

EXECUTIVE SUMMARY

The White Book of the ***Danube International Centre for Advanced Studies on River-Delta-Sea Systems (DANUBIUS-RI)*** sets out the framework for creating a **pan-European Research Infrastructure**. It outlines the need for a new distributed Research Infrastructure (RI) devoted to the study of large river-sea (RS) systems. These systems are experiencing intense and progressive degradation in response to many drivers, including rapid climate and environmental change, and increasing anthropogenic pressures. Given the spatial and temporal characteristics of large RS systems, a new paradigm is required to advance the goal of holistic environmental management. In particular, effective and sustainable solutions can be achieved only by teams of trans- and interdisciplinary researchers, who have the collective expertise to solve these pressing and emerging problems.

The proposed infrastructure, ***DANUBIUS-RI***, comprises a physical *Hub* in the Danube Delta and a network of *Nodes* distributed throughout Europe. This will provide a unique opportunity to group the best existing expertise and facilities in Europe and provide an internationally leading focus to understand, characterize and manage RS systems globally. Opportunities provided by research in the natural laboratories of European RS systems, in particular the *Danube River – Delta – Black Sea system*, will be maximised by building capacity with a new RI and by actively involving researchers and institutions from across Europe. This will provide research outputs of real benefit to the populations of large RS systems in Europe and globally.

The Danube exemplifies many of the major problems confronting large RS systems globally, offering an ideal opportunity for the new infrastructure. The Danube catchment spans 19 countries, while six countries share the Black Sea. It includes some of the richest and poorest areas in Europe, with a complex recent geopolitical history. This presents real challenges in balancing the needs and requirements of habitat conservation and restoration, whilst ensuring sustainable economic development.

The whole of DANUBIUS-RI, as a pan-European distributed RI, will be coordinated by the *Hub* in the Danube Delta. The *Hub* will provide educational facilities, an administrative centre, the gate to the Danube Delta natural laboratory, and the physical location for new laboratories. The *Hub* will link with *Nodes*, composed of leading facilities and centres of research excellence.

In addition to the scientific advantages of locating the *Hub* in the Danube Delta Biosphere Reserve, this offers new opportunities for the development of the regional economy. The *Hub* will work with local communities, offering significant educational outreach and developing the knowledge-based economy.

This White Book summarises the problems of large RS systems; it outlines the new RI and its scientific framework; it describes the specific problems of the Danube River – Delta – Black Sea macrosystem and the opportunities for knowledge transfer and links with other major pan-European RI. The White Book concludes with a summary of relevant research units and international organizations and proposes the steps towards establishing the RI, including its construction and governance.

1. INTRODUCTION

This document provides an overview of the proposed pan-European **International Centre for Advanced Studies for River-Delta-Sea Systems (DANUBIUS-RI)** with the *Hub* located within the Danube River – Delta – Black Sea system. It summarises: i. the rationale for DANUBIUS-RI within the European and global context; ii. its scientific framework; iii. the structure of DANUBIUS-RI; and iv. its relationship with existing research institutions and universities.

The White Book is envisaged as an inclusive ‘living document’ for stakeholders and other interested parties. It highlights the major challenges related to the sustainable management of large RS systems and the opportunity to pioneer new approaches for research and management. Historically, approaches have been discipline specific and limited in scope. A new paradigm is required to provide inter- and trans-disciplinary research solutions that encompass the entire river-mouth-sea system. DANUBIUS-RI, using the Danube – Black Sea macroregion as an exemplar, will provide the infrastructure and opportunity to facilitate this new way of working by bringing together the best facilities and expertise in Europe.

2. GENERAL BACKGROUND

For many years, rivers, deltas, estuaries, coastal wetlands and coastal zones (both singly and as entire river-delta-coast-sea systems) have experienced ever-increasing and progressive pressures, driven to a large extent by explosive anthropogenic development. This has led to drastic changes in land use, over-exploitation of natural resources, and the hydraulic re-engineering of the Earth’s surface, for example through damming, embankment and re-channelling. As a result, most RS and coastal systems globally are experiencing degradation. This has many implications for the future development and opportunities of human communities and environmental health (Lancelot *et al.*, 2002).

Given their scale and dynamics, there are many difficulties in managing large RS systems. Successful examples are largely confined to relatively small RS systems in areas with sparse population (Syvitski *et al.*, 2009, Bucx *et al.*, 2010). With respect to the large RS systems, there has been a general lack of integrated and adaptive management planning in which the river, delta, coast and sea have been considered (and managed) as a single entity. These difficulties are compounded by the multi-dimensional, diverse and dynamic process drivers (both natural and anthropogenic) governing the change and evolution of these systems. To move forward, a fundamental prerequisite is to re-evaluate the current state of our knowledge and

understanding of these complex systems. Recent developments in science and technology now afford opportunities to monitor RS systems at the entire basin scale and in real time.

It is timely therefore that new integrated management and scientific plans are developed for the RS and coastal systems to advance the goal of sustainably managing these systems as foreseen by IGBP/LOICZ (the Land-Ocean Interactions in the Coastal Zone Project of the UN International Geosphere Biosphere Programme). For example, best use must be made of the capabilities offered by the European Space Agency's GMES programme and the Global Earth Observation System of Systems (GEOSS). This new integrated approach to large RS systems will address the recommendations of the World Business Council for Sustainable Development: supporting environmental health means also securing the economy because ultimately *“business cannot function if ecosystems and the services they deliver—like water, biodiversity, fiber, food, and climate—are degraded or out of balance.”* (MEA 2005).

Specifically in the Danube – Black Sea macroregion, future development is threatened by the lack of integrated, comprehensive system planning (Bloesch et al., 2011).

3. VISION OF A NEW RESEARCH INFRASTRUCTURE DEDICATED TO THE STUDY OF RIVER – DELTA – SEA SYSTEMS

DANUBIUS-RI will provide a unique opportunity to bring together the best existing expertise and facilities in Europe and provide an internationally leading focus to understand, characterize and manage RS systems globally. Opportunities provided by research in European RS systems, including the natural laboratory of the *Danube River – Delta – Black Sea system*, will be maximised by building capacity with a new RI and by actively involving researchers and institutions from across Europe. This exemplar will provide research outputs that will be transferrable to other large RS macrosystems globally.

3.1. The need for an International Centre for Advanced Studies on River- Delta – Sea Systems

Although most of the research organisations active in the fields of river, estuarine, deltaic and marine sciences continually undertake multi-disciplinary projects, there is a strong need for an integrative approach to specific questions pertaining to RS systems. The latter is essential given that ecosystems at the land/water interface represent *biodiversity hotspots* providing essential ecosystem services and yet are characterized by extremely dynamic processes. The ever-increasing demands from the human population (both within Europe and globally) exert a significant and growing pressure on the functionality of these potentially vulnerable natural systems. For a holistic approach, all these factors should be considered integral parts of the

ecosystem and it is essential to identify and promote measures to ensure regional sustainability, balancing environmental protection and socio-economic development in an optimal manner.

DANUBIUS-RI will therefore be a unique and ambitious inter-disciplinary platform, which will provide an integrative perspective on RS systems. It will do this by integrating the knowledge and understanding contributed by different disciplines including the Earth, Environmental, Social and Economic sciences. It will facilitate and coordinate research and will offer an infrastructure to deploy and maintain observing stations spanning the river catchment as far as the sea under its influence. DANUBIUS-RI will ensure quality assurance of all data collected, their storage and dissemination.

DANUBIUS-RI aims to provide a world-leading RI that will enable excellent interdisciplinary research in RS systems that will have a high economic impact. This mission accords closely with Europe Horizon 2020 Key Priority 3, Societal Challenges, which aims to bring together resources and knowledge across different fields, (bio)technologies and disciplines, covering activities from research to market. Specifically, by combining the capacities across Europe, DANUBIUS-RI will deliver the critical mass required to tackle complex problems across the different components of RS systems in an integrated way.

Thus, DANUBIUS-RI will become an attractive powerhouse by advancing fundamental research in RS systems and finding solutions to critical, timely and controversial issues.

3.2. The role of DANUBIUS-RI

DANUBIUS-RI will enable study of the key processes of large RS systems and develop sound solutions for sustainable management of these systems using an interdisciplinary approach integrating basic and applied research. This will help deliver environmentally friendly solutions for economic development of these systems that will be identified by working closely with stakeholders.

It will enable:

- study of the processes that influence the evolution of river, wetland, delta, estuarine, lagoon and coastal ecosystems;
- development of a knowledge-based economy to support sustainable economic growth in RS areas while conserving natural biodiversity;
- education through Masters, PhD and post-doctoral programmes in conjunction with universities across Europe; and
- engagement with the wider community through conferences, specialised training courses, workshops, summer schools, developing e-learning facilities and ecological educational programmes for local communities and tourists.

These activities will be carried out in close collaboration with managers of nature reserves, local communities and other stakeholders in order to achieve sustainable management of wetlands and floodplains from the catchment to the coastal sea. It is

envisaged that this philosophy will provide the frameworks and best practice solutions for RS systems across Europe.

It will take the lead in following an eco-business approach by educating the younger generation to respect natural values and change their current consumption patterns. This provides the key to sustainability in soft-tourism, 'green' agriculture (minimized water, pesticide and fertilizer use, no monocultures), use of environmentally friendly technologies and recycling. In this way, stakeholders, including business and local communities, and the natural environment will reap long-term and mutual benefits. DANUBIUS-RI will provide a platform for permanent dialogue among stakeholders to identify and decide jointly on the optimal use of the natural resources of these sensitive areas without disrupting ecosystem structure or functionality.

3.3 DANUBIUS-RI as a distributed RI

As a distributed RI, DANUBIUS-RI will comprise a *Hub* based in the Danube Delta and a set of *Nodes* spanning best available facilities and knowledge across Europe.

The *Hub* in the Danube Delta will have several functions, providing:

- leadership and governance;
- coordination and standardisation of activities within the distributed RI;
- communication with other RIs and major stakeholders;
- key scientific, educational and analytical capabilities;
- the gateway to the natural laboratory of Europe`s largest protected coastal wetland (the Danube Delta Nature Reserve); and
- access to the Lower Danube and the western Black Sea coast.

The *Nodes*, which will be distributed across Europe, will be leading facilities and centres of research excellence, with some offering access to other large RS systems. They will harness existing expertise and synergies by bringing together groups of leading European laboratories to provide the facilities and services needed in a particular field. Each *Node* will comprise a lead laboratory and, in most cases, a group of satellite laboratories with related expertise of the highest quality. A *Node* might consist of a total of, say, five laboratories in different parts of Europe but, between them, providing facilities and services in a particular field of importance to DANUBIUS-RI. The system of *Nodes* will form a geographically distributed observational infrastructure to quantify RS system dynamics and will be used pragmatically for activities that need to be carried out a regional or local level.

