DANube macroregion: Capacity building and Excellence in River Systems (basin, delta and sea)

- DANCERS -

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Summary

The major outcome of this document is a proposal for a new education program for the Danube-Black Sea (DBS) region. In principle the task focuses on different levels of education, namely (i) undergraduate students; (ii) postgraduate students (MSc, PhD); (iii) Postdoctoral fellows; and (iv) scientists. In addition, the requirements of technicians supporting all four groups are addressed within the framework of lifelong learning. Specialised training for professionals working in administrations (environment, navigation) is another goal of this agenda. The proposal for the education agenda is achieved through an analysis of the gaps and opportunities for an integrated approach towards a better alignment of international education and Human Resource development in the Danube Basin. Developments in the DBS include a number of initiatives and activities from before and after the 1990s (the fall of the Iron Curtain). In this context, the document reflects on the challenges including access to education programmes, new developments (including the credit transfer system) and the language requirements necessary for more substantial international co-operation. The document reflects on stakeholder opinions and provides a general discussion of the existing programs in the field of higher education and professional training.

At the moment in the DBS region there are very few opportunities for the exchange of knowledge and skills in professional education (e.g. technicians). A central information platform providing an overview regarding educational and training offers, current scientific projects, available scholarships and relevant funding opportunities is currently missing. This document lists existing types of programmes, including training workshops, exchange programmes, joint education programmes and joint research programmes. It also considers the infrastructure and financial grant schemes, international co-operations and relevant funding sources existing international networks.

It must be emphasised that support for all four levels of education including the relevant technicians is considered necessary. A core point for dedicated activities in the field is to ensure a sound exchange and co-evolution of the involved professional groups. In the document detailed suggestions for the groups are formulated, hence it becomes clear that the support function of technicians in the education process itself must not be neglected. Therefore it is important to promote professional development and facilitate the further exchange of the technicians supporting the education processes.

Undergraduate Students

- The international network should encourage bachelor students to spend one or two semesters at a partner institution in the Danube basin (hosted by academia, research institute or industry) to gain international experience, through the involvement in the Danube related. Also involvement in research projects. That would will facilitate better understanding and provide has potential for in-depth cooperation. The development of a Danube Basin undergraduate student exchange program offering undergraduate special courses with a focus on Danube issues is encouraged. These courses can range e.g. from fundamental subjects like ecology and environmental science, geomorphology, hydraulics, hydrology, sediment transport, to the methodologies of up-to-date integrated water and river management.

Master Students

- The exchange of Master Students is of utmost importance for the future improvement of the DBS management, since many alumni will work later in governmental organisations including ministries, water authorities, and consulting companies involved in the variety of measures necessary to improve water management, not necessarily related to the Danube, but also the other large river catchments. It will also include future professionals in the private sector (e.g. hydropower companies, navigation sector). Such improvements in the education sector can facilitate better water and river management.

Establishing a functional DBS undergraduate- and postgraduate student exchange programme including thematic postgraduate special courses seems feasible. This action will enable the co-evolution of the education sector with the societal- and scientific challenges.

Postgraduate Students

A further goal is to facilitate increased international exchange of PhDs. Such exchange will increase knowledge exchange between countries and existing institutions and will facilitate mutual learning by organising specialised modules or undertaking specific credit bearing research projects (e.g. PhD thesis, scientific projects). Such modules or joint research actions can be implemented at a host institution or through joint or independent research projects. Particularly the joint use of research facilities will enhance exchange and knowledge transfer and could be a vital element given the limited financial resources and the currently existing infrastructures.

As a next step the establishment of a DBS PhD programme can be initiated. In order to develop a long lasting Danube PhD cooperation, a roadmap for further higher education and post-doc co-

operation should be developed. The current deliverable provides necessary information for a mid-term and long-term planning of such roadmap.

Finally, and from a more holistic point of view, one must state that all future Danube education programmes must interact to create synergies. This must include and target experienced scientists, lecturers, professors and technicians that seek further professional development in the broad thematic field. Although the wide focus including river research and sea (Black Sea) research, advanced cooperation in education must look to establish instruments that facilitates a mid- and long-term perspective on the whole Danube River basin and the Black Sea in its entirety.

Lifelong education and professional training programmes

Specific lifelong education dedicated programmes for professionals working in various administrations along the Danube River, from the springs to the Black Sea, are needed to strengthen the uptake of science results into the management of all problems related to the integrated management of the Danube and similar DBS system. Dedicated courses granting training certificates have been requested by representatives working in river management, to be developed on a systematic basis throughout the Region. Besides reaching a common ground for a management and the permanent upgrading of skills by learning about the latest scientific developments and their practical applications, these courses for professionals will strengthen the Danube Region Identity. The certification system should follow the same set of rules that control teaching quality and evaluation activities, such as the one that founded the ECTS system (for further info see http://ec.europa.eu/education/tools/ects_en.htm).

Since research infrastructures are at the core of all implementation actions for the envisaged Danube Region Research and Innovation Strategic Agenda, more emphasis shall be put on training the next generations of research infrastructures managers.

Depending on the type of managers and administrators as well as the field of interest three professional training programs are proposed: (i) specialised courses related to a certain field of expertise (e.g. river hydraulics, sediment transport, flood risk management), (ii) summer schools consisting of a theoretical and practical part, (iii) master course as program in parallel to the job

These courses or schools are supposed to be ended with the handling of certified diplomas.

1. Introduction

Globally, freshwater and marine systems and their transition zones – including deltas and shallow seas - are experiencing growing environmental problems, as a result of increasing population pressure and associated development within an increasingly extreme climate. This presents major challenges to balancing economic and societal needs with sustainable environmental management. In Europe, pollution from agricultural and urban centres and hydraulic engineering are widely recognised to inhibit the achievement of good ecological / environmental status in coastal and inland waters. At the same time, economic sectors such as shipping/navigation and hydroelectric power generation depend on minimum water volumes for their functioning while significantly altering complex dynamics associated sediment movement, water flow, and increasing the potential for alien species introduction. These pressures act in concert with climate change, in which current models anticipate crucial changes in extreme weather conditions (e.g. Döll and Zhang, 2010) and the alteration of the water regime of freshwater and oceanic systems (Doney et al. 2012; Ruckelshaus et al. 2013). These problems must be solved in an integrated way in order to develop sustainable solutions that balance economic and societal needs with environmental protection. Current projections anticipate crucial changes regarding extreme weather conditions, oceanographic conditions and in the water regime of rivers. These changes will, in turn, severely modify basic riverine and marine processes inducing important physical, geochemical and biological responses. To a significant extent, our approach to problems such as these has been discipline specific and considerably more focus on innovative cross-disciplinary research is essential to address current and emerging environmental problems to deliver sustainable and innovative solutions required to address the major societal challenges, including environmental protection and job creation. Another problem is the Brain Drain, which affects the South East European countries. Thus, job creation especially also for academics is of central importance.

These challenges are exemplified in Central / Eastern Europe by the Danube River - Danube Delta - Black Sea system, refered to here as the Danube Black Sea (DBS) system. This region has a complex recent geopolitical history and includes some of the richest and poorest areas in Europe. There are many challenges in environmental management and in, for example, balancing habitat conservation and restoration, addressing the EU 2020 Biodiversity targets whilst ensuring sustainable economic development. With a basin >800,000 km2 in area (Figure 1) and a catchment that spans 19 countries, the Danube River is the most international river in the world, connecting people with differing economic, social, cultural, political and environmental heritages. Of the countries that share the DBS, 11 are EU Member States (Austria, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Italy, Poland, Slovakia, Slovenia, Romania). The 8 non-Member States (Albania, Bosnia and Herzegovina, Macedonia, Moldova, Montenegro, Serbia, Switzerland, Ukraine) are members of the International Commission for the Protection of the Danube River (ICPDR) and committed to implementation of the EU Water Framework Directive. The Black Sea is >430,000 km2 in area, and is surrounded by 6 countries: Bulgaria, Georgia, Romania, the Russian Federation, Turkey and the Ukraine. The Black Sea has

unique environmental characteristics: as a semi-enclosed sea, there is a clear vertical stratification of water masses and it 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 of which the Danube is the largest. Integrated water resource management (IWRM) recognizes the interconnectedness of social, economic, hydrological and ecological needs in river basins and associated coastal zones. Thus, the IWRM approach uses the basin as the managed unit, and recognizes the dynamic relationships between stakeholders and central governments who must work together to meet sustainable development goals. Thus, IWRM aims to balance the needs of stakeholders while balancing the needs of the environment. In principle, it achieves this through the coordination of management across sectors and the active engagement of stakeholders and policy-makers at multiple scales, including local, national, and international. This is the philosophy behind the SRIA for the Danube region (http://www.inbo-news.org/IMG/pdf/GWP-INBOHandbookForIWRMinBasins.pdf).

Within this context, the EU Coordination and Support Action (CSA) project DANCERS (DANube macroregion: Capacity building and Excellence in River Systems (basin, delta and sea) seeks to mobilize actors and resources from public and private sources to increase investment and research and innovation to enhance river-delta-sea management in the DBS region. A starting point is provided by a number of significant pressures identified in the Danube River Basin (DRB) District by ICPDR and formulated in the DRB management plan (ICPDR 2009) and the updated version (ICPDR 2015), with respect to water quality, hydromorphological alterations, river and habitat continuity interruption, hydrological alteration and newly emerging management issues such as invasive alien species (IAS), the protection of all sturgeon species and increasing the adaption capacity to climate change effects. Hence DANCERS is envisaged as a supporting action, which will ultimately help achieve the environmental objectives for the Danube Region by identifying the knowledge and technological requirements to develop a specific strategy for the science, economic development and sustainable management of the Danube Delta area.

Figure 1 The Danube - Black Sea (DBS) System

One of the key aims of the DANCERS Project was to provide strategic guidance on how to improve research and innovation co-operation in the Danube Region in order to better exploit scientific outcomes for the benefit of the economy, environment and society in general and policy makers in particular.

To this end, DANCERS work package 3 [Design] was tasked to devise processes and build upon outputs from work packages 1 [Mapping] and 2 [Understanding] to work with stakeholders in producing three discrete but interconnected outputs:

(1) A regional strategic research and innovation agenda – to provide scientific direction to underpin integrated management of river-delta-sea systems in the DBS regions.
(2) A detailed plan and concept for a new integrated research infrastructure – to link with existing infrastructure in the natural sciences across the DBS regions and with the wider European domain.
(3) Human capital development programme – to provide recommendations for the development of undergraduate, MSc, PhD education and postdoctoral training programmes in order to build capacity for the proposed integrated management approach. This is also framed within the context of lifelong-learning.

These three outputs were delivered in parallel and this document sets out the evidence base and strategy for the education programme to develop the human capital required to deliver the

innovative and integrated management of river-delta-sea systems. People are the most important asset in any research – industry – policy-making community, but the educational framework must be in place to develop the knowledge and skills base to capitalise on this asset and convert the challenges and opportunities presented in river-delta-sea systems into innovative and effective and integrated management responsive to existing and future economic, regulatory and environmental drivers. Effective, responsible and sustainable management requires holistic understanding of these complex societal, engineering and environmental drivers. This document reviews and presents educational and training programmes that can be exploited at different career stages to ensure that individuals have access to best practice and state of the art knowledge when required. The ultimate strategy must be to ensure that the framework is in place that allows the development of skills and knowledge base within individuals to collectively ensure innovation, new understanding and the ability to communicate these outputs effectively. Building on the expertise and contacts of the DANCERS consortium, this document reviews recent and existing exemplars of good practice, including funding requirements and exchange programmes that are needed to fill the capacity and capability needs highlighted for science, policy and industry in the DBS region.

