A COMMON ROADMAP TO THE DANUBE WATER NEXUS

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The Flagship Cluster of JRC projects on the Danube Water-Agriculture-Energy-Ecosystems Nexus (Danube Water Nexus) aims at addressing the water challenges identified by the EU Blueprint to Safeguard Europe’s Water Resources and the EU Strategy for the Danube Region. Tackling the Water Nexus requires integrated solutions going beyond sectoral divides and matching the needs of water of the different users in the region. The transboundary nature of the Danube river basin provides an opportunity for testing impacts of innovative policy actions. The Danube Water Nexus intends to provide input to decision makers and managers in the region about sustainable futures of water resources use. This will involve a continued collaboration with research institutions in the Danube region and with national and international stakeholders such as the ICPDR, the Sava Commission and other River Basin Committees within the Danube (e.g. Tisza). Information obtained will be of direct use to stakeholders in the region and the lesson learnt, also in terms of methodological development, exportable to other river basins in Europe and beyond.

Expected outputs for scientists and stakeholders:

- Establishment of a joint research agenda addressing commonly identified knowledge gaps in the field of the trans-boundary water nexus assessment in the Danube river basin
- Development of a methodology for modelling of water resources, integrating quantity, quality, ecology and hydro-morphology, in coordination with other tools at national and river basin level and extension to non-EU countries of the Danube Region
- Strengthening of crosscutting research efforts linking inland water bodies, the Danube Delta region and coastal waters
- Analysis of scenarios of socio-economic impacts of alternative water allocation measures across competing water-using sectors (agriculture, energy, industry, human consumption, environment, transport) for the years 2030-2050, including an assessment of the provision/valuation of ecosystem services provided by aquatic ecosystems
- Characterization of spatial and temporal trends of emerging pollutants, nutrients, mercury and selected Persistent Organic Pollutants in the Danube and tributaries in the context of the Joint Danube Surveys
- Development of information supporting efforts of countries and international cooperation bodies in the implementation process of the Water Framework Directive and planning of medium and long-term actions for the 2nd and 3rd cycles of River Basin Management.

Mechanisms for working together include:

- Joint publication of research results
- Regular meetings, exchange of PhD students and short stays of model and scenario developers
- Joint participation in Horizon 2020 initiatives and preparation of Danube-relevant trans-national project proposals
- Establishment of a trans-boundary modelling partnership aiming at the development of a multi-model ensemble and comparison of results
- Building of a common trans-boundary database as a component of the Danube Reference Data and Service Infrastructure (DRDSI)
- Seminars for dissemination and training addressing stakeholders and scientists in the Danube region.
Flagship cluster fiche:
THE DANUBE WATER NEXUS (DWN)

1. RATIONALE

The 2012 Blueprint to Safeguard Europe’s Water Resources has identified agriculture and energy as the priority sectors in which water saving and efficiency should be improved in order to ensure a balance between future water demand and supply. This general conclusion for Europe matches the findings of the 2009 River Basin Management Plan for the Danube, where hydropower generation, physical modification and overexploitation of water bodies and diffuse pollution from agriculture have been identified as significant pressures with cross border impacts. Water has been recognised as a central issue in the “Scientific Support to the European Union Strategy for the Danube Region”:

The Danube river basin is a transboundary ecosystem comprising a large number of tributaries, lowlands, a remarkable delta and incorporating a rich and unique flora and fauna. Deteriorating water quality would affect the provision of ecosystem services. The Danube Region is also facing growing water-related risks related to the increased frequency of extreme weather phenomena and global climate change. Although navigation is an environment-friendly mode of transportation, the Danube River and its tributaries are not exploited to their full potential and often impeded by seasonally varying water levels. At the same time, any measures aiming to improvement of navigability (e.g. through major infrastructure works) shall also take due consideration of their possible impacts on the modification of river ecosystems. Tackling pressures on water caused by agriculture represents one of the main challenges to the achievements of the quality objectives of the Water Framework Directive (WFD) in Europe and in the Danube Region. The reform of the EU Common Agricultural Policy (CAP) will increase the opportunities for assisting in the implementation of water protection policies through an efficient use of Cross Compliance and of Rural Development plans.

Energy is another intensive water using sector, e.g. water abstraction for hydro-power generation and for cooling of power plants. Altered flow regimes in the Danube river basin due to climate-induced water level fluctuations or hydro-peakings associated to peak energy supply can impact the water status should a minimum ecological flow not be secured, at the same time putting at risk the capacity of energy supply.

Addressing the water challenges posed by the Blueprint and the Danube Strategy requires integrated solutions going beyond sectoral divides and matching the needs of water of the different users in the region. The project Danube Water-Agriculture-Energy-Ecosystems Nexus (Danube Water Nexus) will think systemically to provide input to decision makers and managers in the region about sustainable futures of water resources use. The transboundary nature of the Danube river basin provides an opportunity for testing impacts of innovative policy actions. Information obtained will be of direct use to stakeholders in the region and the lesson learnt, also in terms of methodological development, exportable to other river basins in Europe and beyond.