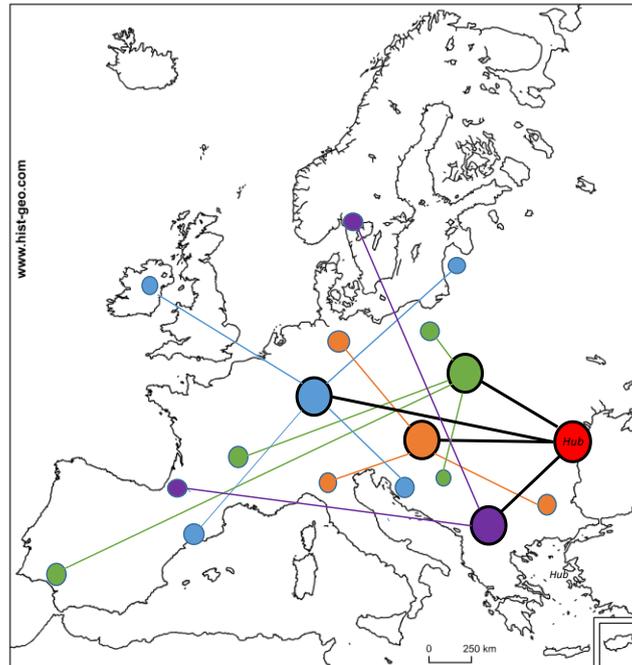


Figure 1. Schematic diagram of *Hub* and *Nodes*

The above diagram shows four imaginary *Nodes* (orange, purple, blue, green). The blue *Hub*, for example, consists of the lead laboratory (large blue circle) and four satellites (small blue circles). All the lead laboratories and satellites are randomly located on the map, and have no implications for where lead laboratories and satellites will be located in practice. Only the *Hub*, shown in red, is correctly positioned. The thick lines link the lead laboratories of the *Nodes* to the *Hub*, while the thin lines link the satellites to the lead laboratories of the *Nodes*.

Nodes will provide:

- facilities and services in a particular field;
- data storage and provision;
- experimental and in situ measurements facilities;
- state-of-the-art analytical capabilities;
- implementation of standardised procedures at a regional scale; and
- interfaces with regional and local stakeholders, enhancing knowledge-exchange.

It is expected that there will be up to ten *Nodes*, each comprising a lead laboratory and up to, say, four satellite laboratories. This will provide the opportunity for all member countries participating in DANUBIUS-RI to have laboratories within one or more *Nodes*. The Preparatory Phase of DANUBIUS-RI will draw up a definitive list of the fields initially to be covered by *Nodes*.

4. SCIENTIFIC FRAMEWORK OF THE CENTRE

In seeking to advance the integrated management of RS systems a number of **major global scientific challenges** arise, including:

- understanding the genesis and natural evolution of large RS systems;
- quantifying the impact of anthropogenic changes on large RS systems;
- determining the vulnerability and/or resilience of large RS systems under a changing climate;
- characterizing biogeochemical cycles in large RS systems;
- advancing integrated management of catastrophic floods/droughts or hazardous materials in large RS systems;
- identifying emerging pollutants and pathogens and understanding their input pathways and fate in large RS systems as well as their related adverse effects or associated risks;
- investigating the consequences of physical destruction of morphological structures and habitats (e.g. through channelization, embankments, damming) and develop measures for hydromorphological restoration;
- conserving and restoring the biodiversity in large RS systems;
- enhancing and protecting the ecosystem services provided by large RS systems;
- developing management solutions for existing and future framework policies, for example the Water Framework Directive (WFD); and
- providing scientific expertise to develop, improve and test tools to advance policy and guidelines for environmental protection.

DANUBIUS-RI will underpin programmes of research in large RS systems that will address these challenges.

The **core scientific capabilities** of DANUBIUS-RI will comprise a pyramid of knowledge upon which the effective integrated management of a large RS macrosystem must be based. The scientific capabilities of DANUBIUS-RI will include:

- an observation infrastructure, where improved, detailed and continuous data and sample collection will be performed;
- the potential to develop new and more advanced analytical and experimental methodologies;
- the development and application of new and improved environmental models of large RS systems to allow for predictions;

- the development and application of new and improved approaches within environmental economics to evaluate the connections between society and nature; and
- the identification of management solutions based upon the detailed forecasting and analysis of future scenarios of environmental change.

Figure 2 demonstrates how appropriate individual solutions will be identified at the top of the pyramid of knowledge, supported by robust and best available data and scientific understanding, building on the capabilities of DANUBIUS-RI identified above.

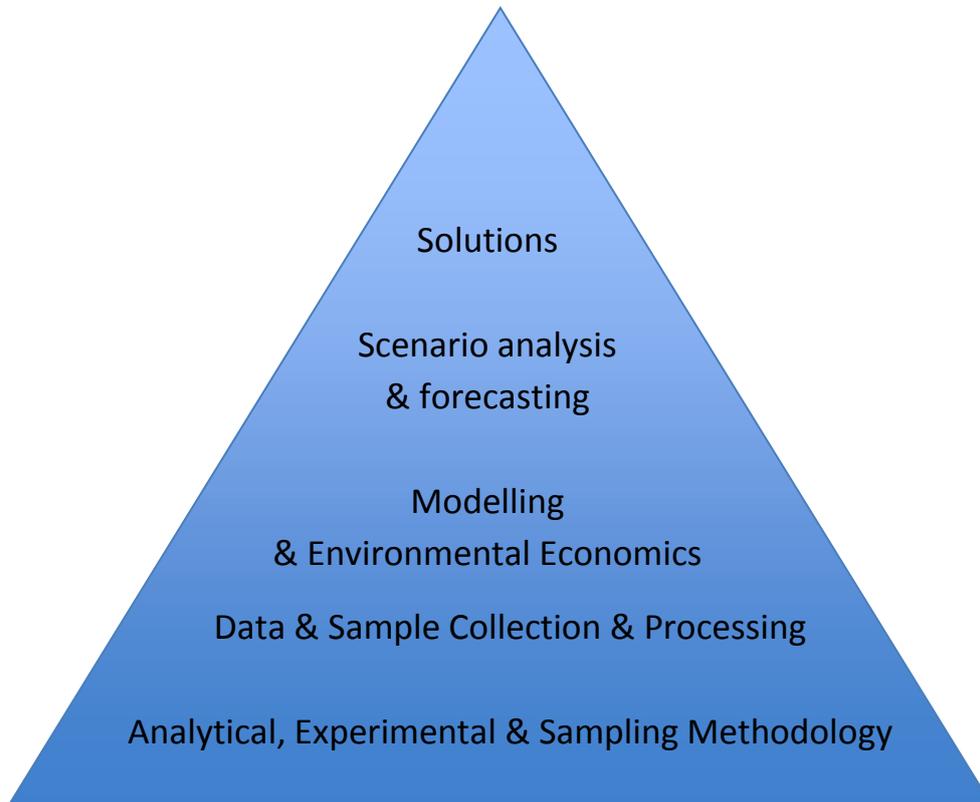


Fig. 2. Core scientific capabilities of DANUBIUS-RI

Research topics of current interest that could be addressed by DANUBIUS-RI include:

- **System characterisation including the genesis and evolution of large RS systems**
 - geodynamic processes influencing large river-delta-sea systems;
 - regional paleoclimate, paleolimnology and paleogeography, sediment transport, biogeochemical cycling, hydrology and morpho-dynamics; and
 - assessment of ecosystems evolution.
- **Environmental change including the impact of global change**

- assessment of changes in ecosystem structure and functionality under natural and anthropogenic pressures;
 - real-time and continuous assessment of environmental quality; development of complex early-warning system to support risk management; and
 - recommendations and guidelines to improve the ecological status of ecosystems with lost functionality and conserve endangered species and habitats.
- **Adaptive and sustainable management of large RS systems**
 - methods and models for sustainable development using the interdisciplinary, holistic approach;
 - system resilience in the context of environmental change (both natural and anthropogenic influences); and
 - evaluation of social dynamics of local communities in the framework of sustainable development.

Traditionally, research on these systems has been discipline specific. DANUBIUS-RI will pioneer a new approach to integrate across cognate disciplines to find definitive holistic solutions drawing upon the work of interdisciplinary research teams. Examples of specific research themes are listed in Table 1.

Table 1. Examples of specific research topics required to address currently identified challenges in large RS systems

System characterization	
ORIGIN & EVOLUTION OF RS SYSTEMS	Genesis of the river & basin; geological structure; Earth crust dynamics and river evolution; interactions between the river and the sea (relation to sea-level changes and connections to other basins; delta formation; evolution of depocentres, etc.).
GEODYNAMIC PROCESSES	Neo-tectonics; uplift processes in orogenic zones and formation and evolution of river terraces; subsidence and sediment compaction; correlation with system evolution.
HYDROLOGY, HYDRODYNAMICS AND SEDIMENTOLOGY	Water and sediment fluxes in RS systems; the sediment cycle (source – transfer – sink); bio- & geo-chemistry of water & sediment throughout the system; hydrodynamic processes at the river/sea interface and in coastal wetlands.
ECOSYSTEM ASSESSMENT AND FUNCTION	Evaluation of the biotic and abiotic status of RS ecosystems; System pollution, eutrophication, toxicity, biodiversity; Evaluation of food-chains, population dynamics and ecosystem function; green-house gas fluxes in wetlands, lakes & sea.
Environmental change	
IN-SITU ECOSYSTEM OBSERVATIONS	Real-time and permanent environmental quality assessment in the RS system; application of new types of on-line sensors and equipment (including micro- and mesocosm techniques); use of biomarkers; Establishing long-term data series to study process changes.
EARTH OBSERVATION AND REMOTE SENSING	Characterizing land and water in the RS systems, monitoring morphological & hydrological changes, studying and monitoring water currents and river plumes, eutrophic conditions, sediment dynamics and seafloor conditions.
GEO-HAZARDS AND RISK ASSESSMENT	Understanding extreme events, their natural & anthropogenic triggering mechanisms at different scales, such as floods, draughts, landslides, storms; earthquakes; slope instability on the continental margin; geo-hazards originating from gas-hydrates.
MODELLING, SIMULATION AND	Predictive tools to assess environmental response; climate and environmental change modelling including impacts on the RS system; effects of extreme events on the system;

HYPOTHESIS TESTING	impacts of sea-level rise.
ANTHROPOGENIC IMPACT ON ECOSYSTEM GOODS AND SERVICES	Damages induced by anthropogenic activity on ecosystems; evaluating the social dynamics of local communities & identify economic opportunities for sustainable development while minimizing biodiversity loss. Ecosystem changes and impacts on human health.
Adaptive and sustainable management	
ADAPTIVE ECOSYSTEM MANAGEMENT	Provision of the scientific basis for sustainably managing of RS systems using an appropriate range of methods and models.
NATURE CONSERVATION & RESTORATION	Improve the ecological status, habitat restoration, bioremediation, restoration of connectivity; guidelines to conserve endangered species & habitats; implementation of EU environmental legislation; assessment of invasive species.
NATURAL RESOURCE ASSESSMENT AND EVALUATION	Studies advancing the sustainable management of biotic and abiotic resources through knowledge-based development and use of a wide range of methods and models (e.g. valuing ecosystem services).
EVALUATING DEVELOPMENT SCENARIOS FOR SUSTAINABLE USE	Interdisciplinary and holistic approach to developing new strategies for sustainable management. Develop methods for and apply/test Decision Support Systems (DSS) and Multi-Criteria Decision Aids (MCDA).

In addition to these scientific and management topics, DANUBIUS-RI will play an important role in:

- facilitating and promoting education – supporting common international and national environmental programmes on the study of large RS systems; environmental education to increase awareness of RS systems;
- environmental laws and regulations - providing the scientific basis to improve and test tools for the implementation of EU policy and guidelines for environmental protection;
- developing innovative green products and technologies – focusing on valuing natural resources in RS systems according to the accepted principles of sustainable development;
- developing innovative R&D technologies, equipment and ICT – new monitoring, measurement and modelling techniques, as well as data collection, processing, storage and transfer require novel technical and ICT capabilities; and
- developing a reliable meta-database by integrating historic literature data and data from DANUBIUS-RI's own research programmes with those from other European organisations.

DANUBIUS-RI will be a unique and dedicated facility within Europe that will take a leading role internationally to address key global challenges in large RS systems.

5. EUROPEAN RS SYSTEMS

Europe has a number of notable RS systems, in particular those based on the Rivers Danube, Ebro, Po, Rhine, Rhone and Volga. DANUBIUS-RI will provide the platform for interdisciplinary research on these systems to increase understanding of RS systems not only in Europe but worldwide.