BOKU coordinated the consortium efforts (with support of University Stirling, University College Cork, WasserCluster Lunz, GeoEcoMar, UNS, UNESCO-IHE) regarding the design of the educational programmes and opportunities required to deliver the skills and knowledge requirements to fulfil the needs to ensure the innovation potential for responsible sustainable management of the river-delta-sea systems.

2. Approach

To define the set of instruments that will enhance the research, innovation and management of the Danube river-delta-sea system, a progressive plan of research was implemented to:

a) Undertake a critical analysis of achievements in integrated river-delta-sea management in the DBS system

b) Analyse the links between the achievements, deliverables and results of the work performed

In each case, the approach addressed the three pillars: (i) *Science and Innovation agenda*; (ii) *Research Infrastructures;* and (iii) *Human Potential.*

2.1 Mapping national, EU and international research/initiatives on river-delta-sea systems

The Danube has been the focus of a long series of research programmes dedicated to river, delta and coastal management, funded at the national and European scale. Central to the development of any research strategy is the assessment of relevant research initiatives that have taken place within the DBS region. To establish the *status quo*, a metadata base was set up to compile information on environmental management related projects undertaken within the DBS over the last 20 years. This provided the basis to understand: (i) the temporal and spatial distribution of the research projects; (ii) which funding institutions dominated the landscape of research funding; (iii) the thematic priorities for research projects in the DBS region; and (iv) identify best practice in water management issues, in relation to the *International Commission for the Protection of the Danube River* (ICPDR); and (v) for projects funded from 2009, identify clusters of research themes and which themes were most productive in terms of research outputs. Details of the methodology and results are presented in Feldbacher et al. (submitted).

2.2 Understanding the needs in knowledge transfer among science, economy and policy makers.

Following assessment of the results of 20 years of research funding, a review of the strengths and weaknesses of existing innovation and research in relation to the DBS system was undertaken through workshops with the three main stakeholder communities over the period March to May 2014: (1) science; (2) industry; and (3) policy makers, decision makers and administrators. From each workshop an analysis of needs was performed and subsequently synthesised into a SWOT and a *knowledge matrix* during the final Dialogue Conference in September 2014. The *knowledge matrix* identifies what is good, what is required and what

needs to be strengthened in the Danube River-Danube Delta- Black Sea system and was grouped according to the three main pillars of research and development: (i) *Science and Innovation agenda*; (ii) *Research Infrastructures;* and (iii) *Human Potential*.

The workshops were supplemented by an online questionnaire, which was designed to obtain the opinions of relevant stakeholders with regard to priorities for basic and applied environmental research in the field of water research in the DBS Region. The questionnaire considers both current and future activities that will be required under Europe 2020 strategy and the strongly related HORIZON 2020 (The EU Framework Programme for Research and Innovation). The aim of the survey was to analyze and assess the current environmental research needs in the region in order to identify a framework for water research related activities. These are grouped under the following three Research and Development pillars to identify a framework for future research cooperation at regional, national and multinational joint efforts: (i) *Strategic Research Agenda*; (ii) *Research Infrastructures*; and (iii) *Education and Training Agenda*.

2.3 Reviewing the State of the Art within River-Delta-Sea Systems

A series of review papers were invited for a special issue of *Science of the Total Environment* to identify the state of the art and best practice in river-delta-sea systems in both knowledge within the physical, chemical and biological aspects of river delta sea systems, their observation, and the social and economic aspects including educational requirements. These articles were peer reviewed by independent international experts through the normal editorial channels, and together provided the third source of evidence to help define the tools and instruments required to boost knowledge transfer, enhance Research and Innovation cooperation for the environment at the more integrated strategic level.

3. Assessment of Educational needs in the DBS region

The assessment was made primarily by the outcomes of the workshops, the review done for the special issue paper (Irvine et al., submitted) and supplemented by additional material derived from the metadatabase.

3.1 Outputs from the end-user workshops

During three workshops a number of educational priorities were identified, focusing in particular on the integration and development for sustainable water management of the entire DBS region. Outcomes on new ideas for an Education Agenda in the DBS region included discussion of career prospects and the needs (and type) of educational activities which might support this to build capacity and capability.

Career Paths: A number of career paths were identified in economic sectors that would benefit from the development of human potential in the DBS region, including:

- areas of pure and applied research spanning and integrating across the disciplines in the science and humanities;
- environmental, ecosystem and natural resource management;
- navigation management along the DBS corridor;
- governance and planning from the local to the international level;
- industry that sustainably builds on the ecosystem goods and services of river-delta-sea systems; and
- environmental policy, law and regulation.

Educational Opportunities: The types of educational activity identified to support this was also highly compliant with the concept and opportunities for lifelong learning. These included:

Exchange programmes were identified for both students and academic staff. Informal and formal exchange programmes were identified for students including undergraduate, taught and research postgraduate level. Erasmus and/or specific inter-institutional exchange programmes for academic staff were also identified. In both cases this would facilitate the exchange of best practice, research and knowledge within and outside the DBS region.

Targeted professional training. Several areas and ideas were highlighted to address the needs of the Danube Region. Access to target training schemes that have some level of recognition and certification to demonstrate competency proved popular. Delivery of such courses could be through short summer and winter schools and online accredited educational programmes. The need for multidisciplinary and interdisciplinary courses were also emphasised to drive towards more holistic thinking of river-delta-sea systems. Similarly, workshops that bring together science-policy-industry were highlighted as a collective mechanism to ensure better understanding of the needs and requirements affecting the Danube river-delta-sea system.

A number of emerging and cross cutting themes were identified from the workshops. The themes can be classed under Communication and Interdisciplinary:

Communication: A general disconnect between science, policy and public needs was highlighted and the need for better communication of relevant research findings to administration, business and citizens for more efficient and effective exploitation of results and data. Support for continuous public information flows and increased environmental awareness was also highlighted with emphasis on the means and method of communication. The development of a citizen science approach for the region was identified as a priority. Citizen based observatories could provide a means for addressing the issues in communication among citizens, conservation groups, the regulators and the regulated. At the same time, communication of key messages can be enhanced by setting up catch phrases or catchy messages to bring issues and challenges to the attention of the public to highlight cases such as “Sturgeon 2020”.

Interdisciplinary: Breaking down the traditional silos of research disciplines was identified as a priority to develop an integrated and more holistic understanding of the Danube river-delta-sea system. Research should also be targeted with a view to the social and economic impacts and this could be achieved in part by interdisciplinary education. The education agenda and infrastructure should facilitate the exchange of knowledge across sectors (e.g. science, business, administration).

The results from the three workshops were synthesized during the Dialogue Conference in Bucharest and are summarised in Table 1. It was recognised that a macro-region as large as the Danube has a diverse spectrum of educational provision and potential. Equally, there are specialisations outside the basin that could be usefully incorporated to develop competencies and capabilities. Irvine et al., (submitted) demonstrated that interdisciplinary courses related to water management were largely delivered outside the Danube region (e.g. the example in Box 1). The workshop participants identified the need for both natural and social sciences and a better linkage and integration between these disciplines to ensure better implementation and impact of the outcomes of the research within basin management.

Table 1 Summary of the SWOT analysis in relation to building human potential

Strengths	**Weaknesses**
o Existing expertise and education competencies at all levels o Education is recognized as one of the top societal priorities in Danube Region. It is Priority Area 9 "Education and skills" in EUSDR o Some Education programs comprise involvement in research activities o Community exists (Universities, Professors, Associations – such as the Danube Region Academies or the Danube Rectors Conference, institutional networks) o Significant cultural diversity in the Danube Region, from the Upper Danube to the Black Sea	o Many education programs do not necessarily fit the present day requirements of economy (companies) and administrations o Education curricula respecting "traditional" domains and disciplines, not covering the river-delta-sea system as a continuum o incomplete picture of existing skills in Danube Region o Inertia in education system in responding to environmental and societal needs and challenges o Capacity building and training actions are limited (rarely provided to non-academic actors like administrations, business community, etc.) o Reduced credibility of the Higher Education system in several Danube Region countries due to some corruption cases o Lack of interdisciplinarity
Opportunities	**Threats**
o Development of Higher Education Institution (HEI) networks o Existing global educational trend towards a cross sectoral/ interdisciplinary approach o Existing public awards for "water research" or "HEI+Administration cooperation" to showcase good experiences (best practice also in some Danube countries) o Twinning actions between HEIs to facilitate mutual learning o ERASMUS and other pan-European actions in the field of water o European legal framework for transferable credits between Higher Education Institutions o Existing European opportunities such as Marie Curie – for training at various research career	o Inertia to changes when dealing with development of new research and professional communities o Lack of ability to involve in the capacity building process all the relevant actors/sectors o Limited access (e.g. bureaucratic barriers) to field work for stakeholders that are not directly involved in water research

stages o Already identified needs for highly skilled experts in future actions (ex. navigation) o Possibility to involve Industry/business funding of HEI training programs, applied research and training activities o Promoting hands-on training in curricula o Framework exists to develop training certificates	

3.2 Feedback from the on-line questionnaire

The on-line questionnaire that operated independently on the DANCERS web page solicited only a limited number of responses, but provided independent validation of the findings from the workshops. The results suggested that exchange programs, workshops and short-course for students were considered of high importance, and more so than formal or informal exchange programs for staff. Partnerships between and among University Institutions were also identified as high priority, especially for institutions within the Danube Basin, although partnerships with other European institutions outside the region were also identified as important. In developing joint educational programmes for the DBS system, priorities in terms of degrees/certificates offered should be (in ranked order): i) Short and highly specialized Joint executive Certificate programs for professionals; ii) Joint Undergraduate Programs; iii) Joint Masters Programmes; and iv) Joint Ph.D. programmes and Double degree programmes.

Joint educational programmes should give priority to preparing students for a career in the following areas (in ranked order): i) Environmental/Ecosystem/Natural Resource Management; ii) Pure/Applied Research; iii) Government / International Organizations; iv) Environmental Planning; v) Law and Policy Regulation; and vi) Industry.

3.3 Additional context

A report in OeaD´news (Nr. 1/94, Sept. 2014, p. 16) stresses that the exchange of students and scientists remains a crucial instrument for mutual understanding. As spatial proximity facilitates collaboration, nearby research facilities should be used together and joint programmes and, mutually recognized, courses should be implemented, and complemented by solid logistic planning and concentration of teaching/learning at specific institutions. International education and exchange programmes like ERASMUS anticipate political integration, as ten central and east European countries joined the education exchange programme years before they joined the European Union. This educational alliance implies a great number of joint science projects, projects to develop curricula, higher education governance and implementation of the goals of the pan-European Bologna Process. The programmes and projects became a driving force bringing together previously separated regions and revived former prospering higher education collaborations. Parallel to this European educational policy development (Bologna process), significant regional initiatives had been created to integrate former Eastern Bloc countries (Central European Initiative, Black Sea Universities Network, CEEPUS, etc.). The DANCERS project aimed to build upon these achievements and pursue an integrated approach to shape a sustainable common future for the Danube Region.

To facilitate exchange and strengthen human capital development in the region, it is essential to provide accessibility to existing services and opportunities. To meet this requirement, a clearly arranged platform is needed that gives a complete overview of institutions, programmes, internships and funding mechanisms and helps students and institutions to connect. For

instance, a student should be able to search for a desired host country, level of education and/or main subject of interest (e.g. water management) and find all suitable offers in DBS. As an example could serve the platform www.studyineurope.eu that helps to find education programmes in Europe, inform about tuition fees, ECTS-system, application deadlines etc. This suggestion implements a certain commitment of the partner countries and institutions to insert their complete set of offers and comply with them.