2. A JOINT ENDEAVOUR

Being a dominant element of society and nature in the Danube River Basin, water has prompted the creation of many research institutions with a focus e.g. from river delta habitats to surface hydrology, from river ecology to quality-quantity aspects of groundwater. Input and experience from these institutions in Danube countries and the International Commission for the Protection of the Danube River (ICPDR) is essential for the outcomes of the project to be representative of regional and local conditions. Cooperation will be established with the Danube Flagship Project DREAM, which also integrates the Danube International Centre for Advanced Studies on River Delta Sea Systems, aiming at the development of research infrastructure and at computer model linkages for habitat modelling. Past projects such as
GLOWA-Danube addressing impacts of change in climate, population and land use on the water resources of the Upper Danube, or KLIWAS focussing on navigation on inland and coastal waterways, which have developed tools linking bio-physical and socio-economic components, will provide a solid background on which further developments in the Danube Water Nexus project can build.

The JRC is providing scientific support to the implementation of a range of EU policies some directly related to water and others affecting status and availability of water through regulations of sectoral activities (e.g. the Common Agricultural Policy). The JRC is also engaged in the development of initiatives to support the Roadmap for a Resource Efficient Europe, which identifies water as an area where innovation is necessary to set us on a path to sustainable growth.

Working together in the Danube Water Nexus project will start from existing collaboration of the JRC with several research bodies and international organisations in the Danube Region and will involve additional partners to fill gaps of expertise as deemed necessary. It will improve the knowledge-base for a multi-scale assessment, facilitate joint building of assessment capacity, address current data gaps and inconsistencies, contribute to harmonization across countries, and support the implementation of EU-water policies in a transboundary context.

3. PROJECT DESCRIPTION

The 2012 Communication on the Blueprint to Safeguard Europe’s Water Resources has set out key actions that need to be considered by water managers and policy makers in EU Member States to ensure balance of water availability and demand from different sectors and respect the needs of nature. In this context the JRC has developed a hydro-economic model to assess the impact of measures on water resources availability and allocation at European scale. One of the key actions of the Blueprint Communication concerns the further improvement of the hydro-economic model and its application at regional and river

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1 The Water Framework Directive, the Nitrates Directive, the Urban Waste Water Treatment Directive, the Priority Substances Directive, the Flood Directive, the Community civil protection mechanism, and others

2 Presently in the field of water quality monitoring in the context of the Joint Danube Surveys, the development of databases to help predict climate change and support soil protection, the deployment of modelling-based flood alerting systems for the entire Danube river basin
basin scale. This is intended to address the challenges of improving efficiency targets at sectoral level and to help Member States in the assessment of the cost-effectiveness of the Programmes of Measures included in their River Basin Management Plans.

The 'Danube Water Nexus' flagship cluster will contribute to build the knowledge base of the Water-Agriculture-Energy-Ecosystems Nexus, carry out scenario analyses of impacts of measures taking the Danube as pilot river basin and compare results for other regions in Europe, using a hydro-economic model to be developed jointly by the JRC and the “flagship cluster” partners.

Scope:
The 'Danube Water Nexus' flagship cluster will address the environmental and socio-economic consequences of changing agriculture-energy pressures on water. This requires a basin-wide perspective and cooperation with countries in the region taking into account needs of all stakeholders. Allocation of available water across different sectors needs to be integrated into the overall economic strategy of the Danube Region based on optimization concepts in order to maximize growth and minimize the environmental impact. Central to the assessment will be the development and application of an optimisation model linked with dynamic, spatially explicit water quality and quantity bio-physical models allowing the selection of measures affecting water availability and water demand based on environmental and economic considerations, and hydrological extremes such as floods and droughts. Optimization will particularly focus on the competing demand between the energy, agriculture, domestic, transport (e.g. inland navigation) and industrial sectors and ecosystems under a changing environment.

Flagship cluster structure:
Implementation of the following Work Packages on the whole Danube river basin will be backed up by three sub-projects intended to carry out more detailed assessments on specific topics felt of relevance for the Danube. The first builds on the decision taken at the ICPDR General Assembly in December 2013 to collaborate with JRC on modelling of nutrient loads and management in the Danube basin. The second will address the assessment of water resources in the Tisza sub-basin with special attention to irrigation water requirements in the in the lower Tisza area, and the third will investigate the Water Nexus in the Sava international river basin in the context of the UNECE initiative.