DANUBIUS-RI will use the Danube River - Delta - Black Sea system as an exemplar for research and knowledge exchange. It provides a natural laboratory that offers many opportunities to improve our understanding specifically of environmental processes within this region and similar systems worldwide. It is envisaged that DANUBIUS-RI will actively engage with the already existing international organisations charged with the environmental and sustainable management of specific elements in the Danube – Black Sea, by jointly establishing plans to solve some of the major challenges within this system. These plans will be facilitated by the data repositories within DANUBIUS-RI and its ability to draw upon new and emerging methods, approaches and models for integrated environmental management.

The Danube Region exemplifies many of the most serious and pressing problems confronting large RS systems globally. With a basin of over 800,000 km² and a catchment encompassing 19 countries, the Danube River is the most international river in the world (Figure 3a). It connects people with differing economic, social, cultural, and environmental heritages, as well as different political backgrounds (Sommerwerk et al. 2010). Of the countries that share the Danube catchment, eleven are EU Member States (Austria, Czech Republic, Bulgaria, Germany, Hungary, Italy, Poland, Slovakia, Slovenia, Romania, Croatia), while eight are currently non-Member States (Albania, Bosnia and Herzegovina, Switzerland, Moldova, Montenegro, Macedonia, Serbia, Ukraine). The eight non-EU countries are members of The International Commission for the Protection of the Danube River (ICPDR) and are committed to the WFD through specifically and formally binding commitments. After flowing for over 2,800 km across Central and Eastern Europe, the Danube River forms a wide delta at its confluence with the Black Sea (Sommerwerk et al. 2009). The Delta is shared by Romania and the Ukraine and is both the largest remaining natural wetland in the EU (~5 800 km² and one of the most valuable habitats for wildlife and biodiversity in the continent (Figure 3b). The Danube Delta is a Biosphere Reserve on the World Natural Heritage List, the RAMSAR Convention List and the UNESCO Man and the Biosphere Programme.

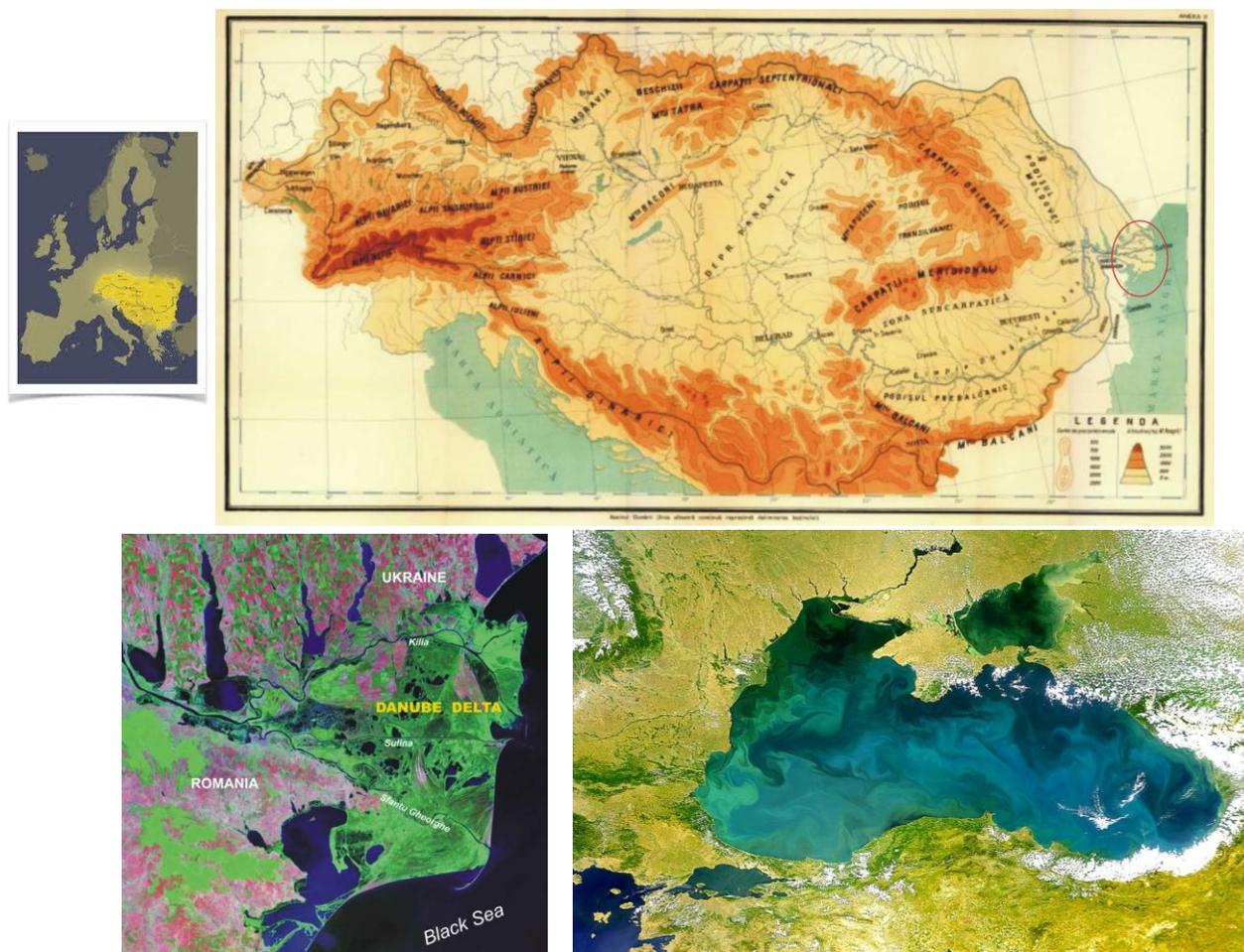


Fig. 3 – The three components of the Danube River – Danube Delta – Black Sea system
(a) the Danube River drainage basin (area ~817.000 km²); (b) the Danube Delta (area ~5 800 km² – satellite image); (c) the Black Sea (area ~420.000 km² – satellite image)

The Black Sea (Figure 3c) has an area exceeding 430,000 km² and is surrounded by six countries: Bulgaria, Georgia, Romania, Russian Federation, Turkey and the Ukraine. This semi-enclosed sea has a clear vertical stratification of water masses and is the largest anoxic basin in the world. Its salinity is significantly lower than the average of the Planetary Ocean and its water balance is controlled by the freshwater inputs from major rivers among which the Danube is the largest. The western Black Sea is strongly influenced by the water and sediment fluxes from the Danube (Ryann & Perkins 2011).

Both the Black Sea and the Danube River have geo-strategic importance as a major navigation route since ancient times, linking Asia and Europe.

6. KNOWLEDGE EXCHANGE AND INNOVATION

The essence of DANUBIUS-RI - bringing together multiple disciplines, world-leading expertise and facilities – is the engine driving innovation. An active exchange and recombination of knowledge will fuel the engine, facilitated by social scientists with expertise in boundary spanning activities.

Examples of where DANUBIUS-RI is expected to bring innovation include: development of specialised sensors, decision-support systems for planning, more efficient use of natural resources (ecosystem services), integrated RS management, and measures for habitat restoration. By this, DANUBIUS-RI will contribute to the EU Innovation Union (http://ec.europa.eu/research/innovation-union/index_en.cfm) and the EU Roadmap to a Resource Efficient Europe (http://ec.europa.eu/environment/resource_efficiency/about/roadmap/index_en.htm).

As a top Research, Education and Innovation Infrastructure for natural, social and economic sciences, DANUBIUS-RI will enhance knowledge exchange by working closely with the existing Research and Education organisations. It will bring together pan-European institutions and Universities from the start and so will benefit from expertise already available. It will cooperate with research teams to tackle significant problems across these large RS systems such as reduction of biodiversity, identifying “environmentally friendly” solutions for economic development, and matching limited resources with increasing population.

Top scientists will be attracted to work on research programmes using DANUBIUS-RI. Their presence will attract young scientists as well as undergraduate and graduate students wishing to gain experience in these attractive and challenging areas.

The education platform offered by DANUBIUS-RI will provide significant added value by creating a forum for knowledge exchange among scientists and between scientists and students. In so doing, the forum will promote cooperative projects, particularly between teams from eastern and western Europe. Intensive courses, summer schools, conferences and seminars will be invaluable mechanisms of knowledge dissemination. Moreover, DANUBIUS-RI will raise awareness of the value of the natural environment and its role in human well-being through ecological tours and talks designed for local communities, teachers or tourists.

As an example, opportunities are provided through connections with the Black Sea Universities Network, which has more than of 100 institutions from the Black Sea Region (including Turkey, Georgia, Armenia, Azerbaijan, Ukraine, Moldova, Romania, Bulgaria, Greece, Albania, Serbia).

7. RELATED RESEARCH INFRASTRUCTURES, INITIATIVES AND PROGRAMMES

The structure of DANUBIUS-RI with the physical *Hub* in the Danube Delta and *Nodes* distributed across Europe will provide the best expertise and capabilities within Europe for RS systems globally.

The lead in developing DANUBIUS-RI has been taken by Romania, which will host the *Hub*. For over two decades Romania has supported research on environmental protection and nature conservation, as well as their effects on human well-being. National funding has been available either in specific programmes for R&D provided by the Ministry for National Education – Scientific Research Activity, or in programmes coordinated by other ministries (e.g. Ministry for the Environment and Water Management, Ministry of Transports – Directorate for Navigation, etc.).

An analysis of the national, international and pan-European funded projects dealing with various aspects of the integrated management in the Danube River – Delta – Black Sea System is being developed in the FP7 Project DANCERS, which started in 2013. DANUBIUS-RI will build upon the projects completed to-date. It will initiate and participate in projects within international frameworks by cooperating with other major research organisations well-recognized in their fields. Research organisations involved in the development of DANUBIUS-RI are listed in Annex 1.

DANUBIUS-RI will seek to be included on the Roadmap of the European Strategy Forum on Research Infrastructures (ESFRI). From the beginning it will be connected with other ESFRI projects, in particular:

- LifeWatch - science and technology infrastructure for biodiversity data and observatories. DANUBIUS-RI will provide the facilities needed to acquire data on aquatic ecosystems from river-delta-sea macrosystems.
- European Plate Observing System (EPOS) - RI and e-science for data and observatories on earthquakes, volcanoes, surface dynamics and tectonics. DANUBIUS-RI will benefit from the distributed infrastructure provided by the geodynamic observatories component of EPOS.
- EURO-ARGO - RI for ocean science and observations. Major information collected by the EURO-ARGO floats will be used to understand better the water and sediment dynamics at river-sea interaction zones.
- European Multidisciplinary Seafloor and Water Column Observatory (EMSO) - the sea-floor observatories will represent the major infrastructures studying the latter part of RS macrosystems.
- Infrastructure for the Analysis and Experimentation on Ecosystems (AnaEE) – experimental facilities to be developed within DANUBIUS-RI will be made available to mutually enhance the capabilities of both RIs.
- Integrated Carbon Observation System (ICOS) – DANUBIUS-RI will deploy a facility to monitor greenhouse gas emissions in natural deltaic and coastal wetland environments.

The Joint Programming Initiatives (JPIs) represent the actions commonly taken towards major challenges in European research by member states, often with support from the EC. JPIs focus on: strategic and innovation agenda, human potential and RIs. Most of the JPIs agreed that the RI aspects must be dealt in coordination with ESFRI - and its various strategic working groups. For the mission of DANUBIUS-RI, there are two JPIs of major interest: JPI OCEANS and JPI Water Challenges. JPI Climate has restricted itself mainly to the study of the climate changes – meteorological and climatological aspects, and less on impacts generated by the changes. The JPI for biology is also grouped with food security and health. Most JPIs have connections with ESFRI Projects: JPI Climate with ICOS, SIOS and EISCAT 3D, JPI Food and agriculture with ANAEE, LIFEWATCH and ELIXIR, and JPI Oceans with EMSO and EURO ARGO. No major ESFRI RIs cover JPI Water Challenges.