It is also important that the students' efforts are credit-bearing at the home institution, international conventions like the Bologna Process, which include agreement among European countries regarding comparability of higher education qualifications, are crucial. With the exception of Kosovo, all countries in DBS (basin, delta and sea) have signed the Bologna Process agreements.

3.4 RAMIRI 1 and 2 FP7 projects

RAMIRI 1 and 2 - Realising and Managing International Research Infrastructures, were pioneered by Professor John Wood and Professor Carlo Rizzuto - former chairs of ESFRI, who tried initially to fill the identified gap of managing research infrastructures in this region. The RAMIRI projects finally aimed to develop a training and networking resource for those involved in the planning and management of research infrastructures (RIs) of international importance, that are based within the European Union and the Associated States. Important information about the projects achievements can be consulted on line at www.ramiri.eu and the most useful RAMIRI' deliverable which is the Handbook is also available on line at http://www.ramiri-blog.eu/.

4. Challenges and opportunities

Scientifically coherent solutions for integrated river-basin-sea management require an interdisciplinary approach that is well-communicated and which can inform decisions of society, industry and governments. In this way, the necessary sustainable and innovative solutions can be developed to address the major societal challenges. For the Danube Region, the Danube Strategy has identified priorities to strengthen and connect the region whilst increasing prosperity and protecting the environment (Figure 2). The new tools and research agenda that DANCERS project proposes below are specifically designed to address these priorities, and capitalises on the Danube basin as "natural classroom". DANCERS project partners sought to engage stakeholders at all levels and in all sectors, and propose an education strategy that is integrated according to stakeholder inputs and oriented towards ecosystem based approaches. Education programmes are in line with the proposed research agenda, which also addresses the main themes of H2020 within the specific context of the Danube Region]

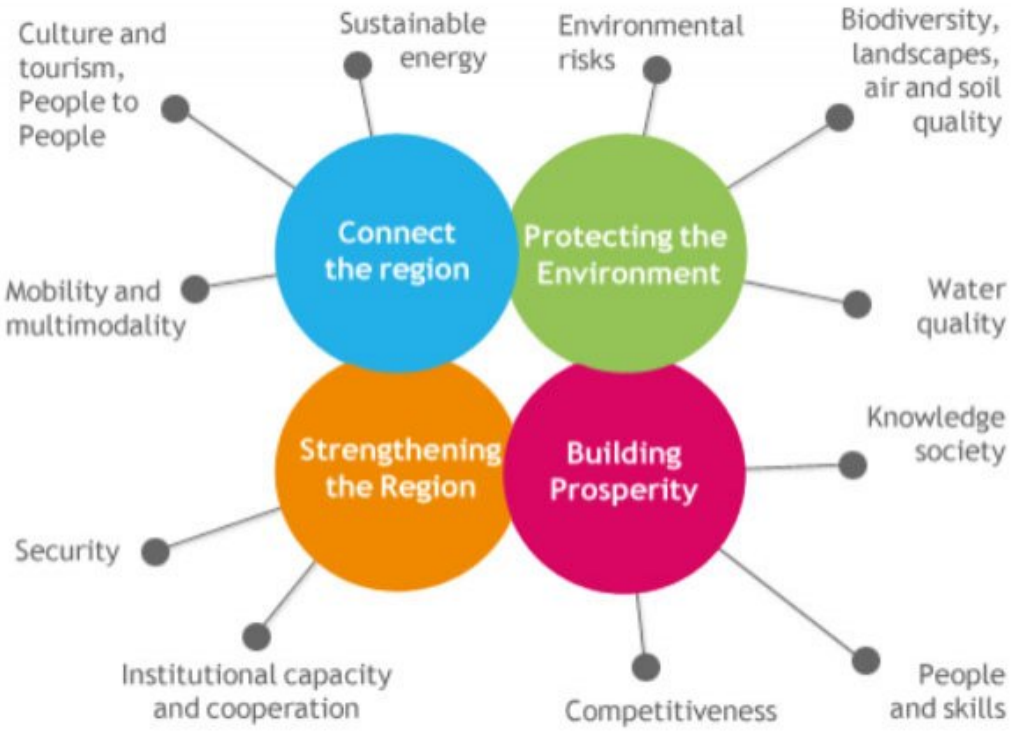

Figure 2 Priorities of the Danube region, as defined by the Danube Strategy (see http://www.danube-region.eu/about/priorities)

One of the papers submitted to the special issue of the *Science of the Total Environment* is 'Educating for Actions: *Aligning skills with policies for sustainable development in the Danube river basin'* by Irvine et al (submitted). The article considers that "the skills and knowledge required for meaningful engagement in water-related decisions are largely identical with the

skills needed to take part in a dynamic sustainable knowledge economy the region strives for. In this sense, education and training for effective water management will serve to support sustainable development, and education for sustainable development will benefit water management".

In view of the above it can be stated that apart from education that is acquired through formal channels, sustainable management for rivers-delta-sea systems requires access to research, information, models and the possibility to form appropriate partnership in order to properly manage such a system. Currently, there are several challenges and opportunities defined at a European level that are applicable to Danube area that would address the needs for education as they have been identified in the previous section.

As of 2001, since EU Ministers met in Prague, education and especially lifelong learning has been recognised as an essential element of the European Higher Education Area. In particular the wish in Europe is to build a knowledge-based society and economy. Danube countries are part of the European area, hence education and lifelong learning strategies are necessary to face the challenges brought by the use of new technologies in order to provide equal opportunities and quality of life.

The Bologna Process has identified the following steps as necessary to create opportunities for students to access knowledge, and as such to respond to the needs of research and innovation in different areas of Europe:

- widening access to higher education;
- creating more flexible, student-centred modes of delivery;
- improving the recognition of prior learning, including non-formal and informal learning;
- developing national qualifications frameworks; and
- improving cooperation with employers, especially in the development of educational programmes.

The Leuven/Louvain-La-Neuve Communiqué further specifies that "lifelong learning implies that qualifications may be obtained through flexible learning paths, including part-time studies, as well as work-based routes" (the Leuven/Louvain-la-Neuve Communiqué, 2009).

In this context DANCERS proposes to develop further joint programmes at university level as well as postgraduate education (e.g. international summer/winter schools) on key issues, especially those specified by stakeholders. These programs should aim to include cross-cutting issues in relation to water management, and should aim to achieve a true interdisciplinary education, achieved by building on existing programmes in such a way that that the results are greater than the sum of the parts. The goal will be to create a genuine "European research area in water management". STAR Network of Excellence – Strategy for Allied Radioecology

programme, based in Oslo, could serve as a model to be followed, as could Integrated Graduate Education, Research, and Training (IGERT), based in the United States (Moslemi et al. 2009).

Five different types of programmes, according to the duration of the exchange and the level of organization, have been identified as applicable:

- Training workshops: short-term (1-max. 2 weeks), including e-learning which could also be used as part of blending learning programs for MSc and PhD programmes:;
- Exchange programmes: short- to long-term (several weeks to 1 year), on an individual base
- Joint courses
- Joint education programmes: long-term, whole groups
- Joint research projects/student exchange on independent projects

Each of these proposed approaches are briefly described below.

4.1 Training workshops

Training workshops are short-term (e.g. summer/winter schools) and can be offered at all educational levels (technicians, undergraduates, postgraduates, scientists). The focus of this task is to seek funding mechanisms such as the EU COST action to promote targeted workshops and training programmes within specific disciplines to develop capabilities in the Danube region.

Within the context of MSc Programmes undertaken within the DBS region, one solution is to include a compulsory component that requires students to participate in 1-2 international training workshops (summer/winter schools) during their master studies to ensure:

i) consideration of state-of-the-art methodologies in the education (in cooperation with stakeholders, qualifications for job market);
ii) the international basin-scale approach; and
iii) interdisciplinarity, encompassing social and natural sciences

Summer/Winter schools should thus be centrally organized, based on long-term funding and a concept including the addressed needs in education in WP 2 (increased Interdisciplinarity, training of close-to-job-market skills, quickly reacting centralized system, involvement of stakeholders, long-lasting programme, etc.). As teachers serve as multipliers of education objectives, summer/winter schools should include teachers as well as stakeholders.

Summer Schools in Europe, originally founded by Utrecht Summer School, provide online information about European summer schools, including topic, location, time, credits, fee. Users can search for course and submit courses
(www.summerschoolsineurope.eu).

Examples of best practice for summer schools include:

- The Danube Summer School (DSS; European Danube Academy), which presents facts, challenges and projects of the Danube Region;
- DIANET-International Schools, which offers young career researchers the opportunity to familiarize themselves with issues pertinent to sustainable development in the Danube region;
- Summer School on Carpathian-Danube Delta-Black Sea sedimentary system (Networking and Dissemination Activity within a EUROCORES Programme);
- Summer school "Intercultural Training with special emphasis on sustainability in agriculture, food production and food technology in the Danube region" (BOKU);
- The Danube Innovation Partnership summer school (technology transfer); and
- The DRC Summer School (IDM - Institute for the Danube Region and Central Europe) and International House Pécs) - promotes regional co-operation among young social scientists
- Danube Delta summer schools organised with the NEAR ("Network for Environmental Assessment and Remediation of aquatic systems") Network projects funded by the Swiss National Science Foundation between 1997 – 2013.
- Danube Delta summer schools on sediment dynamics of the Lower Danube - Danube Delta – NW Black Sea coast and methods of investigations (from theory to field practice and data interpretation) in FP5 Euro-EcoGeoCentre Romania

4.2 Exchange programmes

Exchange programmes offer the opportunity for individuals to spend several weeks to several months in a participating country to gain international experience and enhance international exchange of knowledge and skills. According to the individual aim of the exchange and the respective level, three types of exchange programmes can be distinguished:

- Exchange during the BSc and MSc education, when students spend one semester of their education abroad in order to gain international experience. An example for supporting such an individual exchange is the ERASMUS and ERASMUS+ programme.;
- Joint thesis supervision, when undergraduate and MSc students write their thesis in a participating country. The host university supervises the work and the mother university awards the grades.
- PhD programmes, through which a framework for PhD projects can be developed. The projects answer specific questions and test relevant hypotheses focussed on the DBS

system, but will be based either singularly or jointly within the partner institutions, depending on funding mechanisms and supervisory agreements.

Currently only national programmes can be identified and therefore DANCERS proposes that scientific funding bodies like FWF (Forschungsförderungsfonds) or FFG (Forschungsförderungsgesellschaft) should also work together with other countries to join resources and foster cross border and international collaborations.

International Master and Doctoral/PhD Programmes should be designed based on existing examples. For instance:

- Vienna Doctoral Programme on Water Resource Systems is an interdisciplinary programme that aims at researching complex water resource systems such as aquifers, streams, catchments and water infrastructure. Interaction between the disciplines, international networking, a tailor made training programme and high quality mentoring are key priorities of the programme.
- Novi Sad Master Programme on Ecological engineering (Faculty of sciences, Department of biology and ecology) is also an interdisciplinary programme, which compiles mathematical (statistics and modelling), technical (remote sensing in freshwater ecology), IT (data mining (from this year)), chemistry (ecotoxicology) geographical (hydrology and hydro morphology) and biological courses (macrophytes, macroinvertebratae, ichthyofauna, invasive species)

4.3 Joint education programmes

Joint educational programmes are defined as long term programmes (four to eight semesters) aiming at the close cooperation of institutions and a joint degree, addressing advanced types of higher education (MSc, PhD).

