European Commission

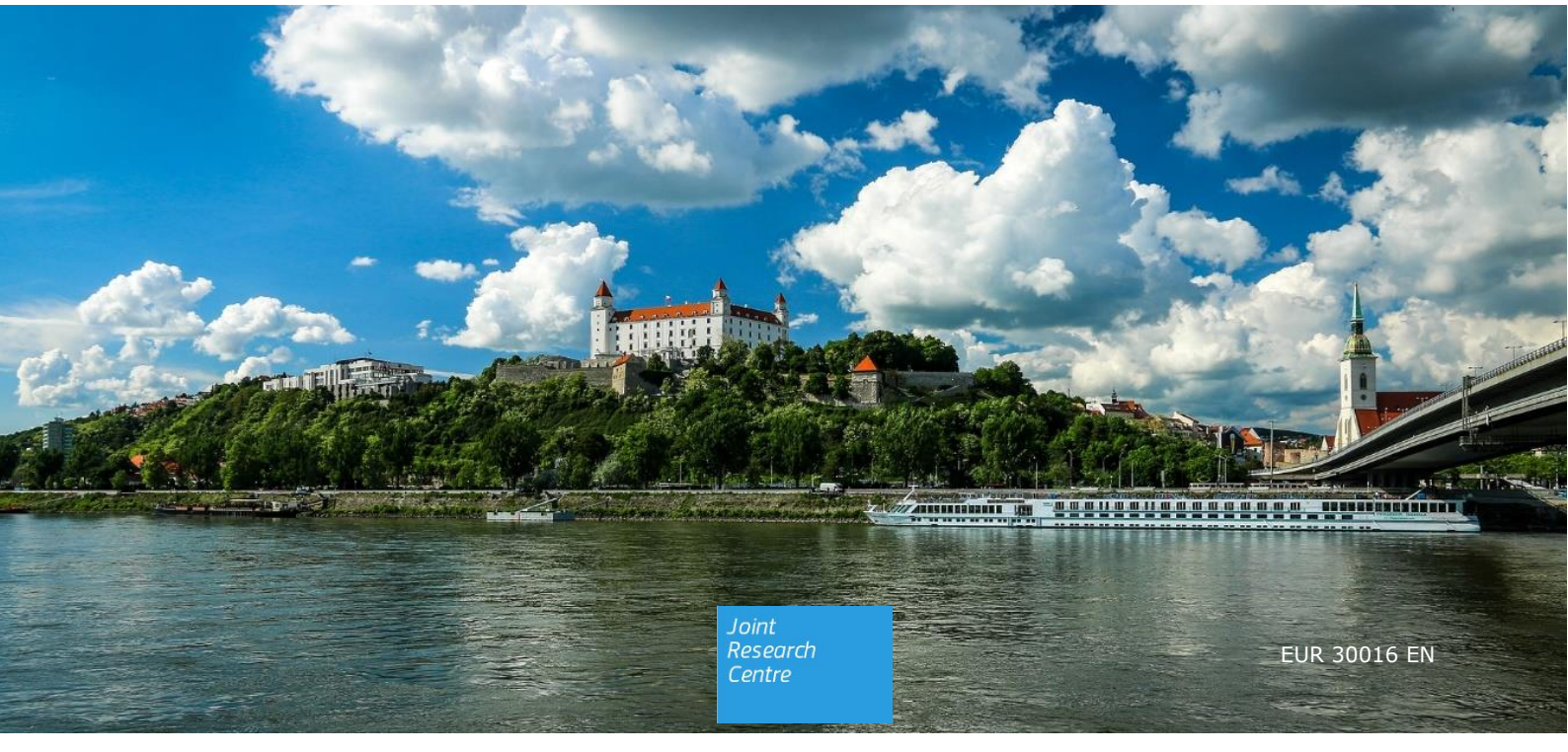
JRC SCIENCE FOR POLICY REPORT

Water scenarios for the Danube River Basin: future challenges and preparedness

A foresight study to inform water management in the Danube River Basin

Alberto Pistocchi, Laurent Bontoux, Sara Rafael Almeida

2020



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EU Science Hub
https://ec.europa.eu/jrc

JRC115635

EUR 30016 EN

PDF ISBN 978-92-76-14177-8 ISSN 1831-9424 doi:10.2760/134358

Luxembourg: Publications Office of the European Union, 2020

How to cite this report: Author(s), *Pistocchi, A., Bontoux, L., Rafael Almeida, S., Water scenarios for the Danube River Basin: future challenges and preparedness. A foresight study to inform water management in the Danube River Basin;* Luxembourg: Publications Office of the European Union, 2020, ISBN 978-92-76-14177-8, doi:10.2760/134358, JRC115635.