UNESCO – Man and the Biosphere (MAB) Programme is an international initiative of critical mutual interest. The development of strong ties between UNESCO – MAB and DANUBIUS-RI increases the global profile of the RI, while the involvement of the European deltas in the RI adds value to UNESCO-MAB. The Danube Delta was the first delta to receive the status of Biosphere Reserve (concept developed by UNESCO-MAB), with the Ebro and Rhone following and the Po to be declared in 2015.

As Biosphere Reserves, deltas are meant to act as Natural Laboratories. As major points for observations, measurements and other sites to be developed within the Hub and Nodes of DANUBIUS-RI, they will establish through the real implementation of the “natural laboratory” concept, a best practice that can be followed at a global level.

Processes occurring in the transitional environments are of major importance for LOICZ, a global project. DANUBIUS-RI provides facilities needed to fulfil this goal.

8. STEPS TOWARDS THE ESTABLISHMENT OF DANUBIUS-RI

8.1. Shaping of the concept, contents and status of DANUBIUS-RI.

A series of major steps are required to draw the detailed picture to shape DANUBIUS-RI as a truly Pan-European RI for RS systems. The following have already been achieved:

- The Danube component of DANUBIUS-RI was granted the status of Flagship Project in the European Union Strategy for the Danube Region (September 2013);
- Letters of support have been received from the Greek Government, the Academy of Sciences of the Republic of Moldova, the Academy of Sciences of the Republic of Bulgaria.

- status of Major Project from the Romanian Ministry for National Education in the financial EU exercise for Structural Funds 2014-2020;

A major action is the beginning of the building of the first unit of the *Hub*, involving Romanian National funding, in 2013.

Also related to the construction, DANUBIUS-RI has been granted the status of strategic RI project in Romania, with a dedicated budget from Structural Funds.

For full recognition of DANUBIUS-RI the following further actions are required:

2014 - 2016

- official Letters of Support from coordinators of other ESFRI pan-European RIs;
- permanent development of the White Book, as a scientific case study for DANUBIUS-RI;
- submission of successful bid to 2016 ESFRI Roadmap;
- development of the detailed socio-economic impact of DANUBIUS-RI – not only as major document requested for any ERDF application – but also as support document for its strategic importance;
- submission of the funding application for a Major Strategic Project to the Structural Funds ERDF (2014 –2020);
- development of a bid for Preparatory Phase (PP) funding for DANUBIUS-RI. During the PP all details concerning its structure, partnerships (*Hub* and *Nodes*), connections between partners, partnership rights, infrastructure management issues, legal aspects, e-infrastructure protocols, capabilities and solutions will be solved, in order to obtain operational sustainability. In the first stages of the PP project – the list of requested infrastructures and facilities at the *Hub* and other *Nodes* will be finalised. This includes the preparation of the Legal Entity for DANUBIUS-RI as an ERIC (European Research Infrastructure Consortium);

8.2. Development of the *Hub* of DANUBIUS-RI

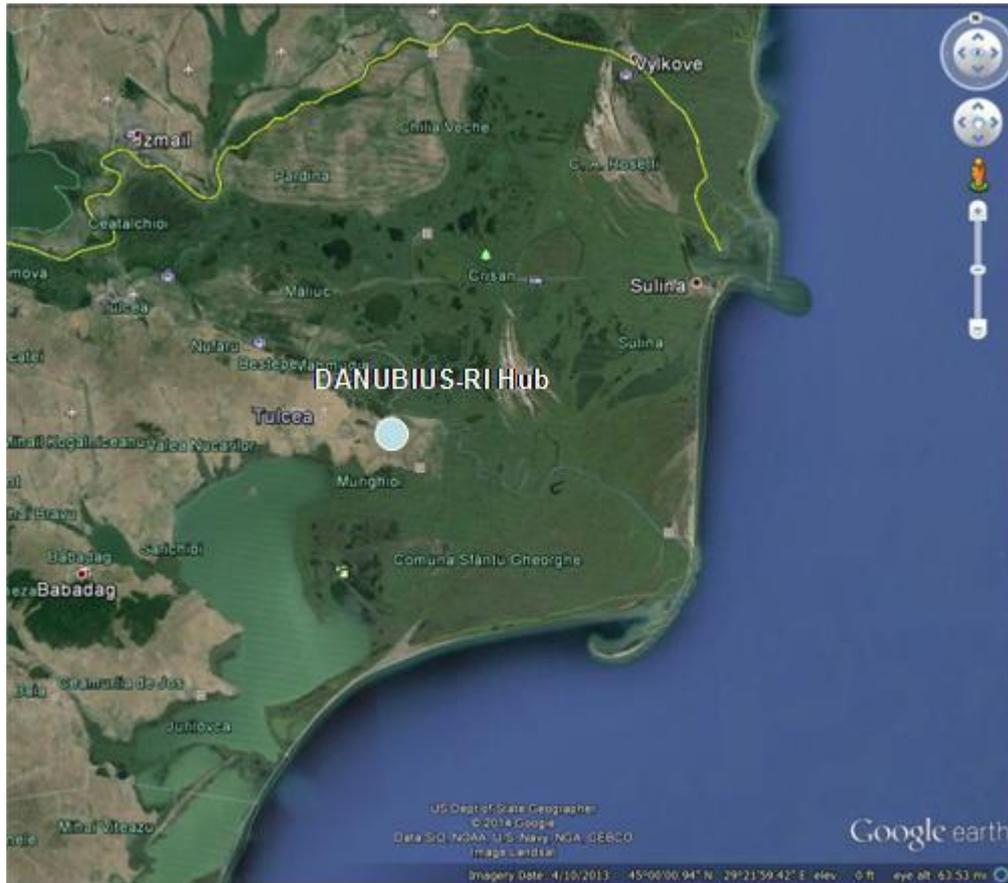


Fig. 5 - Location of the Hub of DANUBIUS-RI (courtesy Google earth)

The location of the *Hub* of DANUBIUS-RI was selected from eleven sites within the Danube Delta Biosphere Reserve. It will be located on the right bank of the St. Gheorghe arm, within the Danube Delta Biosphere Reserve, at Murighiol. This location ensures easy access by road and via the Danube River. It offers immediate access to the Danube Delta, as well as easy access to the coastal zone and the Danube River before the delta's apex. The Murighiol Local Council has approved ten hectares of land for DANUBIUS-RI.

The establishment of the Hub will proceed in three phases, based on the feasibility study and needs that might be identified along the very detailed concept development process.

Phase 1 – 2016-2017

The *first construction phase* of the *Hub* consists of the building of the initial support infrastructure – the 'field station' with accommodation and storage facilities, supplying laboratory and office equipment. Also required at this stage will be the

development of connections with existing national and international research infrastructures and facilities engaged in studies on RS systems.

- This phase foresees the construction and equipping of ~75 % of the total buildings planned. administrative building of DANUBIUS-RI and office building for scientists;
- building with meeting/lecture rooms, conference halls, library, IT Centre (e.g. cloud computing centre); and
- buildings for the accommodation of scientists, technical and administrative staff, students and visitors.

The technical and logistical facilities of the *Hub* will conform to current standards of green management strategies: water supply, energy supply, waste water treatment; pier facilities for research vessels and boats.

Value of the investment for Phase 1 – 60 Million Euro.

Phase 2 – 2018-2019

The *second phase of construction* involves supplying, installing and testing advanced, specialized scientific equipment that will provide a modern, first-rate European infrastructure for inter- and multidisciplinary studies of the complex factors controlling environmental state of the RS systems and their evolution. The Value of the investment for Phase 2 – 30 Million Euro.

Phase 3 – 2019-2020

The *third phase of construction* will be marked by the continuation of development of infrastructural capabilities according to the needs identified for the Hub; these will consist of future cutting edge science research capabilities but also in research vessels for studying the river, the delta and the sea. The Value of the investment for Phase 3 – 60 Million Euro.

9. DANUBIUS-RI GOVERNANCE

Proposal development and submission for ESFRI call

The proposal development is being led by Romania with an Executive comprising three Project Coordinators and the chair of an International Initiative Committee (IIC), which comprises representatives of participating laboratories and other organisations. It advises the Executive on all matters regarding the development of DANUBIUS-RI and its submission to the ESFRI Roadmap.

Preparatory phase (after acceptance on the ESFRI Roadmap)

The preparatory phase will be led by Romania through a Project Coordinator. An Interim Council will be established with representatives of participating countries and organisations. A number of Work Packages will be established, each led by an appropriate individual from Romania or another participating country.

Operational phase

DANUBIUS-RI will be established as a European Research Infrastructure Consortium (ERIC), consequently all the governance arrangements will be following ERIC guidelines. The ERIC will include the DANUBIUS-RI *Hub* based in Murighiol, while some of the constituting *Nodes* may be outside the ERIC.

The *Hub* will provide leadership and governance, coordination and standardisation activities, communication with other RIs and major stakeholders, and key scientific, educational and analytical capabilities. It will be the gateway to the natural laboratory of Europe's largest protected coastal wetland, and facilitate access to the Lower Danube and Black Sea. The *Hub* will be the main responsible for communication with external RIs, to facilitate communication among *Nodes* and with the main stakeholders of DANUBIUS-RI, as well as to ensure key scientific, educational and analytical capabilities. *Nodes* will be scientific and data-providing Centres of Excellence, and interfaces with regional stakeholders. They will provide facilities and services, and implement standardized procedures at the regional scale. Activities will include experimental and in situ measurements facilities, analytical capabilities and data storage. This structure will enable DANUBIUS-RI to build on existing expertise and synergies to support world-leading interdisciplinary research and innovation.

The management and decision structures will follow ERIC rules with regards to organization and operation activities, and will adequately and promptly respond to specific needs arising from the geographical distribution of the *Nodes* and their national regulations. Below are listed the main layers and bodies comprising the management and administration team:

- decision and strategy level;
 - General Assembly (GA);

- Independent Advisory Board
- Executive committee
- Management Committee;
- Scientific Committee (SciCOM);
- Technical Committee (TechCOM);
- Intellectual Property Rights Committee (IPRCOM);
- Audit committee
- Evaluation Committee
- The General Director / President;
- Administration level;
 - *Hub* Operational level ;
 - Operational working teams;
- *Hub* maintenance level;
 - Functional departments.