As guiding principles in establishing joint educational master programmes several examples across Europe can be considered. These examples, which are not exhaustive, are listed below:

- International Joint Degree Master Programme in Limnology & Wetland Management (LWM), which is designed for scientists, technologists, engineers, conservationists and environmental managers who have professional interest in aquatic ecosystem research and management.. LWM is a joint degree master programme of BOKU, Egerton University, Kenya and UNESCO-IHE Institute for Water Education, The Netherlands. The M.Sc. programme structure/curriculum consists of three semesters of 4-months each, which are held in Austria (Boku), Kenya (Egerton University) and The Netherlands (UNESCO-IHE), and followed by a 6-months research period.

- CASEE Danube AgriFood Master, which is the International Joint Degree Master Programme on ”Sustainability in Agriculture, Food Production and Food Technology in the Danube Region (Danube AgriFood Master)” that is implemented as a joint degree

offered by the University of Natural Resources and Life Sciences, Vienna (Austria); Szent István University (SZIE), and Gödöllő (Hungary). Several other universities Corvinus University Budapest (HU), CULS Prague (CZ), WULS (PL), University of Zagreb (HR), University of Novi Sad (SR), Slovak Agricultural University Nitra (SK) and USAMVBT Timisoara (RO) have contributions in terms of courses, MSc thesis supervision and summer schools. Graduates receive a Joint Master Degree

- The "Master of Danube Studies", an international joint programme between eastern European countries of the Danube that aims to develop a study program to qualify graduates from different educational backgrounds to become knowledgeable in the regions characteristics as well as to create a network of well-trained Danube experts who will further shape the future of the European macro-region along the Danube.

- The "EnvEuro" Master which is a two-year European Master Programme in Environmental Science, offered by four leading European universities; University of Copenhagen (DK); University of Hohenheim (D); Swedish University of Agricultural Science (Sw) and the University of Natural Resources and Life Sciences Vienna (A). The Master is focused on soil, water and biodiversity. It features an introduction to environmental science, six different specialisations, and finally a Masters thesis in environmental science

- The UK' Natural Environment Council Doctoral Training Partnerships (DTPs). In the UK research studentships that fall under the remit of the Natural Environment Research Council (NERC) are currently allocated to consortia of universities with external partners (from industry, charities, research organisations, NGOs) as appropriate. This has made a significant contribution to bring Universities, institutions and end-users together to tackle strategic and blue skies science. Currently (2014/15) there are 15 DTPs across the country offering 240 funded studentships. The number of studentships awarded to individual DTPs, varies between 12 and 28, and is determined by a competition in which DTPs are periodically judged on the following criteria: Research Excellence 35%; Training Excellence 35%; Multi-disciplinarity 15%; Partnership Operational Management 15%. The scheme seeks to focus research studentships in institutions where there is a strong research culture that can offer a scientifically excellent training environment. The students thus benefit from peer learning and are members of a wider group of researchers providing opportunities to develop and exchange ideas, supported (where appropriate) by the necessary research infrastructure. End-user (e.g. industry, government, charity) engagement is also encouraged through CASE awards, which provide additional funding and experience for research implementation and impact for the student.

- The UK' Centres for Doctoral Training (CDTs). The UK's research councils including the Engineering and Physical Sciences Research Council (EPSRC) and Natural Environment Research Council (NERC) and Economic and Social Research Councils (ESRC) fund a

series of Doctoral Training Centres (CDTs) which provide specialist training Facilities. The motivation for the DTCs is that research students should benefit from working with a critical mass of supervisors that are undertaking research that is considered to be internationally excellent. However, in contrast to research studentships allocated to DTPs, the focus of the DTCs fall within 'priority areas' that are determined periodically from engagement with Universities, Strategic Partners and other stakeholders. These centres can be based at one of a consortium of Universities and are in response to areas where training needs have been identified, including for example: (i) NERC CDTs for: Oil and Gas, Soil Science, Big Data; and ii) EPSRC CDTs for: Cyber Security, Complexity Science, Digital Economy. As with NERC DTPs, end-user engagement is encouraged benefiting the student, end-user and maximising the impact of the research.

- Education Programme Driven by a Major Stakeholer. River Basin Management MSc. The Scottish Environment Protection Agency (SEPA) identified the need for specialists in drainage basin and flood risk management. As a result, SEPA and the Scottish Funding Council established a Flood Risk training programme with Stirling and Dundee Universities in 2009 to address the hydrology and catchment management skills gap in the environmental sector in Scotland. This resulted in the training of 30 students in total, 15 at Stirling via an MSc in River Basin Management, most of whom are now employed by SEPA.

An excellent exemplar of good practice, from outside the Danube Basin, is the Nile Basin Capacity Building Network for River Engineering, led by UNESCO-IHE:

Nile Basin Capacity Building Network for River Engineering (NBCBN-RE). The first phase of this project started in 1995, in direct response to the need for professional manpower development in the water sector in the Nile Basin Region. The Egyptian Government took the initiative to establish the first regional centre for capacity building in River and Hydraulic Engineering. The Dutch Government supported this initiative financially and IHE Delft provided technical assistance. The regional training centre (RTC) was established at the premises of one of the strongest research institutes in the region: the Hydraulic Research Institute (HRI) in Egypt. In a short time the centre became well known not only within Nile basin Countries but also further in the African Continent and Arab Peninsula. Currently, the HRI Regional Training Centre are further organised on self-sustainable basis. The report of the project evaluation concluded in 2000 that:

"... the project has fully satisfied the objectives of the Netherlands' assistance in institutional and human capacity building as well as the objectives of the Sail Projects Programme. The project has given a considerable contribution towards capacity building in the Nile region in the field of Hydraulic Engineering in River basins. A very capable Training Centre has been established at HRI that is very well integrated within the institute, and has shown its ability to organise and give courses in this field. Staff of HRI has been trained and has demonstrated their ability to take over most of the lectures in the curriculum."

The second phase of the project started in 2000, when the Dutch Government decided to support this challenging project through its SAIL Program and the involvement of IHE-Delft as the facilitating institution. The approach taken was to let the network develop gradually, building on what is already available, and to stimulate and support further regional co-operation. Therefore the logic was to choose the successful HRI Regional Training Centre as the regional focal centre for capacity building in River Engineering. Realizing the experimental character of the project and especially the complexity of the

network development process the scope was deliberately limited to just one domain of water field: **River Engineering**: NBCBN-**RE**. This domain includes aspects like river processes, river morphology, GIS, hydropower, surveys, monitoring, forecasting and modelling and river engineering works like regulating and navigation works. The vision was that if this pilot appeared to be successful and feasible, other water domain areas could adopt this model and start similar initiatives.
In 2004, the third phase of the project started with consolidation, integration and extension of the activities. Six country nodes have volunteered to act as the host institution for a particular regional research cluster: Egypt, Ethiopia, Sudan, Tanzania, Uganda and Kenya. They take the lead in coordinating and implementing joint applied research in a specific topic of river engineering together with several of the other nodes participating in the research activities. Regular research cluster events are being organized in each of these hosting countries, with participation of researchers from all 10 Nile basin countries. At the moment 13 regional research groups are active on the platform under these six research clusters.

The **major achievements** of the project so far are:

- Successful establishment of modern facilities at the HRI-regional Training Centre in Egypt at Delta Barrage, Cairo. Currently, a large alumnae network is active in the Nile region. Several graduates of the 3-months Diploma Course on River Engineering organised at the premises of the HRI-RTC are graduates of the MSc and PhD courses from well-known universities.
- A network secretariat (NBCBN-SEC) is active at the premises of HRI.
- Six regional research clusters have been established, connecting more than 150 professionals from all ten Nile Basin Countries. These research cluster-hosting countries are: Sudan, Egypt, Tanzania, Uganda, Ethiopia and Kenya. An overview of the main research topics as well as the countries participating in each of these six research clusters is given in Figure 3.
- Apart from a static also a dynamic web site has been developed for NBCBN that functions as the virtual collaborative meeting place (platform): www.nbcbn.com.
- Initial development of a comprehensive knowledge map and knowledge/dissemination centre at NBCBN-SEC merging all the scientific outputs of the regional research clusters.
- Development of some new training tools by using modern ICT tools.

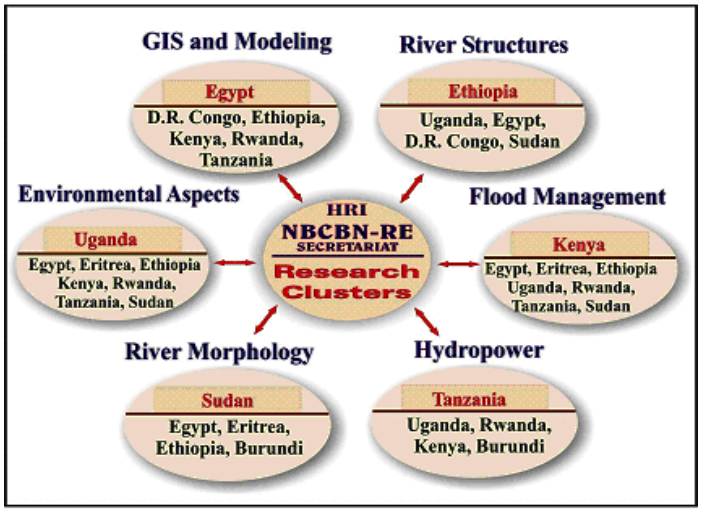

Figure 3 Structure of NBCBN-RE

4.4 Joint research programmes

Joint research programmes such as joint PhD research groups and early career researchers, should be promoted to improve the exchange of knowledge and skills and build connections and trust between the scientific communities within DBS region. Examples include European scale twinning programmes as well as many inter-institutional programmes and co-operation agreements organised at the local and regional level.

- H2020 Twinning Programme addresses networking gaps and deficiencies between research institutions of the low performing Member States and regions and internationally-leading counterparts at EU level. The twinning initiative is designed to counteract the increasing tendency for research intensive institutions to collaborate increasingly in closed groups, crowding out the large number of promising institutions and groups. Twinning aims to strengthen research in both capacity and profile in a particular knowledge institution by creating a link between this institution and at least two internationally leading research institutions in other Member States. This is achieved by short term on-site exchanges for staff, workshops, summer schools.
- An example of inter-institutional collaboration agreement exists between the Centre for Ecological Research in the Balaton Limnological Institute of the Hungarian Academy of Sciences Academia and the Romanian Institute of Biology in Bucharest. This cross boarder collaboration within Lake Balaton and the Danube Delta Lakes is exploring the impact of drought and climate change on water levels and zooplankton responses over the last 20 years. This research is in support of efforts that have focused on the use of zooplankton as an ecological water quality element within WFD. This research programme forms the basis for a bi-lateral mobility grant between the two intuitions.
- Co-operation agreements between institutions can also provide a platform to improve common research and provide training support for undergraduate, postgraduate and PhD level students. The Centre for Ecological Research in the Balaton Limnological Institute of the Hungarian Academy of Sciences Academia and the Romanian Institute have such an agreement with the Babeş-Bolyai University in Romania.