1. Database development
A database on inter-dependencies across water, agriculture and energy in the Danube Region will be developed. These activities will benefit from data made available through the Danube Reference Data and Services Infrastructure (DRDSI) and at the same time will contribute to populate the DRDSI with the additional datasets collected and/or generated in the framework of the cluster. All new data will be properly documented in order to facilitate their re-use. The access to the data will be governed by rules and procedures defined for the DRDSI.

- The database will cover quantity and quality aspects related to the use of water in agriculture (e.g. irrigation, animal rearing, reuse), the use of energy for water (e.g. long-distance transfers, pumping, treatment) and of water for energy (e.g. power plants, hydropower, shale gas, biofuels). It will also include socio-economic indicators such as demand functions by economic sectors, households, public utilities and unit costs of selected water management options, as well as indicators for transport like the minimal water levels needed for inland navigation. Activities in this Work Package will be closely linked to the cluster for the creation of a Danube Reference Data and Services Infrastructure (DRDSI).

- Monitoring of water quality will be carried out in the context of the JDS-Joint Danube Survey 3. The JRC will cooperate with laboratories in the Danube’s countries by providing a spatial assessment of Semi-Volatile Organic Compounds (Dioxins, dioxin-like PCBs, PBDEs, and PFOS), emerging Persistent Organic Pollutants and polar hazardous compounds, mercury and nutrients in samples from all tributaries and upstream and minimum 5 km downstream of the confluence of each tributary. Comparison with data collected at identical sites during the previous survey JDS 2 will allow an estimate of temporal trends of pollutant emissions.
• Soil and crop related data for Danube Basin extracted from a range of pan-European assessments will be made available. For example, key soil properties, organic matter, estimated soil erosion, soil sealing intensity, salinisation, land productivity dynamics, etc. It should be noted in almost all cases, individual countries have more detailed data that the JRC. However, the information at national level is very heterogeneous, which makes large area assessment difficult. In many cases, the data held by the JRC are the only pan-Danube level information. In the medium-term, a ‘state of the environment’ style report on the soils of the Danube Basin, with collaboration of Member States (as a contribution to the State of the Environment Report for 2015).

• Information on energy generation potential and associated water needs, including bioenergy production following the IEA-bioenergy approach that JRC has contributed to develop, will be incorporated as background for the modelling and scenario analyses.

2. Hydro-economic modelling

The work will rely on the use of a hydro-economic model applied for the entire Danube region coupling water quantity, quality and an economic models running in a multi-criteria optimisation environment. The multi-criteria approach will allow the selection of measures affecting water availability and demand based on environmental and economic considerations including damage due to water shortage and excess. The modelling will include an assessment of water footprint for energy and agricultural production in the Danube Region considering trade options.

• This Work Package will build on the development made by the JRC in the preparation of the Impact Assessment of the EU Water Blueprint for Europe and on models presently applied on the Danube in the context of various initiatives. It is proposed in a first step to develop an inventory of existing models currently used in the Danube Region by local, regional, national authorities and scientific institutes. A screening analysis of the existing model will be performed to identify the potential candidates to be used throughout the Danube Region to conduct the hydro-economic modeling.

• A benchmarking of the appropriate models results will be performed against available national and regional model results made available to the project and fed into the previously described database. The benchmarking will focus on pilot areas where more detailed information is available and extensive local knowledge and expertise exist. Potential sites include the Tisza and the Sava River Basins.

• All hydrological elements in the Danube river basin will be linked to a network of sources and demand sites for energy production, for urban and industrial water uses, for ecological and environmental flows (including quality elements) and agricultural needs. Water withdrawals and return flows will be developed for each of these demand nodes, or determined using empirical relations between water and type of productive uses. Water balance modelling will provide annual relations between their components to characterise changes in hydrological years.

• Simulations will be carried out to assess the effects of water-retention measures, water-saving measures, and nutrient-reduction measures as well as land use change on several hydro-chemical indicators, such as the Water Exploitation Index (WEI), Environmental Flow indicators, the 50-year return period river discharge as an indicator for flooding, and economic losses due to water scarcity for the agricultural sector, the manufacturing-industry sector, the energy-production sector and the domestic sector. Based on simulations of water depth, the economic losses for industry and inland navigation (higher fuel demand, less cargo per vessel, higher transport costs, due to the usage of alternative modes of transport, costs to lighten the ships, etc.) will be calculated for selected critical regions.

• Multi-Criteria Decision Models will provide a systematic mean for comparing trade-offs and selecting alternatives that best satisfy the decision maker’s objectives. Taking economic and environmental constraints into account, the optimisation model will allocate available water to all end users while ensuring the best trade-offs for economic and environmental sustainability.
3. Scenario analyses

This Work Package will carry out analyses of future scenarios of water demand and supply, an assessment of trade-offs between alternative schemes of water allocation across the agriculture and energy sectors, and the selection of optimal management options to reduce vulnerability of water ecosystems and ensure a sustainable agricultural production and the provision of ecosystem services. Scenarios will be run on the basis of macro-economic trends involving changing land use and climate conditions for 2030 and 2050 taking into considerations also water requirements by industry, human consumption and the need to ensure a minimum environmental flow. Attention will be paid to regional validation of scenarios through the involvement of stakeholders.