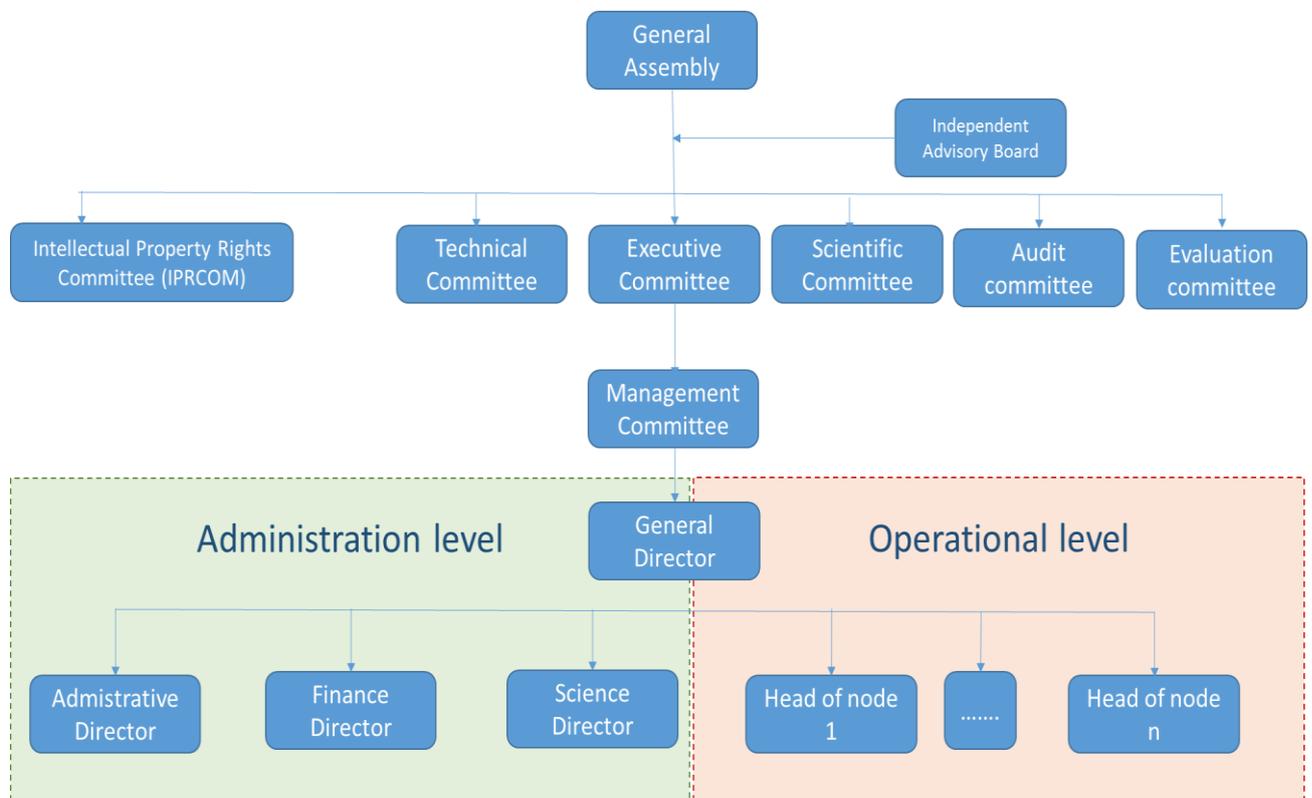


Fig 6. DANUBIUS-RI Proposed Governance Structure for the Operational Phase. Governance bodies and positions

10. PROVISIONAL BUDGET ESTIMATES FOR CONSTRUCTION AND OPERATION

Structural Funds, Horizon 2020, EDIB and national financing represent the most important financial instruments to finance DANUBIUS-RI. Major stakeholders have expressed their commitment to engage their national funding agency officials to sign the Memorandum of Understanding (MoU) and obtain their Member State participation in the pan-European distributed open-access RI.

More accurate figures will be determined by a feasibility study to be carried out in 2015, when will be considered all the aspects related to DANUBIUS-RI *Hub* setup and its corresponding phases for construction, equipment installation, as well as its connectivity to different facilities distributed among the *Nodes*. The financing component has three different subcomponents that shall be considered:

- preparatory phase detailed financing scheme;
- accessing the funds for all stages of the project
- pricing and access policy.

List of possible major funding sources which can be identified at this point, and which require careful monitoring during all stages of development, includes:

- European funding agencies;
- European Structural and Investment Funds (ESIF) 2014 – 2020;
- National funding agencies;
- Other international funding agencies;
- Partners financial commitment;
- Private funding (allow access to research facilities within the *Hub* and *Nodes*, provide transfer of know-how and technology);
- Research clients (companies, local/ national / international organizations);
- Educational services providers for PhD and students.
- Annual Member and Observer subscriptions;
- Remuneration for services from the user community;
- Grants for specific research activities.

Each of the participating bodies has to monitor and attempt to access financing during all stages, covering both national and international funding opportunities.

Special attention needs to be given to periods of financing gaps between main stages of the project development, when financing should be also accessed in order to sustain the preparedness and development of the next steps. Close collaboration with national funding agencies that signed the MoUs is required in order to cover the potential identified gaps. We recommend yearly search, identification and application for national financing for DANUBIUS partners.

The foreseen financial arrangements on a medium and long perspective from source of financing perspective are:

- 2015-2023 fully funded from external sources (national, EC, international) for a total of up to EUR 185 million;
- 2024-2029 funded 50 % externally and 50 % from revenues received from granting access to DANUBIUS-RI on different research projects (R&D, innovation, experiments, industry);
- 2030 onwards – 30 % externally and 70 % own financing.

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Annex 1

List of potential DANUBIUS-RI partners, who have submitted Letters of Intent or are actively participating in development of the project

AUSTRIA

WasserCluster Lunz (WCL) The Interuniversity Centre for Aquatic Ecosystem Research, WasserCluster Lunz, combines freshwater expertise with know-how in related disciplines of the three partner universities (University of Vienna, University of Natural Resources and Life Sciences, Vienna, and the Danube University Krems) and pursues basic as well as applied aquatic ecosystem research. WCL is committed to providing innovative research on structure and function of freshwater ecosystems including lake, running water and wetland ecosystems, and to safeguard the sustainable use of their resources. Ranging from microbial ecology to biogeochemistry, from restoration ecology to aquatic ecosystem management, including biodiversity research, ecotoxicology and aquatic food web research, WCL has established international cooperation to address current problems and identify potential future problems for freshwater ecosystems and their sustainable use. We contribute to educational programs at undergraduate and graduate level of the partner universities with more than 600 students a year and to postgraduate training programs in the field of freshwater ecosystem sciences. WCL carries out research in the following areas which are closely related to those of DANUBIUS-RI:

- carbon and nutrient dynamics in running water systems and floodplain systems in the Upper Danube catchment;
- effects of restoration and ecosystem management measures on aquatic ecosystem functions;
- biodiversity research and assessment;
- food web research
- plankton ecology, algae, macrophyte and invertebrate ecology; and
- habitat and trophic modelling in complex aquatic environments.

Experimental sites: experimental outdoor flumes of different size ranges, large flume in cooperation with BOKU Vienna, outdoor mesocosm experiments in the lake and permanent outdoor mesocosms. *Permanent field sites operated by WCL:* Lunz area: Lake Lunz and associated stream catchment with continuous measurement of various environmental parameters including meteorological data. Danube floodplains: 2 monitoring stations and field measurement programs since more than 15 years. *Analytical facilities for aquatic ecosystem research:* (nutrient and carbon analysis, lipid analysis, molecular analysis) in sediments and water and microscopy. Taxonomic expertise. *Equipment for field research:* cars and boats for lake and river investigations. Room facilities: teaching activities (for groups ranging from 20-100 persons), laboratory facilities for guest researchers equipped according to the latest standards and accommodation in-house for guest scientists

University of Natural Resources and Life Sciences (BOKU), Vienna is a teaching and research institution that focuses on the fields of agriculture, forestry and timber

management, civil engineering and water management (including waste management), food science and biotechnology, and landscape architecture and conservation. Emphasis is placed on technology, economics and ecology. All fields of study consider environmental aspects and the protection of natural resources, with sustainability as a key element of the modern teaching and research activities.

BULGARIA

The Bulgarian Academy of Sciences (BAS) is the main national research center joining research institutes from all scientific fields. It was created in 1869 and presently leads the investigations and innovation in natural and social sciences. BAS has supported officially the DANUBIUS Project and maintains close collaboration with the Romanian Academy of Sciences. Presently, the listed below institutes of BAS are involved as main research institutions in Danubius, but others may join later as the collaboration develops.

The Institute of Oceanology (IO – BAS)

The Institute of Oceanology, Varna, (www.io-bas.bg) affiliated to the Bulgarian Academy of Sciences (IO-BAS) is the National body for oceanographic research. The main research activities are based on interdisciplinary studies in the field of marine physics, chemistry, geology, biology, ecology, coastal dynamics, ocean technique and technology, data management and underwater investigations. The Institute hosted Bulgarian National Oceanographic Data Centre (BGODC) and National Oceanographic Committee. Traditionally involved in all aspects of marine research it also offers consulting and expert services, environmental impact assessment studies, education and training. The total scientific staff is 48 scientists (19 senior scientists - Professors, 29 junior scientists - Assistant Researchers, DSci. – 2, PhD - 27). The Institute's experts are involved in consulting decision and policy makers for elaboration of environmental friendly regulations and standards for sustainable management of Black Sea living resources at governmental and local authorities' level.

IO-BAS is the Regional Activity Centre and Focal Point of Black Sea Environmental Programme. The Institute participated in almost all GEF and Black Sea EU programmes implemented in the region and was involved in and coordinating a number of national, bilateral and international Projects: NATO-TU Black Sea, NATO-SfP-971818, NATO SfP ODBMS, GEF BSERP. During last years IO-BAS actively participate in a large number of FP5, FP6 and FP7 among which, Sea-Search, SeaDataNet, Black Sea SCENE, UP-GRADE BS SCENE, MyOcean, SESAME, ECOOP, EMODNET, GEOSEAS, EUROFLEETS, E-AIMS etc. The institute has coordinated two of the major Black Sea GOOS projects ARENA and ASCABOS as well as CESUM-BS project.

IO-BAS is responsible for national environmental monitoring programme in the Black Sea. The Institute has build Port Operational Marine Observing System for major Bulgarian ports and Galata platform observing system providing data from open sea. BGODC is responsible for Black Sea Argo program of profiling buoys and for Black

Sea In-Situ thematic assembling center in MyOcean project as well as the National Sea Level Service.

IO-BAS is operating multipurpose RV “Akademik” with more than 200 research cruises and PC-8B research submarine capable to dive with 3 men crew till 250m depth.

The National Institute of Meteorology and Hydrology (NIMH – BAS) is main institution performing research and operational activities in Meteorology, Agrometeorology and Hydrology in Bulgaria. These activities follow the standards and regulations of the World Meteorological Organization (WMO). NIMH is the official representative of Bulgaria in the WMO. The organization is among the oldest structures in the country, established more than 125 years ago.

The activities of NIMH comprise: Monitoring, analysis, and forecast of atmospheric and hydrospheric processes; Study of spatial-temporal characteristics of climate and water resources; Study and forecasting of atmospheric and hydrospheric composition and its variations of natural and anthropogenic origin; Hydrometeorological Service for the territory of the country and the Black Sea for the central and local authorities, population and a wide range of users; Prediction of hazardous meteorological and hydrological events for protection of lives and property and others.

The Research Priorities of NIMH include:

- Improving the network of measuring stations, the methods of monitoring, transmission, processing and interpretation of data.
- Evaluation of hydro-meteorological resources: climatic, agroclimatic and water, their fluctuations throughout the country and their influence on the economy.
- Development, implementation and maintenance of modern methods for short- and medium-range forecast of hydro-meteorological processes, such as numerical modelling, satellite data acquisition and processing, radar data interpretation, etc.
- Development of methods for long-term weather forecasting.
- Studying of clouds physics and holding aerologiczni measurements.
- Studying of atmospheric and hydrospheric physical and chemical processes, composition and its variations of natural and anthropogenic origin. Modelling pollutants transfer, and sediment regime of rivers.
- The staff of NIMH is 700 employees, 90 of which hold scientific degrees and research positions. Currently, there are 20 PhD students.

Institute of Biodiversity and Ecosystem Research (IBER-BAS): The Institute of Biodiversity and Ecosystem Research (IBER) was established on 1 July 2010 after merging of Institute of Zoology, Institute of Botany, and Central Laboratory of Common Ecology on the basis of resolution of General Assembly of Bulgarian Academy of Sciences from 23.03.2010. Significant national and international researches are carried out in IBER in theoretical and applied aspects of ecology, biodiversity, environmental conservation and sustainable use of biological resources. Now the Institute has high qualified staff and the plan is to train such staff in the area

of botany, mycology, zoology, ecology, hydrobiology, conservation biology, environmental genetic, evolutionary biology and other closely related scientific areas, as well as to ensure scientific information, to give methodic supply to governmental institutions and civil society structures, and to present the country in European Research Area within its competence.