4.5 Pedagogy

Didactic skills underpin education and long-term teacher training and teacher accountability can reap better economic returns than financial or technical incentives (Evans & Popova, 2015). Furthermore, open and inclusive teaching accommodates students with different cultural, economic, and social backgrounds, necessary to achieve in the management of transnational and culturally complex basins such as the DBS system. Emphasis on teaching and learning techniques is increasingly common. In particular, active-learning in which students engage in real-life problems is effective for knowledge retention and to creating an enabling environment to apply innovative solutions to complex problems. Furthermore, active learning leads to positive attitudes towards lifelong learning, which results in openness to new models of

teaching and learning. Appropriate didactics equip professionals and societies with the skills to move toward sustainability and an enabling environment for societal transformation (United Nations, 2014). Developing and fostering cognitive skills that are adaptable and innovative can be realised through development of the transferable skills advocated by the Bologna Process. Creative problem solving and critical thinking also promotes co-operative learning (Treffinger, 1996; Weatherley et al., 2003) and interpersonal skills, and complimentary knowledge that can support broader objectives of sustainable management (Cheetham.and Chivers, 2005; Sahlber and Oldroyd, 2010). The development of interpersonal skills and positive attitudes to problem solving tend to follow when people can effectively interact with others and learn through a cooperative framework (Johnson and Johnson, 2009).

4.6 Infrastructure and Finances

Financing of all the above listed opportunities poses a challenge in securing the funding for such initiatives. It is advisable to develop a strategy for acquiring grants that will allow an increase in mobility and knowledge transfer for individual researchers and students from the DBS region. This could include grants for visiting and hosting experts for short term and medium term stays. Finding funding and applying for grants is a challenging task. Examples of funding opportunities are listed in Table 2. A short description of these funding agencies is given in the annex of this report.

Table 2 Example of funding structures (for details see Annex)

Name	**Type**	**Offers**	**Target groups**	**Included countries from the DBS region (ISO 3166, ALPHA-2)**	**Website**
Funding programmes or organizations:					
CEEPUS "Central European Exchange Program for University Studies"	Interuniversity mobility and exchange programme	Grants Joint education programmes (doctoral programmes) Networking	Students and academics	AT, BA, BG, HR, CZ, HU, MD, ME, RO, RS, SK, SI	www.ceepus.info
ERASMUS+ **EU programme for**	Mobility, exchange, and cooperation programme	Grants Joint education programmes	Students, trainees, academic and non-	EU-member states; Higher Education Institutions in	ec.europa.eu/programmes/erasmus-plus

education, training, youth and sports (2014-2020)		Networking	academic staff from schools, universities, and companies	neighbouring countries, and non-EU Balkan countries in projects outside the EU	
ELLS Euroleague for Life Sciences	Network of universities	Grants Master programmes, summer schools Networking	Students and academics	DE, AT, CZ	www.euroleague-study.org
EU COST **European Cooperation in Science and Technology**	Networking programme	Funding of e.g. workshops, training schools, travel costs	Researchers from universities, research institutions, NGOs, industry and SMEs	AT, BA, BG, HR, CZ, DE, HU, RO, SK, SI, RS	www.cost.eu
Action A-CZ, **Action A-SK,** **Action A-H**	Bilateral cooperation fund in the tertiary sector	Grants Joint training and research programmes summer schools	students, academics	A, CZ, SK, H	www.grants.at www.dzs.cz www.omaa.hu www.aktion.saia.sk
International Visegrad Fund	Fund for cooperation and exchange	Research grants Scholarships Mobility programmes	students, researchers; universities, schools, NGOs, companies	CZ, HU, SK, BA, RS, UA, ME	visegradfund.org/
ITN **Innovative training**	Maria-Slodowska-Curie Action (EU)	Scholarships for joint research and doctoral	Early stage-researchers; universities, research	EU memenber states + BA	http://ec.europa.eu/research/mariecurieactions/about-msca/actions/itn/index

network		programmes	institutes, enterprises		_en.htm
ERDF European Regional Development Fund	EU research fund	Funding of innovation and research	research facilities	BG, CZ, DE, HU, HR, AT, RO, SI, SK (incl. non-member states as partners)	ec.europa.eu/regional_policy/index.cfm/en/funding/erdf/
EURASC European Academy of Sciences	University network	Grants for publications, meetings, workshops, etc. Awards	scientists, researchers, educators, engineers and public authorities	European states	http://www.eurasc.org/
CEI Central European Initiative	Regional intergovernmental forum	Cooperation fund (seminars, workshops, short training courses,etc) Know-how exchange programme	Institutions	AT, MD, ME, BA, BG, RO, CZ, SK, RS, HR, HU, SI, UA	http://www.cei.int/
Networks:					
CASEE ICA Regional Network for Central and South Eastern Europe	Network of Central and South Eastern European Higher Education Institutions	Joint research and education programmes (e.g. Danube AgriFood Master) Conferences, e-platform	students, academics	AT, HR, CZ, HU, RO, RS, SK	http://www.ica-casee.eu/
DRC Danube's rector conference	University network	Training courses (e.g. summer schools, workshops), conferences	Students, academics	AT, BG, BA, DE, HU, CZ, HR, RO, MD, RS, SK, SI, UA	http://www.drc-danube.org/
ACA	European	studies and	Institutions	AT, CZ, DE, SK,	www.aca-secretariat.be/

Academic Cooperation Association	network for higher education	research on trends in higher education internationalisation networking	for higher education		
BSUN Black Sea Universities Network	Inter-university cooperation	workshops, congresses	Universities	BG, MD, RO, UA, HR	www.bsun.org/

5. Strategic Education Agenda

In the following chapter a proposal for a new Danube education programme is made. The goal is to suggest a strategic education agenda that includes all levels (from undergraduates to full scientists), accompanied by technicians.

5.1 Proposal for a new Danube (River Delta Sea) education programme

Based on the presented challenges and opportunities with which the educational needs are faced, DANCERS proposes a model for a new Danube educational program that could lead to a better integration of the river-delta-sea management practices.

In principle the new Danube education programme is a pyramid type approach and addresses different levels of education (Figure 4).

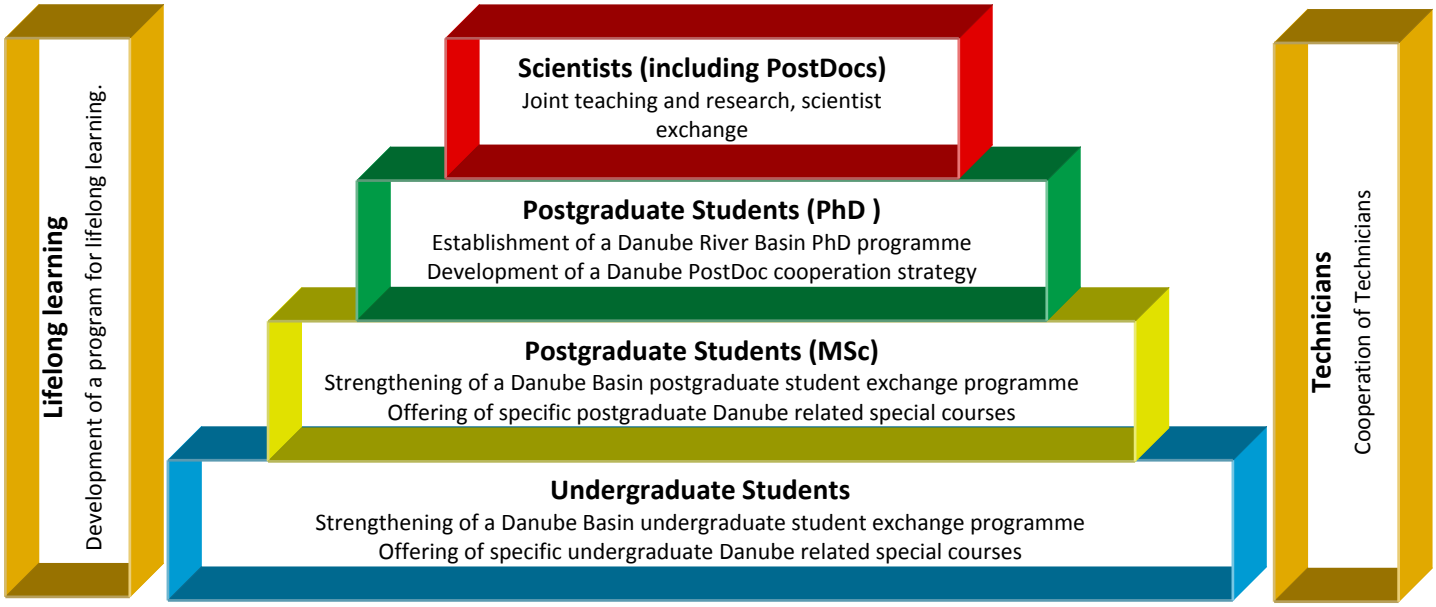

Figure 4 Proposed Model for a Danube Educational Programme

The main aim of such a programme is to build a network of institutions and to develop agreements and mechanisms to facilitate the exchange of experts, students and scientists at the following educational levels within the Danube Basin.

The programs and courses offered at different levels can be made either face to face or by using information technology currently available in the European educational system.

In the first case we refer to the traditional form of a course in which participants receive information and knowledge transfer at a site. The case of learning by e-learning refers to the use

of existing information and communication technology (ICT) such as Moodle platform, a free, open-source PHP web application for producing modular internet-based courses that support a modern social constructionist pedagogy which is widely used in the European educative system.

Each of the components of this programme is detailed bellow and in 3 to Table 7.

5.2 Technicians

One big challenge of the EUSDR is the difference in educational structure between individual countries, i.e. regarding professional education and chances on the job market (oead´news 1/94 p. 23). To facilitate exchange of personnel it is necessary to ensure a high level of quality in basic training; standardised methods; and promote exchange of know-how on an advanced level. Therefore, technicians should be encouraged to visit labs for short term hands on training courses, helping to foster technical cooperation between research centres and industries. Also, it is crucial to grant internationally recognised certificates for participants of the training courses.

Relevant course contents could include e.g. measuring water quantity (discharge, sediment transport) and water quality parameters (quality assurance/quality control practices), data acquisition, storage and preparation of samples, generation of regulatory data, calibration and maintenance of lab and field equipment, conducting data management including statistical analyses and field sampling etc.

It is important to note that technicians support all levels of education (see Figure 4). Thus, a cooperation of technicians in the Danube Basin will improve the technical skills level for problem solving.

5.3 Undergraduate students

The international network should embolden bachelor students to spend one or two semesters or to undertake research projects at a partner institution in the DBS region (academia and industry sector), to gain international experience.

At the bachelor degree level, there is a large range of possibilities for international exchange in DBS region. What is missing is a clearly arranged platform that gives a complete overview (see “Accessibility” in chapter 2b).

There should also be a strengthening of a DBS undergraduate student exchange programme and an offering of specific undergraduate DBS related special courses. These courses range e.g. from fundamental subjects like environmental science, geomorphology, hydraulics, hydrology, sediment transport, ecology, social and political science courses to an integrated water and river management. It is important that these programmes are reviewed regularly (3-5 year cycle) with potential employers within the DBS system to ensure that skills portfolio fit the needs of employers and the challenges of the region.

5.4 Postgraduate students (MSc)

Master Students exchange is of utmost importance to the future improvement of the Danube River Basin Management since many alumni will work later in governmental organisations like Ministries, Water Authorities, Consulting Companies (planning measures to improve the water management situation in the Basin) or the Private Sector (e.g. Hydropower Companies, Navigation sector). Thus there is a direct impact of the education improvement on water and river management.

By strengthening a Danube Basin postgraduate student exchange programme and offering of specific postgraduate Danube related special courses these goals should be reachable.

One element could be a newly developed Master´s programme based on the following topics:

a) Ecology and limnology, including assessment methods, restoration and management schemes, etc.;
b) Hydrology and hydraulics, from theory to practical application
c) Sustainable water management, including e.g. sustainable flood protection, hydro-power, navigation, river preservation and restoration, sustainable water use for irrigation; and
d) Socioeconomics, including eco-tourisms.