- With the inclusion of ‘greening’ measures combined with the cross-compliance, the CAP represents an option to ensure that agricultural production uses natural resources in a sustainable way. Furthermore, biofuel policies may potentially impact production structure and land use having implication for farm practice adjustments, land use and overall markets developments. Agro-economic scenarios for the Danube Region will include aspects related to these policy developments and external factors and their relation to water allocation and water scarcity. A particular focus of the agro-economic analysis will be on productivity effects, market impacts, land use changes, development of incomes and their variation across regions and agricultural sectors. This work will be based on the use of the CAPRI model developed and maintained under the agro-economic modelling platform iMAP.

- The changing allocation of water to and within agriculture can have impacts on agricultural production. Through bio-physical and crop modelling the impacts of a water supply modified in space and time as compared to today’s situation on cereals yield and production will be analysed and evaluated. Based on feedbacks from the second above-mentioned work package, this study will include the impact of changing irrigation water regimes (blue water) as well as changing patterns of precipitation as the natural water supply to agricultural plants (green water) due to climate change for chosen scenarios.

- Regional climate scenarios will initially be those prepared for the PESETA-II study (Projection of Economic impacts of climate change in Sectors of the European Union based on boTtom-up Analysis). They are based on the work of all major regional climate modeling groups in Europe that collaborated in the FP6 ENSEMBLES project. The use of consistent and up-to-date climate scenarios will be a strong element in the project as they will be used to calculate possible economic impacts of climate change (e.g. on the navigability of rivers) and of adaptation options.

- The Land Use Modelling Platform (LUMP) which integrates sector-specific projections and plans (e.g. on macro-economy, agriculture, forestry, demography, transport) will provide results at a detailed geographical scale, taking full account of competing land use demands (for example for household, industrial settlements, etc.) and of spatial policy restrictions (e.g. Nature 2000 sites or other protection mechanisms). Bio-physical interactions between land, water, vegetation, are also considered. Specific scenarios of policy options (concerning e.g. regional development and cohesion) will be assessed and their impacts quantified, following selected environmental, social and economic criteria. The impact of significant changes on water balance will be also simulated and evaluated.

- The energy model POLES has been extensively used in the context of mid- and long-term energy scenarios. The model will be used to address the alternative patterns of exploitation of hydro-electricity in the countries of the Danube Region in the scenarios addressed, depending on the water resource availability and the deployment of other power generation technologies.

- Water management measures to be assessed will comprise improvement of the efficiency in the use of water (irrigation, energy, industrial uses), increase of water retention capacity through natural (floodplains, polders, wetlands) or technical infrastructure (dams, reservoirs), improvement of the quality of available water by changing farming practices, water transfer from one basin to another.
4. Timeline

May 2013  Bratislava meeting
May 2013  2nd Technical Meeting Danube Water Nexus
January 2014  3rd Technical Meeting Danube Water Nexus
January 2014  Specification data needs
May 2014  4th Technical Meeting Danube Water Nexus
October 2014  Model inventory
October 2014  Available scenario inventory, further scenario development needs
November 2014  5th Technical Meeting Danube Water Nexus
March 2015  Deliverable Scenarios (land use and climate scenarios)
June 2015  Deliverable Danube database
June 2015  Deliverable Pilot River Basin results
December 2015  Deliverable Integrated modelling toolbox
December 2015  Deliverable Impacts of scenarios

Related priority areas of the EUSDR:

PA 1A - Mobility – Waterways (coordinated by Austria and Romania)
PA 02 - Energy (coordinated by Hungary and the Czech Republic)
PA 04 - Water Quality (coordinated by Hungary and Slovakia)
PA 05 - Environmental Risks (coordinated by Hungary and Romania)
PA 06 - Biodiversity, landscapes, quality of air and soils (coordinated by Bavaria and Croatia)

Policy context and related legislation:

EU reference documents:
- EU Water Framework Directive and EU Blueprint to safeguard Europe’s water resources
- EU Floods Directive
- EU Roadmap for a Resource Efficient Europe
- Common Agricultural Policy Reform
- EU Climate and Energy package

Other reference documents:
- Danube River Basin Management Plan (adopted by the ICPDR in the framework of the implementation of the EU Water Framework Directive)
- Joint Statement on Guiding Principles for the Development of Inland Navigation and Environmental Protection in the Danube River Basin (by the ICPDR, the Danube Commission and the International Sava Commission)
- Declaration of Transport Ministers on effective waterway infrastructure maintenance on the Danube and its navigable tributaries

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