Priority directions are:

- Structure and functioning of biotic communities, ecosystems and landscapes in the present and in the past.
- Diversity of organisms and their ecological and evolutionary relationships on all levels: from genetic and population to ecosystem level.
- Origin, development history and dynamics of biota and its components: flora, mycota and fauna.
- Scientific basis for conservation of living nature: identifying of threats and developing of methods for their removing or limiting.
- Approaches and methods for sustainable management of protected nature objects.
- Approaches and methods for sustainable management of biological resources, incl. studies on resource importance of species and communities not used before.
- Ecology and biology of species of economical and social importance, incl. approaches and methods for assessment; limiting the impact and regulation of density of invasive species, pests, parasites and other organisms of importance to medicine, nature protection, agriculture, forestry, fishery, hunting, managements of bio-resources and other human activities.
- Scientific basis of ecological risk assessment, the quality of environment and impact on it, elaboration of approaches and methods for biodiversity assessment, bio-monitoring and safety systems.

The Institute has well-equipped laboratories for various floristic, faunistic, mycological and ecological studies: chemical, phytochemical, genetic, molecular, karyological, biotechnological, parasitological light-microscope laboratory and ecological microbiology, GIS-centre, LTER centre, library and Editorial department. The Institute has rich collections of animals, plants and fungi, seven experimental field stations in *Sreburna* and in the town of *Sozopol* (both are LTER sites), Biosphere Reserve, *Kalimok Reserve*, *Atanasovsko Ezero Reserve*, *Beglika* locality, *Parangalitsa* Biosphere Reserve, *Plana Mt.* At the institute important scientific projects, funded by national and European sources, and applied projects on the protection and sustainable development of the environment are implemented.

The scientific staff of IBER comprises 157 scientists, including 18 professors, 30 docents, 56 chief assistants and 21 assistants. The number of the PhD students is 40.

FRANCE

The Ecology and Environment Institute (INEE) of the French National Centre for Scientific Research mission is to promote and facilitate research of excellence in global ecology. The research is conducted by a network of research units in the areas of ecology and environment including biodiversity and human-environment interactions.

This research provides answers to issues related to global change, i.e. globalization of human activities, consequences of human actions on environment and its effects on health. The institute aims to stimulate the emergence of environmental science as an integrated scientific field. The knowledge provided by this field meets the social demand for environmental engineering expertise, support remediation and, more broadly, the challenges of sustainable development.

The Institute also supports research and research training in its field of competence, develops the interface between research and society and contributes to the creation of new vocational courses in environmental science.

For reaching this objective, the INEE identifies universities as its first partner. Are also concerned: regional and local authorities, and large national research and training institutions.

The National Institute of Earth Sciences and Astronomy (INSU) has the mission to design, develop and coordinate research of national and international importance in astronomy, Earth Sciences, of ocean and space that are conducted in partnership with universities and other large national research and training institutions.

INSU ensures the implementation of incitative actions on research in coordination with other concerned agencies, and build a strategy of programmation of national and international equipment for the study and observation of Earth and the Universe. For this purpose, INSU ensures the coordination of Observatories of Sciences of the Universe and the funding of Earth and Spatial Research. It is strongly involved also in several national and international observatories, as the European southern observatory, Euro - Argo, EMSO: European multidisciplinary seafloor observatory, IAGOS: In-service aircraft for a global observing system, and ICOS : Integrated carbon observation system.

GERMANY

Helmholtz-Zentrum Geesthacht Zentrum für Material- und Küstenforschung GmbH (HZG) belongs to the Helmholtz Association of German Research Centres. HZG is located in Geesthacht near Hamburg, with staff of ca 650 scientists, engineers and technicians. The main HZG research areas cover environmental research focussing on coastal, marine and polar systems as well as materials science with foci on advanced engineering materials, research with neutrons and synchrotron radiation and regenerative medicine. HZG comprises four research institutes and the German Climate Service Centre. Amongst the four research institutes at HZG, the Institute of Coastal Research is divided into 3 sections; "System Analysis and Modeling", "Development of Operational Systems" and "Biogeochemistry in Coastal Seas".

Major HZG research platforms include COSYNA; the Coastal Observing System for Northern and Arctic Seas, as well as extensive experimental and testing facilities: pilot plants, mainframe computers, a research vessel and environmental monitoring facilities. HZG is one share-holder of the German Climate Computing Centre

(DKRZ), one of the leading computing centres worldwide exclusively dedicated to climate modelling. The DKRZ data bank is one node of the climate simulations of the Intergovernmental Panel on Climate Change (IPCC).

HZG engages in projects to support research and innovation at national and European levels. Since the year 2000, researchers at HZG coordinated some 40, and participated in more than 120 EU projects co-financed by the European Commission, mainly through FP5, FP6, FP7 and HORIZON 2020 framework programmes. HZG holds more than 600 patents in areas such as advanced engineering materials and regenerative medicine. HZG maintains its own technology transfer department which provides services to HZG researchers covering e.g. protection of intellectual property, licencing, and support to spin-off.

HZG's organisational structure is based on project management principles which promote networking of HZG's activities internally and in particular with external partners. About 62% of HZG's annual budget (89 million Euros in 2013) is provided by the national federal and states governments, while 38% are generated via additional income such as EU and national research projects, contract research, and licensing of HZG patents for products and processes. High-level training and education for e.g. students, PhD-students, and post-docs at HZG is provided by numerous of its institute and department leaders, several of which being part-time affiliated to universities. HZG maintains central administrative, financial, technology-transfer, legal and project management departments providing its researchers with full support in all related issues.

The **Federal Institute of Hydrology, Koblenz (BfG)** is a scientific institute of the German Federal Government. The BfG is specialized in current and future aspects of river hydrology, water resources management, water pollution control, ecology, water conservation, and development and new construction of federal waterways. Hosting the secretariat of the German National Committee for UNESCO's International Hydrology Programme (IHP) and of WMO's Operational Hydrology Programme (OHP) and a UNESCO center for water quality, the BfG provides several global data centres with water-related information. The BfG is represented in several transnational river commissions in Europe, such as those of the Rhine, Elbe, Oder, and Danube. The aim of the 320 employees is to develop interdisciplinary oriented sustainable concepts and measures pertaining to water availability, sediment management, biological diversity, environmental, ecological and ecotoxicological impacts of all kind of activities at rivers and streams. The institute participates in numerous national and international co-operations and activities on water-related issues with a strong focus on large rivers and transitional waters. It is also in charge with monitoring activities of rivers and transitional waters with recording their environmental conditions and changes in hydrological information systems. The BfG has state-of-the art experimental facilities such as laboratories and permanent monitoring stations providing excellent opportunities for interdisciplinary water research.

GREECE

Hellenic Centre of Marine Researches (HCMR) is the main organisation for oceanographic, inland waters, marine biology, genetics, fisheries and aquaculture research in Greece. It constitutes of three relevant Institutes. The Institute of Oceanography (IO), which will be main partner of HCMR in DANUBIUS-RI, has been

involved in numerous EU-funded RTD projects, either as coordinator or as a partner (e.g. SESAME-IP (Coordinator), PERSEUS-IP (Coordinator), CINCS, MTP-II MATER (Coordinator for East Med), METROMED (Coordinator), KEYCOP, INTERPOL (Coordinator), ADIOS, BEEP, IASON (Coordinator), MERSEA-IP, HERMES, HERMIONE, EUR-OCEANS, ECOOP, CIRCE, SPICOSA, MESMA, MARIFISH, PEGASO, MyOcean, etc). In 2005, the Institute of Oceanography was given the National Excellency Award in Greece. The HCMR is legally bound to apply the WFD and the MSFD in Greece. It has major field equipment, including 2 research vessels, 1 manned submersible, 2 ROVs and a range of water column and seabed sampling and surveying instruments.

HUNGARY

Department of Environmental Engineering – Széchenyi István University

The Department of Environmental Engineering at the Széchenyi István University is an interdisciplinary group of academics who focus on a wide range of environmental assessment problems. The department was established in 1992 to provide a basis for Environmental Engineering course and research on the fields of environmental sciences, environmental economy, regional studies and environmental policy. The department manages the Environmental Engineer BSc course and also participate in teaching of several of BSc and MSc level courses of the Széchenyi István University. The department also run ten ERASMUS courses in English and German for foreign students. The department offers educational and practical expertise, knowledge and skills in the areas of: Environmental Status Assessment; Environmental Analysis; Water Protection; Noise mapping; Sustainability Analysis of Regional Development; Building Energetics; Environmental Management and Project Management. The main services provided by the department are: preparing studies, analysis, evaluation on environmental protection and sustainability; solving practical environmental problems; counselling support: in the fields of environmental protection projects for companies, corporate social responsibility, environmental protection and sustainable system solutions at settlement and regional level; noise measurement and noise mapping; preparing energetic revisions and correction plans; determining the building energetic dimensions, certifications and planning projects.

Centre for Ecology, Hungarian Academy of Science (CER) is to carry out high quality research on the biological diversity of forest, grassland, lake and river ecosystems, to learn about these systems, and to provide evidence of the importance of their conservation. The Centre is the home of researchers from various disciplines, including ecology, botany, hydrobiology, meteorology, agronomy, forestry, as well as interdisciplinary sciences.

The Centre is the largest ecology institute in Hungary, and therefore it is dedicated to being an advisor to the nation on issues related biodiversity and ecosystems, and also responsible for supporting the development of ecology in Hungary. We established and maintain the Hungarian ecologists' blog, organise and host meetings, and take part in education and outreach of research. The CER which was established in 2012, combining three research institution(Balaton Limnological Institute founded at 1927, Botanical Research Institute founded at 1955, Danube Research Institute founded at 1957). We are working on the integration of these institutes and disciplines, as the solution to our environmental problems cannot be solved in isolation. New research projects and our involvement in both global and EU

level policies on ecosystem services shows our commitment to putting biodiversity into a wider context.

The main research topics of the centre are:

- the study of the composition, structure, dynamics and functioning of terrestrial and water ecosystems;
- the study of the sustainability of ecosystem services from an ecological view;
- research correlating to the international operative agreements regarding the protection of habitats, biodiversity and water quality;
- effect analysis of land use, landscape management, water use, control of waters, and other interventions modifying the state of the environment, furthermore providing scientific basis of actions aimed at restoration and the study of the background and relations of ecological processes on global, regional and local scale.

Institute for Geological and Geochemical Research (IGGR) was funded in 1955 and since January 1st, 2012 the Institute is operating as a part of the Research Centre for Astronomy and Earth Sciences, Hungarian Academy of Sciences. The institute has no department structure, instead, the laboratories - as functional units - and two research groups (Archeometry and Geochemistry & Palaeoclimate R.G.) form its structure.

Since its funding it has been the leading geochemical research institute in Hungary and acknowledged world-wide. The institute is equipped with four state-of-the-art laboratories:

- stable isotope mass spectrometry
- electron microprobe
- X-ray diffraction (XRD) and X-ray fluorescence (XRF)
- organic chemistry and analytical chemistry

The Institute is involved in national and international projects related to archeometry, and research on freshwater limestones, speleothem, tree rings, Secondary carbonate in soils and paleosoils as paleoenvironmental proxies, palaeoclimatology based on isotope hydrology, ice cores etc.