The programme should include an obligation for an internship/apprenticeship in a research institute or in industry. For the further development also see „Guidelines for Curriculum Development and Quality Assurance of Joint Master Programmes“(Euroleague for Life Sciences). MSc management boards should include representation from employers to ensure that the programmes fit the skills requirements with sufficient interdisciplinary for employers in the DBS system.

5.5 Postgraduate students (PhD)

A further goal is to facilitate an international exchange of Danube Basin PhDs, aiming at exchanging and assimilating know-how between countries/institutions and advancing knowledge by either taking specific, specialised modules or undertaking specific credit bearing research projects (e.g. PhD thesis, scientific projects) in a host institution or jointly. Also, the jointly use of research facilities would enhance exchange and knowledge transfer and could be an eligible development considering limited financial and material resources.

To meet these challenges and needs in education, we propose that CASEE, Danube Rector´s Conference (DRC), the European Academy of Science and the Black Sea Universities Network (BSUN) should be integrated to work on a Danube specific programme, to enhance the efforts and implement it. Also, it is proposed to seek pan-European funding and supervisors with key expertise distributed across the region and beyond to capitalise on the expertise available. CEEPUS could serve as a model programme. In addition, programmes encouraging end-user

engagement to tailor research to meet the challenges of industry, business, regulators, conservation agencies and government. The UK's CASE award scheme is a model that can be built upon which maximises the benefits to the student and maximises the impact of the research.

Based on these models the establishment of a Danube River Basin PhD programme should be initiated. Furthermore the development of a Danube education cooperation strategy should be initiated.

5.6 Scientists

Finally, the proposed Danube education programme includes also the scientists, from PostDocs, junior to senior lecturers to full professors. In this field a joint teaching and research program and a scientist exchange strategy among the Danube Basin University is envisaged (see Figure 4). In order to reach these goals the following roadmap could be followed: In a DBS conference scientists of the whole region, dealing with water and river research, could meet and discuss ways and strategies to establish a joint teaching and research program (could be also within existing series of conferences, e.g. Danube Conference, IAD conference every second year, Danube Future for young scientists DiaNet School). In this conference also working groups should be installed with specific tasks that cover both, teaching and research. Within a period of two years a concrete strategy should be available as draft version, to be discussed and adopted in a final conference. In parallel means to improve the scientist exchange between different Danube Region universities should be evaluated. Thereby, the DRC and BSUN should be involved so that there exist at the end direct implementation ideas that allow the realisation in practise.

5.7 Lifelong learning

Across Europe the importance of providing lifelong learning is increasingly recognised and can take many forms: in academic institutions, in places of employment, at home (distance learning) and through leisure activities. At one level, lifelong learning can facilitate retraining of individuals, providing a more flexible labour force. It also enables individuals to develop their knowledge and technical expertise to adapt to changing requirements of the labour market and fulfil the requirement of continuous professional development. It is important to acknowledge that this also applies to administrators and managers (Table 7) as well as scientists.

In the UK (NIACE, 2009: www.niace.org.uk), a recent review of lifelong learning advocates a 4-stage model: i. up to 25; ii. 25–50; iii. 50–75, and iv. 75+. While people in the first stage may learn as 'young people, in the second stage, lifelong learning can sustain productivity and prosperity. Training and education opportunities are also important in stage 3, to facilitate retraining, but increasingly, stage 4 is becoming important in delivering an appropriate curriculum in later life.

A major request that came out during the DANCERS workshop with the managers and administrators in May 2014. All participants required to have systematic intensive training, during which to be instructed in the latest scientific updates / available tools.

Depending on the type of managers and administrators as well as the field of interest three professional training programs are proposed:

1. Specialised courses related to a certain field of expertise (e.g. river hydraulics, sediment transport, flood risk management, observation and big data)
2. Access to specific MSc modules operating on a short course basis and earning credits which can eventually lead to a diploma or MSc. Such programmes could run in parallel with career development for employers
3. Summer schools consisting of a theoretical and practical (including field work)
4. Courses related to a certain field of expertise would be offered by a special University covering a subject in demand

Specialised courses related to a certain field of expertise would be offered by a special University covering a needed subject.

Summer schools could be offered by several universities and be implemented at a special location, eventually close to the Danube River and the Danube Delta / Black Sea coast (depending also on the topic). There, theory and practical work should be included in order to allow a more easy transfer of basic research into application.

A third suggestion is the development of a Master course as program in parallel to the job, meaning that the courses would have to take place in the evening or on weekends. It could be envisaged that this could be a special Danube Region (River-Delta-Sea) Master program or through the e-learning facility.

These courses or schools are supposed to be ended with the handling of certified diplomas.

Tables 3-7 below describe the logic of dedicated interventions that can be set to meet the identified challenges. In order to present a particular logic for the different target groups 5 different overview tables were set up that focus on the particularities of the groups. The tables - similar to logical framework approaches (logframes) and describe the main challenges that can be addressed, derived objectives for the specific groups. The activities show the possible action that can be set, also intended outputs and results and the means of verification are summarized in the table.

The information contained is not exhaustive and most importantly provide an overview how identified challenges can be transformed into direct action. The logic established can be easily taken up in dedicated programmes of funders or during the setup of "real" action. Potentially it can also support the setup of dedicated proposals to funders or for the take-up from the side of funders and as said, in the course of establishing thematic funding interventions.

Table 3 Education programme for Technicians

Challenges adressed	Objectives	Activities	Outputs/results	Means of verification
Broad variety of educational settings for technicians Job market challenges for the educated technicians Differing level of quality of basic education or training available for technicians Widely neglected importance of the group for research and monitoring of environmental processes No qualification framework for the recognition of completed trainings or further education	• Facilitating horizontal learning from existing good examples of further education and training of technicians • Facilitation of quality education/training for technicians • Developing a set of key methodologies (content or cornerstones of possible joint curricula or at least their elements) • Inclusion of job market requirements and employers expectations in education programmes involving technicians • Setting standards and criteria for a quality education framework in the specific experimental topics for further education • Facilitate exchange in the group of technicians by stimulating peer learning • Developing tools that encourage and enable technicians to support the existing expert levels	Identification of main employers and the different requirements and qualification of technicians with regard to the concerned research topics Establishing common standards and definition of curricula through a consultation process. A consultation must also involve the formal education providers, the potential or current employers. Exchange among educational providers and employers targeting technicians to establish a common vision and the cornerstones for a qualification framework of technicians, based on real needs and good practice Developing modules that could be combined to develop curricula for courses to train technicians (interactive and practical training modules) Establishing a commonly accepted certificate for training participation that would be widely accepted also across borders Establishing a qualified training also by use of available funding sources and inclusion of technicians in projects. Exchange and peer learning in the international context should be encouraged.	• List of potentially involved organisations in activities targeting the group of technicians • List of potential topics and trainers • Facilitating the dialogue on possible joint action in the DBS region with events or back to back to other relevant events • Establishing a dedicated newsletter for technicians or a section in existing media or e-media • Vision and roadmap for further cooperation, for the benefit of better prepared and trained technicians contributing to relevant environmental monitoring and research activities • Establishing modules of curricula that could be widely of use, also through a dialogue with the (current/potential) employers • Establishing a macro regional or European label for quality training courses for technicians in the topics covered • Funded training courses in example in the LLL programme in ERASMUS+, CEEPUS etc. Establishing an award for the “best technician of the year” or	Number of organisations involved in (pilot) actions for the specific group of technicians Awareness of joint activities in the domain (i.e. response to announced exchange opportunities) Presence of the topic “continuous education of technicians” in regular events addressing qualification in relevant research domains Developed modules and their description, use of the modules Technicians involved in direct exchange with other organisation (national level, international level) Use of the developed label in the region or on European level Established funded actions or regular support schemes for the target group Awards (or symbolic awards) issued

		Establishing a scheme for structured exchange of personnel i.e. in the LLL component of the ERASMUS+ or in CEEPUS projects Enabling technicians to participate in international activities through language courses	other specific awards	

Table 4 Education programme for Undergraduate and Taught Postgraduate Students

Challenges adressed	Objectives	Activities	Outputs/results	Means of verification
Limited job market response in university programmes in the field Missing inter-linkage of higher education and real research projects No clear binding element for related similar education programmes (no existing "label") Small number of existing Danube basin wide exchange programmes for undergraduate students Missing specialized courses addressing Danube issues No developed specialized curricula involving the broad variety of scientific topics relevant for well qualified undergraduates Limited exchange and application of quality curricula	• Empowering the existing universities to develop joint activities • Provision of information for the students about opportunities at the various education providers • Improving the relevance of study programmes following the job market demands • Establishing a recognized and internationally known "label" for the HEI cooperation by employing similar standards for HEI programmes • Establishing the curricula/modules for a Danube specific joint programme of existing HEIs • Establishing a mechanism to monitor existing study programmes and benchmarking the existing to underline good practice that can be adopted also from other existing HEIs • Developing a toolbox of possible integration options of undergraduates in scientific work • Facilitating the exchange of students in the domain to	Establishing a functional exchange on developments and information to facilitate joint action on institutional level Systematic collection of undergraduate study programmes in the DBS Region specifying currently existing content of study programmes ("profiles") Systematic identification of employers of e.g former students, potential employers Developing a toolbox for HEI to communicate with the employers Establishing a set of a formalized criteria for a jointly by committed HEIs developed label Establishing Danube joint study programmes involving a number of relevant education providers Set up a strategic learning process i.e with a roadmap or action plan. This would involve the development of a monitoring procedures (toolkit) of existing study programmes (applicable also to newly developed). A pilot benchmarking can help to identify best practice and facilitate learning from successful practice. Also peer visits would be anoption	• List of HEI and other education providers organisations involved in HEI programmes relevant • Accessible list of study programmes focusing on the Danube Region or generally on the specific related scientific topics • Toolbox consisting of a methodologies and strategies defining how to communicate better with the potential employers, this could be workshop methodologies, consultations, checklists for formal meetings, cases that can show the potential of better cooperation • Label that is well known and refered to (in the same scientific domains, beyond, in other world regions) • Study programmes with a clear focus in the field and makro-region • Established monitoring and benchmarking roadmap for learning from other study programmes (i.e. focusing on: content of programmes, management, capacities,	Number of listed HEIs and other education providers for undergraduates (number of relevant study programmes identified) Use of the database by the undergraduates when searching for education opportunities abroad Number of HEIs and other education providers systematically developing a consultation with potential employees Use of the toolbox by monitoring the meetings etc. that are documented as cases i.e. on a sharepoint/cloud, testimonials collected systematically during consultations Use of the label when presenting to undergraduates study opportunities (also across borders) Number of study programmes established

development or associated quality assurance processes	provide room for exchange and self reflection (including feedback to host organisations) • Better integration of students in "real" research work in the domain	Establish foras for undergraduates or upgrade existing exchange meetings of student associations in the domain by hosting such fora back to back to scientific events or other relevant makro regional events. Open announcement of "student research opportunities" or better link up with "public science" initiatives Awards for best research results from students (could be several categories, sponsored awards, a ceremony etc). This could be awards for the HEIs, the students, the professors etc.	international outreach etc.) • Meetings taking place back to back to scientific events addressed to undergraduates • Specific international action supporting the link-up of student councils active in the domain • Research projects involving undergraduate students • Awards established	Monitoring tools for HEI undergraduate programs developed Learning actions (like benchmarking actions) supported Students involved in scientific events Awards released Number of organisations focusing systematically on

