disciplinary research and enhanced implementation within the Danube – Black Sea system.

The Human Capital Development Programme

DANCERS proposes a model for a new Danube educational programme that could lead to a better integration of the river-delta-sea management practices. In principle, the new Danube education programme has at its core a pyramid base and approach that aims to address different levels of education. The main aim of such a programme would be to build a network of institutions and develop agreements and mechanisms to facilitate knowledge exchange within the Danube Basin.

The major outcomes of the project will be published in a special issue of the scientific jounral Science of the Total Environment. FP7 DANCERS was funded under the EC Grant no. 603805. The in extenso results of the project were published in the following books, freely available also online (see below):

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JDS 3 from an environmental history and social science perspective – Part II: What the river told us about its socio-natural history

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Introduction

Following a first review of the third Joint Danube Survey (JDS 3) from an environmental history and social sciences point of view (Schmid and Haidvogl 2015), this second and final part discusses selected main results of this basin-wide survey (ICPDR 2015a). Our overall aim is to enrich and broaden the scholarly debate about the current state of the Danube by including long term, socio-ecological perspectives from environmental history. We concentrate on three topics that are also relevant for determining the 'ecological status' of a distinct river section as well as of the Danube river basin (DRB) as a whole according to the EU-Water Framework Directive (WFD):