IRELAND

University College Cork (UCC) is Ireland's premier research university, offering under-, and postgraduate studies to over 17,000 students, and attracting the highest peer-reviewed research income per head nationally. UCC is home to major research institutes and centres, including the Environmental Research Institute. The Coastal and Marine Research Centre (CMRC) and staff of the School of Biological, Earth and Environmental Sciences (BEES) are part of the Environmental Research Institute. The CMRC has been involved in Ocean Management initiatives since 1994 and is currently engaged in over 25 national and European marine focused projects including eight EU Framework projects and four INTERREG projects. The Centre is the Lead Partner on the large-scale INTERREG NWE project, IMCORE, Former Node Leader on the FP6 project, SPICOSA and is a Workpackage leader in several current FP7 projects, including COEXIST, GEOSEAS, NETMAR, MESMA and MARLISCO and it a partner on other projects including CORALFISH and KNOWSEAS. Within the CMRC the Groups that are of direct relevance to this particular project proposal are:

- the Governance Group, participant in numerous national and international projects aimed at improving understanding of the inter-relationships between

government, market and civil society at a range of scales). The Group has extensive experience of organising and delivering workshops across Europe to a range of focused on integrated approaches to addressing local issues.

- the Coastal Processes and Sea-bed Mapping Group, with research done through the use of remotely sensed and ground based methods. Coastal work includes monitoring coastal processes (e.g. beach erosion, sediment transport) using a range of instrumentation and advising on coastal management. In recent years the group has been active in training university students in seabed mapping techniques and analysis.

Staff in the School of BEES cover a wide range of environmental disciplines and carry out pure and applied research on all aspects of the freshwater and marine environments funded by national (e.g. National Parks and Wildlife Service, Environmental Protection Agency) and international initiatives and agencies (e.g. INTERREG, FP, ESF). River, lake and catchment studies are currently examining the impact of forestry activities on freshwater fisheries and biodiversity, approaches to fisheries management and conservation in eutrophic lakes, and the impact of invasive alien species in freshwater bodies (including genetic mapping of dispersion).

ITALY

Institute of Marine Sciences (ISMAR) As part of the National Research Council (CNR), ISMAR resulted from the unification of all the institutes dealing with marine research. It conducts research in polar, oceanic and Mediterranean and Black Sea regions, focusing on the following themes:

- the evolution of oceans and their continental margins, studying submarine volcanoes, faults and slides and their potential impacts onshore;
- the influence of climate change on oceanic circulation, acidification, biogeochemical cycles and marine productivity;
- submarine habitats and ecology, and the increasing pollution of coastal and deep-sea environments;
- the evolution of fish stocks with a view to keeping commercial fishing within sustainable limits and improving mariculture and aquaculture practices; and
- natural and anthropogenic factors impacting economically and socially on coastal systems from pre-history to the industrial epoch.

National Institute for Geophysics and Vulcanology (INGV) is currently the largest European body dealing with research related to natural hazards. Its main mission is to monitor and study natural phenomena in both the solid and fluid components of the Earth. INGV cooperates with Italian and international universities, and public/private institutions. INGV operates in close coordination with the Ministries of Education, University and Research, Environment, Defence, Foreign Affairs and Civil Protection Authorities in the frame of large research programs of national and international relevance. Among many projects funded by the EC, some are of specific interest for DANUBIUS-RI: the two European RI EMSO and EPOS (coordinator), HYPOX (partner).

MOLDOVA

Moldavian Academy of Sciences, Chisinau

The Institute of Chemistry of the Academy of Sciences of Moldova is a leader in the international scientific research in the field of environment and water sector: There are several international projects with CNRS (National Center for Scientific Research) of France, BMBF (Federal Ministry of Education and Research) of Germany; Belarusian Republican Foundation for Fundamental Research, ANCS (National Authority for Scientific Research) of Romania; the State Agency on Science, Innovation and Information of Ukraine, STCU - ASM, the Joint Operational Programme "Black Sea Basin 2007-2013", FP7 -PEOPLE -2013- IRSES. The journal „Chemistry Journal of Moldova” is edited in English. In the frame of Institute of Chemistry is created multidisciplinary Center of Study and Monitoring of Water Quality which will focus on the following problems which fit the DANIBIUS RI objectives:

- development of the theory of the redox state in the environment and clarification of the reduction-oxidation mechanisms of the components during the process of aquatic systems quality formation;
- elaboration of novel methods and technological procedures for water treatment using different local natural sorbents and activated carbon;
- development of quantitative aspects of the theory of stability of homogeneous and heterogeneous multicomponent systems for estimation of the fate of pollutants in contaminated ecosystems;
- implementation of new analytical methods and strengthening of institution capacity for the analysis of chemical and biological parameters of water status according to WFD;
- Geo-database and GIS elaboration of water resources for data processing and on-line access to the information for decision makers;
- development and implementation of modern technology in environmental measurement and observation for the optimization of surface and groundwater monitoring network: remote sensing, chemical and biological sensors, etc;
- promotion of scientific activity for more effective cooperation between different institutions in water sector;
- organization of the service for water quality and quantity analysis, civil engineering and water management (including waste management);
- personal training in field of water analysis.

NETHERLANDS

DELTARES

Deltares is an independent institute for applied research in the field of water, subsurface and infrastructure. Throughout the world, we work on smart solutions, innovations and applications for people, environment and society. Our main focus is on deltas, coastal regions and river basins. Managing these densely populated and vulnerable areas is complex. We are convinced that it is only by forging alliances that we can tackle the challenges we face. That is why we collaborate closely with governments, businesses, other research institutes and universities at home and abroad. Moreover, we do not keep our breakthroughs to ourselves; we share them with others. Development of new knowledge depends on sharing the knowledge we have. Government authorities, community organisations and the commercial sector benefit from our research and specialist consultancy. Our activities always aim to maximize knowledge development and knowledge transfer. Our motto is Enabling

Delta Life. As an applied research institute, the success of Deltares can be measured in the extent to which our expert knowledge can be used in and for society. For Deltares the quality of our expertise and advice is foremost.

Knowledge is the core business. Our research is always a response to the needs of society. We focus on five themes:

- Flood Risk
- Ecosystems and Environmental Quality
- Water and Subsoil Resources
- Delta Infrastructure
- Sustainable Delta Planning

All contracts and projects, whether financed privately or from strategic research budgets, contribute to the consolidation of our knowledge base. Furthermore, we believe in openness and transparency, as is evident from the free availability of our software and models. Open source works, is our firm conviction. Deltares employs over 800 people and is based in Delft and Utrecht.

UNESCO – IHE Institute for Water Education is an institute offering international postgraduate water education and research. It is an independent Category 1 Institute of UNESCO, located in Delft, The Netherlands. It confers fully accredited MSc degrees and promotes PhDs. Since 1957 the Institute has provided postgraduate education to more than 14,500 water professionals from over 160 countries, the vast majority from the developing world. Every year an average of 200 students are starting their MSc studies. Over 130 PhD fellows are currently enrolled and numerous research and capacity development projects are carried out throughout the world. In research, its expertise is especially in problem-oriented scientific and applied research that yields outcomes relevant to developing countries and countries in transition. The institute has vast experience in research projects and led EU FP6 project SWITCH (Sustainable city of the future), FP7 project KULTURisk and the recently started PEARL (Preparing for Extreme and Rare Events in Coastal Regions). UNESCO-IHE is partner in many other projects like FP7 WeSenseIt and Wateromics and the Australian CRC for Water Sensitive Cities project Socio-Technical Flood Resilience. As a global institute UNESCO-IHE is playing a role in development of the post-2015 Sustainable Development Goals and is in the Task Force of the European Innovation Partnership (EIP) on Water. UNESCO-IHE Institute for Water Education is, therefore, well positioned to play a key role in DANUBIUS-RI both in advising on international cooperation and funding and in educational development and human capital development. The latter will include developing needs and procedures for inter- and trans-disciplinary educational and research capacity building.

ROMANIA

National Institute of R & D for Biological Sciences was founded in 1996 by merging three research institutes and one regional research centre (in Bucharest,

Cluj, Iasi and Piatra Neamt) with inter-connected and complementary activities in the life sciences. This institute is conceived as a Centre of Excellence in the life sciences. Its mission is to promote multidisciplinary basic and applied research in the life sciences (cellular and molecular biology, biotechnology and biodiversity), to undertake scientific and socio-economic consulting, as well as to promote national and international networking. In the last decades, new branch offices and field stations have been established, the most significant of which is the branch office with laboratories in Constanta and Murighiol. This is an active research unit which focuses on biodiversity, ecology, environmental studies, as well as monitoring and development of conservation/restoration strategies. It is an affiliated centre of the International Centre for Genetic Engineering and Biotechnology. It carries out fundamental and applied research on biology, biochemistry and ecology in a highly competitive, networked research environment, and has attained high national and international visibility.

NIRDBS carries out research in the following areas which are closely related to DANUBIUS-RI:

- biodiversity and measures of biodiversity restoration: ecology, ecotoxicology, especially molecular taxonomy and syn-taxonomy of species in Romania; plant and animal taxonomy; autecology, assessment of ecological risk factors affecting habitats; paleo-limnology;
- sustainable development and sustainable resource utilization; structure, functionality and productivity of ecosystems;
- molecular and cellular biology, especially molecular dynamics;
- bio-analysis; development of methods for ecosystems monitoring (sensors; biosensors); impact of pollutants on ecosystem safety; bioremediation strategies;
- evaluation of ecosystem modification against human health status and
- bioinformatics; modelling and simulation.
- biodiversity monitoring and assessment using novel technologies (UAVs, LiDAR, etc.)
- biometrics, biostatistics, remote sensing measurement and analysis
- calibration models and evaluation of ecosystem status
- environmental risk assessment and predictive modelling

NIRDBS is providing R&D and analysis services for a number of Romanian and international organizations and structure, such as Ministry of Environment (advising on data management and formulation of predictive scenarios for Romanian Regulation Body “Apele Romane”), Bagdasar Arseni Hospital, National Institute of R&D for Food Bioresources, DSM Nutritional Switzerland etc

National Institute of R & D for Marine Geology and Geo-ecology (GeoEcoMar)

is a national institute in the marine geosciences and environmental sciences. It carries out complex comprehensive surveys on the Danube River – Delta – Coastal Zone – Black Sea geo-system. It has a modern RI, including the 3 000 t R/V “Mare Nigrum”, the R/V “Istros” for rivers and coastal seas, a laboratory-house boat “Halmyris”, and modern buildings and laboratories in Bucharest and Constanta. This enables it to undertake complex, multidisciplinary studies in the framework of national and international programs. It participates in projects of the EU FP 6 and 7, ERA-NET, regional and trans-border programmes, as well as in bilateral cooperative projects with France, Germany, Netherlands and Switzerland. The main research fields are: marine geology and geophysics, mineral and energy resources, and

environmental protection, focusing on the marine, coastal, deltaic and fluvial environments. The main objectives are:

- to study the surficial and deep geological structures of the Danube-Danube Delta-Black Sea geo-system, to model and forecast its evolution under the influence of global climate change and sea level change;
- to outline new resources (mineral, conventional and unconventional energy, biological) taking into account legislation on environment protection;
- to provide to decision-makers relevant scientific information on adaptive, sustainable and integrative management of the marine and coastal environments, in particular with respect to structure, protection and functioning of the characteristic ecosystems;
- to study natural hazards specific to the marine, fluvial and lacustrine environments (landslides, gas release, tsunamis, erosion, floods, extreme seasonality etc.), their monitoring, forecasting and mitigation;
- to study sedimentary paleo-environments for a better understanding of the modern depositional environment;
- to implement up-to-date techniques, technologies and biotechnologies, including long-term monitoring systems;
- to participate in the construction of platforms and technologic parks in order to study the deep-sea environment, to capture the sea flow of energy (waves, tides, gas hydrates, wind) and to improve positioning of marine constructions;
- to study carbon dioxide capture and storage in geological structures as possible methods of reducing the emission of greenhouse gases; and
- to participate in environmental education, to involve the younger generation in natural sciences with a particular emphasis on the marine, coastal, deltaic, lacustrine and fluvial environments.