Table 5 Education programme for Undergraduate and PhD Students

Challenges adressed	Objectives	Activities	Outputs/results	Means of verification
Difficult access of PhDs to research infrastructure (like libraries and laboratories) in other countries Weak exchange or hosting of PhD students among the existing research organisations in the region Limited exchange (or use) of supervisors for PhD thesis in the region and with the region in the relevant research domains No common PhD programme exists that would be a credit bearing scheme following common standards Missing strategies of the PhD hosting organisations for the involvement of PhD´s in credit bearing research Weak participation of PhD students in state of the art research projects in the makro-region	• Exchange of best practice for proactive involvement of PhD students in research • Enabling better access to sites for field studies • Facilitation of access to research infrastructures like labs, collections and libraries i.e. at host institutions • Hosting a substantial number of PhD´s at research organisations abroad • Enhancing the involvement of international reviewers/supervisors for PhD thesis • Set up of joint PhD programmes focusing on the DBS region and most relevant research domains • Motivating the hosting organisations to involve PhDs in excellent research • Establishing a PhD platform providing information about PhD positions or open research assignments (or internships) • Facilitating the exchange among PhD students being the next generation of active researchers	Establishing PhD Danube programme(s) involving a substantial number of PhD hosting organisations (a "light" curricula could be established if necessary) Provision of support to PhDs in need for access to field sites Support and information for the access to libraries, collections, databases, laboratories. This could be contact persons or even national contact points. Establishing a platform or releasing a newsletter announcing relevant PhD positions open at research organisations in the DBS region Showcasing good and successful practice (i.e. in a newsletter, a facebook group or a blog) by presenting cases and experiences, results Developing institutional strategies to integrate PhDs in activities Supporting PhDs for presenting research results at scientific events, on websites, in dedicated or attached to main scientific events Using the existing national research grants for PhD work abroad (intentionally open	• PhD Danube programme involving a significant number of organisations from the region and beyond • Support for PhDs going abroad • Hosting PhDs at own organisation • Supervision of PhDs • Newsletter informing about opportunities • Dedicated information about national funding in the region for going abroad • Access to field sites supported • Hosting of PhDs in labs, libraries, collections • Case study collection showing good practice • Institutional strategies also focusing on the role of PhDs • Presentations of PhDs at scientific conferences • Papers published • Awards for host institutions, research teams or single PhDs	Number of enrolled PhDs in a newly developed PhD programme PhDs hosted from organisations in other countries Supervisors involved in PhD thesis internationally (in the relevant scientific domains) Field visits for collection or measurement supported with labs, collections etc. Information sources for PhDs established Number of case studies (good practice of exchange of PhDs) documented and published (online, diverse media) Organisational strategies developed reflecting the challenges for PhD hosting and sending Number of published papers in the different journals (internationally reviewed, national publications, proceedings etc.)

		to several fields) by signalizing the readiness of the host organisations to support incoming PhDs Recognition of good performance by issuing awards based on a competition		Contacts established with the support of PhD exchange activities (would need more specification) Funding consumed by PhDs in the specific domain (i.e. for incoming or outgoing PhDs) Awards issued to PhDs or their host organisations (needs more clarification)

Table 6 Education programme for Scientists

Challenges adressed	Objectives	Activities	Outputs/results	Means of verification
Research focus is determined rather by the scientists than "needs based", experience with application oriented research in the DBS region exists only punctually Researchers to not investigate systematically the needs of the public administration. Dedicated knowledge about potential formats and communication channels with the administration involved in the key issues concerning water and river management are underdeveloped. The potential of interdisciplinary research is not fully exploited by researchers. Knowledge about potential relevant disciplines exists but direct exchange across disciplines is done only occasionally. Research conducted and teaching assignments are seldom synergetic. The potential of staff involved in research for the teaching process is not fully used. Necessary soft-skills of scientists for better leadership and research team work are underdeveloped.	• Systematic development of soft skills (including teambuilding, presentation skills) • Fostering knowledge about the potential of interdisciplinary work • Developing skills to understand better the needs (and obligations) of the public administrations to facilitate more needs based research • Establishing tools that ensure synergies of teaching and research • Promote publishing competences and knowledge about publishing opportunities • Supporting the systematic career planning of scientists • Enabling the development of cross border cooperation of senior and young researchers (Mentoring) • Systematic development of language skills to enable international	Set up of modules for soft skill training of scientists in the Danube education programme i.e. on: • Proposal writing • Leadership and team building • Interdisciplinarity • Communication skills and dissemination Competence building activities like seminars to develop better communication with public administrations, this would address scientists or research teams Presenting role models for integration of research and teaching (i.e. teaching from research practice, seminars with practical examples etc.) and promoting through websites or awards. Individual backstopping provided from the research organizations a researcher works to support career development Establishing as a part of a Danube education programme a mentoring action across the DBS region (or even beyond). It would involve scientists and senior scientists that would work	• Trainings focusing on soft skills (in English language) • Showcasing good examples of the teaching-research interaction • Workshops supporting the direction of research towards needs of the public • Awards for best teaching scientist to showcase the potential • Publications in higher ranking publications and involvement in international research and publishing teams • Establishing a template and modi operandi for Career development plans, jointly developed with the staff of a research organisation - defining also commitments • Pool of available senior mentors and scientists expressing interest • Language training courses organised by the research organisation (or jointly organised)	Number of Training modules developed Number of scientists participating in soft skill trainings Number of events facilitating a needs based approach of an organisation Presented cases of good research-teaching accomplished Awards for best research-teaching interaction Organisations developing systematically career plans and dedicated support/promotion actions Mentors available Mentees interested Language courses organised Participants that completed such language course

Research organisations do not systematically develop the publishing competences of early stage researchers A structured career planning for scientists is not facilitated by the organisations or the researchers themselves. No formal mentoring process exists that would support early stage researchers in their development English language skills for international collaboration are not always sufficient	cooperation	on a voluntary basis (balanced approach not excluded) Research organizations can organize language courses to improve terminology and expression skills of researchers		

Table 7 Education programme for Administrators

Challenges adressed	Objectives	Activities	Outputs/results	Means of verification
Very limited exchange among the administrations across borders in the River basin itself and with the Black Sea authorities Isolated capacity building activities No continuous training opportunities Interaction with research providers and in particular with HEIs is limited The high number of new legal documents and standards regulating i.e. water management or environmental protection, new software tools like GPS supported tools require continuous training efforts Administrations do not provide favourable conditions for the uptake of research findings in their day-to day work Understanding of the river-	• Mapping of the different clusters of public administration involved in river/delta issues to support the identification of most pressing knowledge gaps • Showcase the already existing capacity building initiatives (i.e. in SEE-TCP funded projects, etc.) • Identification of successful showcases of cooperation of researchers with the public administration • Joint reflection of the current practice and developing a methodology for the identification of needs on the side of public administration for researcher support • Establishing a "community of practice" for exchange and "informal" learning • Learning from already existing short term programmes to establish mid and long term training opportunities • Providing a continuous forum for exchange across borders (emphasis on latest developments with regard to cooperation with research) • Provision of training courses that best fit the needs of public	Mapping the relevant administrative actors in a systematic way to enable peer to peer communication Establish fora where the "informal" learning from existing cooperation of administration and researchers can be facilitated through inspiring practice, networking among the both groups Brokerage and networking events exploring the real needs of the public administration with regard to capacity building (and human resources) Developing a midterm plan for staff development on the side of public administration. This could be done by inviting "peers" from other countries to identify knowledge gaps. Establishing summer schools for administrations to facilitate knowledge exchange and provide better knowledge of the potential of cooperation with researchers Set up of modules for the public administration to get on-hands information for the use of new tools and the support function of research for decisions etc.	• Showcases of inspiring practice • Learning ambassadors showcasing own experience from the work with researchers • Learning administrations that develop a forward looking vision for capacity building of own staff taking the role of research serious. • Needs based definition of training content • On-hand training for administrations based on real needs (workshops on new methods of monitoring waters, evidence based management etc.) • Summer school for administrations with significant research input • Quality standard for trainings can be certified	Number of identified inspiring practices Number of promoted practices and promotion actions Twinning activities across borders to support processes in other countries Interest of public administrators (visitors, readers, participants) Actions for identification of training needs (in workshops, national brainstorming sessions) Workshop topics jointly identified by researchers and the administrations On-hand training sessions or workshops organised Summer school curricula developed Summer schools organised (financed from projects or on resources)

delta-sea continuum (and other key models) is limited	administrations • Developing a certification or label for accomplished LLL courses	Developing a certificate, acknowledged by public administrations in the countries of the region (could be i.e. a Tempus project or developed in the framework of ERASMUS+ or a DR-TCP)		

6. A Forward Look

Task 3.3 derives a proposal for a new Danube education program, focusing on different levels of education. In addition, the requirements of technicians supporting all levels are addressed within the framework of lifelong learning. Specialised training for professionals working in administrations (e.g. environment, navigation) is another goal of this agenda.

The Danube education program forms the basis for the short, mid and long term improvement of the existing situation. In the short-term specific courses, exchange programs etc. could be started using existing funding schemes and mechanisms in place. In addition, engagement with stake-holders and employers to ensure that sufficient skills training and interdisciplinarity is in place at undergraduate and taight postgraduate level. This could easily be achieved at minimal costs through consultation exercises, reviews and the undergraduate level, and advisory panels for MSc programmes at the postgraduate level. In the mid to long-term new summer schools, master programs supporting lifelong learning should be developed, enabling individuals to undertake modules on a day-release basis on through intense two week modules. For these additional teaching staff, funding and special timing as well as a combination between theory and practical work will be needed.

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Annex

Description of potential Projects, Programmes and Initiatives to support the development of a dedicated Education Programme

International Cooperations Funding Sources

- CEEPUS

  The "Central European Exchange Program for University Studies" is an inter-university cooperation and mobility programme for students and lecturers, involving 16 member states. Each country pays its incoming students and teachers and has to pledge at least 100 scholarship months per academic year. Main activities are university networks (institutes/faculties or departments of the relative universities, which work in the same field) operating joint programs ideally leading to joint degrees, especially joint doctoral programs. But they also provide scholarships for study visits, short-term scientific work and visits of summer schools. Each network has a thematic focus. There is an academic coordinator in each faculty, who assists the students.
  Current member countries are: Albania, Austria, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Hungary, Macedonia, Moldova, Montenegro, Poland, Romania, Serbia, the Slovak Republic and Slovenia. Prishtina/Kosovo is also participating. From DBS region are not included: Ukraine, Germany, Georgia, Russia and Turkey.

- ERASMUS+

  supports learning mobility of individuals (university level and professional education abroad). Accessible for university students, apprentices and trainees completing a study visit or internship and employees progressing professionally. The exchange is not limited to EU states.
  Also it offers endorsement of political reforms. Eligible for funding are activities regarding the political agenda of the EU in the section general and political education, the implication of the elements of transparency and recognition of the EU (europass, ECTS), national information centres (NARIC, Eurydice, Euroguidance, eTwinning), or the political dialogue within and outside of the EU. Also fundable are collaborations aiming at the advancement of innovation and best practice by supporting strategic partnerships of organisations and institutions developing and implementing joint initiatives, exchange of experience and promotion of peer learning. Furthermore, knowledge alliances (e.g. partnerships between higher education institutions and companies) and alliances for branch specific skills (cooperations between education/training providers and the working world) will be supported. In the field of higher education there are also

provided aids for international partnerships conducting joint education programmes and regional cooperation (“capacity building”)

- ERASMUS + Traineeship

  is a programme for students in higher education, students of vocational courses in college or recent graduates, interested in getting work experience. It enables them to find work abroad for two to 12 months as part of your course, which will help them to gain valuable international experience. Host countries are the 28 member states of the EU, Iceland, Turkey, Norway, Liechtenstein and the Former Yugoslav Republic of Macedonia.