The **Danube Delta National Institute for Research and Development (DDNI)** was established in 1970, whose main purpose is the basic and applied research in ecology and environmental protection for the management substantiation in the Danube Delta Biosphere Reserve (DDBR) and other wetlands of national and international importance on biodiversity conservation and sustainable development. From 2010 DDNI is subunit of National Institute for Environment Protection.

Due to its expertise and contribution to the local, regional and national research and development programs, DDNI has been nominated as:

- Centre of Excellence for Deltas & Wetlands
- National Reference Centre for Land Cover and Fisheries
- Main Scientific Advisor of the Ministry of Environment and Sustainable Development for the implementation of the NATURA 2000 Network in Romania
- For the last 5 years DDNI conducted several complex projects in support of the National Strategy for the Environment Protection and the Government Program, as: Ecological and Economical Resizing in Danube Floodplain, Natura 2000 national network of protected areas and natural reserves, rehabilitation of the coastal infrastructure and the elaboration of Danube Delta Biosphere Reserve Master Plan. At European level, DDNI is participating in projects financed under the EC Framework Programs, Interreg SEE Danube Floodrisk, Danube Parks, Habit Change, regional and trans boundary programs.

- The main research topics of the DDNI scientists are:
- structure, evolution and function of the specific wetland ecosystems;
- monitoring of the biological diversity and environmental factors in Danube Delta Biosphere Reserve;
- modeling the processes that are the basis of ecosystem functioning;
- assessment and reduction of the human impact and sustainable use of the biological natural resources (fish, vegetation, game and landscape);
- ecological restoration of the ecosystems that have been injured by the negative human activity; and ecological rehabilitation of threatened species;
- development of the spatial data infrastructure (SDI) for the system Danube River – Danube Delta - Black Sea by supporting and creating local geonodes through Geographical Information System (GIS) and use of the remote sensing techniques;
- scientific substantiation of the normative acts projects that regulate the environmental protection based on multi-scale, spatially explicit scenarios;
- researches and studies for implementing the EU Directives, Danube Strategy and international conventions that Romania has adhered to on environmental issues.

SPAIN

International Centre for Coastal Resources Research (CIIRC) is a public consortium integrated by the Generalitat de Catalunya (Regional Government of Catalunya), the Universitat Politècnica de Catalunya (UPC), with the support of the UN Environment Programme (UNEP/UN). CIIRC is thus a non-profit public Research Centre. The main goals of CIIRC are to initiate and coordinate the execution of studies related to the coastal zone and coastal resources, develop and disseminate tools to aid in the management of coastal resources, and facilitate the transfer of knowledge and technology towards the industry and the administration, promoting the dissemination and exchange of information. CIIRC has a wide experience in managing research and research projects in the fields of coastal and estuarine hydrodynamics and water quality, oceanographic engineering, coastal morphodynamics and morphology, harbour engineering and operational oceanography, in close cooperation with UPC, mainly based on the use of numerical models, field permanent networks and an internationally recognised hydraulic lab (featuring the third wave flume CIEM in the EU in this field). CIIRC has been involved in numerous projects on coastal evolution and management funded by the EU, Spanish Government, and Autonomous Government of Catalonia, including ARTEMISA, PREVIMED, RIMA, RISTE and ARCO, and EU projects MEDDELT, FANS, WAVELAB, HYDRIV, HYDRALAB-II, DELOS, ECOSUD (led by CIIRC), WAVELABII, FLOODsite, AQUAS (led by CIIRC), HYDRALAB-III, MARIE, CIRCE, BAWAPLA, FIELD_AC, HYDRALAB-IV. Most of these projects have strong environmental components and some of them coordinated by CIIRC. It has also organised several international courses funded by the EU Commission in the MAST and Environment Programmes dealing with coastal dynamics, engineering and management and several international and national conferences. CIIRC is made up of a team of highly qualified professional staff (circa 30 postgraduate and/or PhD level researchers, 20 of which are fulltime researchers and 10 combine research tasks with lecturing), with sound experience and coming from different technical/scientific backgrounds.

SWITZERLAND

Swiss Federal Institute of Aquatic Science and Technology (Eawag) is a world-leading aquatic research institute. It has a well-established portfolio of activities – research, education and consulting & knowledge transfer. Its research, which is driven by the needs of society, provides the basis for innovative approaches and technologies in the water management. Research at Eawag focuses on three main areas: water as a habitat and resource (Aquatic Ecosystems), water in urban areas (Urban Water Systems) and water contaminants (Chemicals and Effects). These areas are tackled by twelve research departments that are in very close cooperation for reaching synergies by interdisciplinary research. Eawag also supports a multitude of research initiatives and centres of excellence, including its own Center for Ecology, Evolution and Biogeochemistry (CEEB) and Competence Centre for Drinking Water (CCDW). It works closely on projects with the Competence Centre for Environment & Sustainability (CCES) domain of the ETH and the Swiss National Science Foundation (SNSF). Eawag cooperates with different institutes and universities from Romania and other SW European countries in the framework of different European and international programmes as SCOPES and ESTROM (a programme financed by SNSF and terminated in 2008).

UNITED KINGDOM

University of Stirling Biological and Environmental Sciences (BES), within the School of Natural Sciences, is pioneering research in key niche areas of environmental research located at the interfaces between organisms, environments and societies. Research in BES is organised into two distinctive groups: (1) Ecology, Evolution and Conservation; and (2) Environmental Systems, Environmental Change and Environmental Protection. and we contribute new understandings of earth surface processes, the biology of the environment and the scientific aspects of environmental management including conservation and restoration. Specialisations include: (i) characterising aquatic and riparian environments through earth observation; (ii) fluvial geomorphology and hydroecology; (iii) water quality, eutrophication, cyanotoxin, biogeochemical cycling and microbial pollution; (iv) paleoenvironmental reconstruction; (v) biogeographical impacts of climate change; (vi) pollution monitoring and impact assessment; and (viii) wildlife conservation.

University of Birmingham The School of Geography, Earth and Environmental Sciences (GEES) comprises 60 academic staff with 5 inter-disciplinary research specialisms: Water Sciences; Geosystems; Environmental Health Sciences; Society Economy and Environment; and Urban and Regional Studies. The School has well-equipped laboratories for environmental chemistry (incl. stable isotope and fluorescence spectroscopy), sedimentology, ecology, groundwater and palaeobiology research. It includes the nationally important Lapworth geological Museum. It has a large postgraduate school, with thriving postgraduate and undergraduate degree programmes. Researchers in a number of areas of the School could potentially contribute to the work of DANUBIUS-RI for both research and teaching purposes.

University of Hull has over 3300 staff, over 22,000 undergraduate students and over 3500 postgraduates The Department of Geography, Environment and Earth

Sciences has a long history of excellence in research and its application to real world problems. The Department employs 28 academic/research staff and over 20 PhD students working on a wide range of research projects. It has a portfolio of UK, EU and industrial funded research with a total value in excess of £6M, including several on-going UK NERC and UK EPSRC research projects and EU FP7 projects. Energy, Environment and Sustainability have been the major issues addressed within the University Strategy and research on this area have been undertaken for many years by a group of distinguished scientists. The diversity of the research activities, the dedication of the staff and the culture of collaboration, has earned the Department an international reputation and the excellent results in the 2008 UK RAE assessments.

Scottish Universities Environmental Research Centre (SUERC) is a collaborative facility operated jointly by the University of Glasgow and Edinburgh University. It hosts five Natural Environment Research Council (NERC) Facilities that are available to UK scientists through competitive application. SUERC's mission is to perform, stimulate and support high quality basic, applied and strategic research, within the Scottish University community and beyond, in the Earth, Environmental and Biomedical Sciences through development and maintenance of high-end analytical facilities, inter-disciplinary exchange and collaborative interaction. SUERC provides a focus in Scotland for high quality research through its own research programme and by assisting partner universities successfully to bid for research grants and deliver research outputs. Through teaching and training, SUERC contributes to the future supply of highly able scientists. Commercial research and testing is a valuable source of additional income and frequently contributes to national welfare and security. The Stable Isotope Biochemistry Laboratory houses state of the art instrumentation to measure stable isotopes. Excellent facilities for compound specific isotope analysis allow low-level biomedical tracer studies and investigation of source terms in the natural environment.

UKRAINE

Odessa State Environmental University (OSENU) is the key higher education centre in Ukraine in the area of Environmental Studies. Over a long period the main aim of OSENU (founded in 1932) was to train personnel in the fields of environmental quality monitoring and environmental control. In the field of Hydrometeorology OSENU has been training specialists for the World Meteorological Organization for more than 50 years. The curricula for training specialists meet all international standards and are acknowledged by hydrometeorological services all over the world. Since 1957 the University has provided training for some 1600 specialists from more than 70 countries, including circa 150 Candidates and Doctors of Science.

OSENU, as a scientific institution, has been carrying out research into:

- provision of weather forecasts and issuing timely warnings of hazardous weather phenomena for various areas of economic activity and kinds of organizations;
- modelling of geophysical objects and tendencies of climate change, estimation of their impact on various fields of economic activity;
- comprehensive and integrated study of water objects, development of science-based guidelines for the management of water regime and environmental conditions as well as prognostics of qualitative and quantitative changes in the future;

- study of regularities in creation of hydrological, hydrochemical and hydrobiological regimes in the off-shore and open seawater areas, modelling and prediction of their environmental conditions and water dynamics as well as hydrodynamic processes in the coastal zones;
- mathematical design for influence of weather conditions on the processes of productivity formation, development of new and improvement of the existent methods for agrometeorological prognosis of growth, development and productivity formation;
- provision of hydrometeorological and geophysical data for the Air Force, the Army, the Artillery and Rocket Power and the NAVY.
- management, economic and legal substantiation of nature protection activity.

The Ukrainian Scientific Center of Ecology of the Sea (UkrSCES), Ministry of Environmental Protection of Ukraine (UkrSCES) was founded in January in 1992 on the basis of the Odessa Branch State Oceanographic Institute. It is the main institution of the Ministry of Environmental Protection of Ukraine in the field of marine ecological researches. UkrSCES – is a unique institution of all state ecological systems of monitoring within the Black and Azov Seas, which provides a whole complex of tasks of the ecological monitoring.

The main task of UkrSCES is scientific and practical providing of realization of public policy of Ukraine in relation to the protection, rational use and rehabilitation of natural resources of the Black and Azov Seas basin, and also providing implementation of international obligations of Ukraine, in relation to marine aspects.

Scientific activities:

- conducting monitoring of the state of the environment of water areas in Ukraine, the Global Sea and coastal territories;
- elaborating programs for environmental monitoring and protection, sustainable use of nature resources and providing environmental safety to territories and aquatic areas;
- carrying out studies on the nature processes in marine ecosystems, coastal ecosystems and factors influencing them;
- carrying out work tied with preparation and distribution of ecological certificates, including international level;
- providing scientific and practical insurance against ecological risks;
- working out ,improving and applying novel methods, and methods of analysis and evaluation of the state of the nature environment, anthropogenic loads, metrological provision of analytical measurements;
- creating, applying and maintaining automated systems and data bases;
- organizing conferences, symposiums, courses, seminars, lectures, practical lessons and other forms of advancing the qualification of specialists in the field of environmental protection, use of nature resources, providing ecological safety, management of nature protection activity, providing specialists with high scientific qualification;
- practical activity in the protection of nature environment, sustainable use of nature resources.