- ELLS

  The Euroleague for Life Sciences (ELLS) is a network of leading universities cooperating in the fields of Natural Resource Management, Agricultural and Forestry Sciences, Life Sciences, Animal Sciences, Food Sciences, and Environmental Sciences. It offers international master programmes, summer schools / intensive programmes, student exchange, grants and awards, international networking, joint teaching and lecturer mobility.

- EU COST

  The European Cooperation in Science and Technology supports networking projects in all scientific and technological fields in Europe and Worldwide by funding events (workshops, training schools, conferences), travel costs and publications. The choice of topic is free. At the moment there are 35 European countries are involved (28 EU member states, 19 Non-EU-members) and one cooperating state Action. Cooperations are also possible with research institutions from “Near Neighbouring Countries“ and third countries.

  The COST Action “Earth System Science and Environmental Management (ESSEM)” welcomes strong interactions with international initiatives, programmes or organisations. ESSEM also supports interdisciplinary research networks on adaptation and mitigation for regional or local authorities and policy makers. The new Open Call will be published on the COST website. Proposals can be submitted as of January 2015. It is suggested to hand in a project in this call.

- H2020

  Horizon 2020 is the financial instrument implementing the Innovation Union, a Europe 2020 flagship initiative aimed at securing Europe's global competitiveness.

  Seen as a means to drive economic growth and create jobs, Horizon 2020 has the political backing of Europe’s leaders and the Members of the European Parliament. They

agreed that research is an investment in our future and so put it at the heart of the EU's blueprint for smart, sustainable and inclusive growth and jobs.

By coupling research and innovation, Horizon 2020 is helping to achieve this with its emphasis on excellent science, industrial leadership and tackling societal challenges. The goal is to ensure Europe produces world-class science, removes barriers to innovation and makes it easier for the public and private sectors to work together in delivering innovation.

Horizon 2020 is open to everyone, with a simple structure that reduces red tape and time so participants can focus on what is really important. This approach makes sure new projects get off the ground quickly – and achieve results faster.

The EU Framework Programme for Research and Innovation will be complemented by further measures to complete and further develop the European Research Area. These measures will aim at breaking down barriers to create a genuine single market for knowledge, research and innovation.

(https://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020)

- ITN (Innovative Training Networks)

  aim to train a new generation of creative, entrepreneurial and innovative early-stage researchers, able to face current and future challenges and to convert knowledge and ideas into products and services for economic and social benefit. This action is meant primarily for organisations such as universities, research centres or companies that propose a research training network. Individuals can apply for the specific positions created by these networks. Partnerships take the form of collaborative European Training Networks (ETN), European Industrial Doctorates (EID) or European Joint Doctorates (EJD).

  It promotes research and doctoral programmes conducted by European / international networks consisting of universities, non-university research organisations, companies and actors in the socioeconomic sector. The choice of the research topic is free ("bottom up approach"). Maximum project duration is 4 years. Candidates cannot have more than 4 years research experience after their graduation and cannot have already completed a PhD programme. Furthermore, in the past 3 years the scientists cannot have lived more than 12 months in the host country.

  ITN are addressing structuring and quality-increasing effects on training programmes for junior scientists, whereby the competence of the scientists should be strengthened by the right combination of scientific education and training into transferable skills. Career perspectives in academic and non-academic sector should be improved by international, interdisciplinary and intersectorial mobility.

Examples of bilateral education programmes

- Action Austria – Czech Republic

  is a bilateral cooperation in the tertiary sector through grants and collaborative projects aiming at the advancement of cooperations between universities in the field of sciences, research and teaching as well as the exchange of students and academic staff of universities. The fields are:
    - Cooperation of Sciences, Research and Teaching
    - Academic Mobility of students and academic staff of universities
    - Academic student excursions
    - Summer schools and summer language courses

- Action Austria – Slovakia

  is a scholarship that contains similar activities as the Action Austria – Czech Republic, i.e. scholarships for students (MSc, PhD, PostDoc, lectors, scientists, language summer schools…) During the last 20 years, "Aktion Österreich – Slowakei Wissenschafts- und Erziehungskooperation" was oriented to: initiating collaborations, academic mobility with the purpose of joint research projects, short term visits for project initiation, summer schools in different scientific fields, language summer schools in both languages, study excursions, bilateral scientific events (conferences, symposia, congresses, seminars), joint student events, lecturer mobility, grants for doctoral candidates, promotion of new study programmes, joint degree Master´s programmes, joint publications, projects aiming at bilateral/regional/European projects in education and science (<5 000 EUR), bilateral projects with interdisciplinary approach etc.

- Action Austria – Hungary

  is a scholarship that contains similar activities as the Action Austria – Czech Republic. The foundation for cooperation of Austria and Hungary, established in 1990, promotes exchange and development of joint activities in research and teaching, summer schools, scholarships…

- International Visegrad Fund

  The International Visegrad Fund is an international organization based in Bratislava founded by the governments of the Visegrad Group (V4) countries—the Czech Republic, Hungary, the Republic of Poland, and the Slovak Republic—in Štiřín, Czech Republic, on June 9, 2000. The purpose of the fund is to facilitate and promote the development of closer cooperation among citizens and institutions in the region as well as between the V4 region and other countries, especially the Western Balkans and countries of the Eastern Partnership. The fund does so through grant support of common cultural,

scientific and educational projects, youth exchanges, crossborder projects and tourism promotion, and through individual mobility programs (scholarships, residencies).

- European Regional Development Fund:

  The ERDF aims to strengthen economic and social cohesion in the European Union by correcting imbalances between its regions. It focuses its investments on several key priority areas, one of them beeing “Innovation and research”

- The European Academy of Sciences (EURASC)

  is a non-profit non-governmental, independent organization of the most distinguished scholars and engineers performing forefront research and the development of advanced technologies, united by a commitment to promoting science and technology and their essential roles in fostering social and economic development. The EURASC aims to recognise and elect to its membership the best European scientists with a vision for Europe as a whole, transcending national borders both in elections and in actions, and with the aims of strengthening European science and scientific cooperation and of utilising the expertise of its members in advising other European bodies in the betterment of European research, technological application and social development.

- The Swiss National Science Foundation (SNSF) SCOPES Programme (Scientific Cooperation between East Europe and Switzerland)

  Is a programme aimed at research groups and institutions in Switzerland and Eastern Europe who would like to launch a research and education co-operation. Besides the research grants, a strong component is represented by the human capacity development. Opportunities range between education projects (eg. NEAR Project) to individual grants. Focus countries include also those from the West Balkans, Moldova and the Ukraine (type A), but also Romania and Bulgaria (Type B).

- many subject/country-related scholarships

  (i.e. Ernst Mach grant, Marie Sklodowska Curie Innovative Training Networks, Bertha von Suttner scholarship) can be found on www.grants.at

- specific calls for funding opportunities can also be found on e.g. danube-inco.net/informationservice/calls_for_funding_opportunities

International Networks

- CASEE

  The “ICA Regional Network for Central and South Eastern Europe”, in short CASEE, is a network of Central and South Eastern European Higher Education Institutions relating to the Life Science disciplines (agriculture, food, biotechnology, natural resources, rural

development and the environment). It is an international non-profit organization that aims to stimulate and support its member institutions in the development of a European dimension in education and research through the development of concerted actions and in engaging globally. The objectives of the network are to support the development (and later implementation) of the EU Strategy for the Danube region, to strengthen research, education and University Development in this region, to develop joint research, educational and other projects (e.g. joint curricula, joint continuous educational offers, structural development, human resource development, QA and know-how-transfer, e.g. via an e-platform)

- Danube Rectors' Conference

  The Danube Rectors' Conference (DRC) is a strong network of almost 70 universities in the region along the Danube. Its aim is to improve higher education in teaching and research, and the advancement of its member universities by establishing sustainable contacts

- Alps-Adriatic Rectors Conference

  AARC is constituted to promote dialogue among the higher educational institutions of the Alps Adriatic regions in the fields of education, scientific research and didactics. AARC is engaged in supporting collaboration of teachers and students in different academic fields.
  AARC cooperates with the requisite institutions of the European Union in scientific research and in the different cycles of higher educational training, including lifelong learning. 36 universities are member of the AARC, half of the universities are located in the Danube River basin.

- Budapest Danube Contact Point (BDCP)

  supports feasible and financeable projects in the framework of the EU Strategy for the Danube Region and functions as a smart tool providing strategic advisory services, relationship management support and financial expertise for stakeholders of the Strategy

- The Academic Cooperation Association (ACA)

  is an international think tank in the area of international cooperation in higher education. Since 1993, ACA has worked to promote innovation and internationalisation of European higher education in collaboration with its pan-European network of member organisations, each responsible in their respective countries for supporting internationalisation in education and training. ACA's activities include research and analysis, evaluations, consultancy for private and public bodies, advocacy and publications.

- Central European Initiative (CEI)

  CEI is a regional intergovernmental forum committed to supporting European integration through cooperation among its Member States. It combines multilateral diplomacy and project management, both as donor and recipient, while bridging European macroregions.

- Black Sea Universities Network (BSUN)

  BSUN is an inter-university cooperation framework for the Black Sea Economic Cooperation Organization

- Network for Environmental Assessment and Remediation of aquatic systems (NEAR)

  NEAR sought to narrow the gap between science and practice, between science and education, between Western Europe and the Central and Eastern European Countries". Funded by the Swiss National Science Foundation since 1997, NEAR has undertaken educational activities involving 9 universities and 5 national research institutes from 8 countries (Switzerland, Romania, Bulgaria, Ukraine, Poland, Moldova, Georgia, and Azerbaijan), led by the University of Geneva. Funding was made available in four successive projects (to NEAR 4 – ended in 2013). To the overall funding from the Swiss National Science Foundation, towards the end of the period other funding were made available from various other sources. Progressively NEAR become a reference as an efficient and cost effective training organisation in water related issues, preparing curricula, improving teaching method and quality, with practical implementation in the classroom and in field.

  The general goals of the programmes (which focused on the Lower Danube – Danube Delta and NW Black Sea coast) included:
  - Development of a scientific network between Central and Eastern European countries and Switzerland to improve teaching and to stimulate research in natural environmental sciences;
  - Development of a curriculum in natural environmental sciences, particularly focused on aquatic ecosystems;
  - Organize field-based teaching for advanced students and young university teachers with a focus on environmental status assessment.

  Curricula were prepared by advanced scholars from all participating countries assisted by external invited experts. Thematic workshops were organised in partner countries with overview lectures given by the invited experts. These were followed by discussions in groups aimed for constructing a curriculum outline. Short lectures provided interesting case studies relevant for the participating countries, to be included in the curriculum. In total, NEAR held 9 major workshops, a well attended conference in Geneva in 2003 and 4 Summer Schools on watershed and delta environmental problems (Danube Delta in 1998, 2008, 2012 – the first one in Romania, the following 2 in the Ukraine, along Lower Danube watershed in 2003). The summer Schools benefited from

a number of outstanding invited lecturers and from a competence of the staff and infrastructure of research institutions in Romania and Ukraine.

A reliable measure of NEAR success was the readiness of several Universities to introduce many elements of the curricula to their new educational programs. These curricula accompanied by a collection of case studies were published in two volumes (Dominik et al., 2005; 2010) and the third is press (Loizeau et al. 2015). All the NEAR published teaching materials (courses, case studies, accompanied by PowerPoint presentations can be freely downloaded (open access) at http://www.unige.ch/sciences/near/Publications.html .