Title *Water scenarios for the Danube River Basin: future challenges and preparedness. A foresight study to inform water management in the Danube River Basin*

Abstract

We present the outcomes of a foresight study aimed at identifying the emerging challenges for water management in the Danube region, considering a set of possible future socioeconomic and political scenarios. For each scenario, we analyse the possible implications for key water management issues (wastewater treatment, diffuse pollution and hydromorphological alteration). Based on this analysis, we identify possible no-regret actions to adopt in the Danube region in order to improve water management in the long-term, along the three main lines:
1) Developing effective communities.
2) Basin-wide integration of the management of certain issues.
3) Bringing nature protection to the core of strategies.
Sharing and strengthening capacity at various levels of water management is a precondition to avoid marginalization and impoverishment of regions within the Danube. Education of the youth in schools and universities (including through student exchanges and harmonization of educational programmes) is essential to create a more ecologically aware society.

"*It is an emergency.*
In order to survive as a species we need to define our utopia
(…)
We have to imagine something that doesn't exist
carve intentionally into the future
and demand space for hope
(…)
let's imagine a world where nature and technology collaborate
and make a song about it
(…)
then move into it
(…)
imagine a future and be in it."

Björk
Utopia Tour, 2018

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Acknowledgements

This report is based on reflections initiated at a workshop held in Budapest at the end of October 2016, further described in Bontoux et al., 2018[1]. All workshop participants are gratefully acknowledged for their generous contribution.

JRC colleagues Bernd Gawlik and Ad de Roo are particularly acknowledged for their contribution to the preparation of the workshop and for providing background knowledge on water management and the quantitative simulation of scenarios of water resources in the Danube region[2], respectively.

The work is part of the JRC support to the European Strategy for the Danube Region (EUSDR), under the "Danube Water Nexus" flagship cluster of activities. The definition of scenarios (section 4 of this report) derives from a MSc thesis of Mr Augustin Gallot-Lavallee at the Imperial College, London, in collaboration with the JRC. We wish to thank Augustin for his contribution to this work.

The analysis of this report was developed mainly during the year 2017, and the starting assumptions and scenarios were defined during 2016. Although the work does not necessarily reflect a number of socioeconomic and geopolitical developments occurred in the region, and Europe in general, in more recent times, the Authors have made all possible efforts to keep the narrative up-to-date. Therefore, it is deemed that the recommendations drawn from this work may retain their validity even under other scenarios that may emerge in the near future.

We would also like to thank Lorenzo Benini from the European Environment Agency (EEA), as well as JRC colleagues Fabio Farinosi and Julian Wilson, for reviewing this report and providing very useful comments and suggestions.

Authors

This report was prepared by Alberto Pistocchi, Laurent Bontoux and Sara Rafael Almeida of the JRC.

[1] http://publications.jrc.ec.europa.eu/repository/bitstream/JRC114803/jrc114803_danube_workshop_flash_report_online_final.pdf

[2] A full report on this assessment can be found in Bisselink et al., 2018: https://ec.europa.eu/jrc/en/publication/impact-changing-climate-land-use-and-water-usage-water-resources-danube-river-basin

Executive summary

Managing water resources effectively is not only vital to a sustainable development of the European Union, but must also be at the core of the regional development agenda in all its aspects.

The management of water resources cuts across the European Union Strategy for the Danube Region (EUSDR), as it affects, and is affected by the societal, environmental, economic, geopolitical and industrial dimensions of a river basin as complex as the Danube's.

This complexity creates strategic and policy challenges that are difficult to address. It requires the mobilisation of knowledge from many sources and its integration into a coherent understanding of the Danube River Basin system. The objective of this exercise was to combine quantitative data with a qualitative foresight approach to explore possible emerging issues and the associated threats and opportunities, propose actions to address them and formulate recommendations for the future management of water resources in the Danube River Basin.

Evidence on the Danube River Basin

Socioeconomic conditions of the Danube region:

The Danube region shows strong diversity in economic conditions, with EU Member States generally in better economic conditions than countries which are not members. Member States in the Upper Danube have markedly stronger economies than Lower Danube countries.

Industry represents an important share of GDP for all Danube countries except Bosnia-Herzegovina. Agriculture usually accounts for much less and tends to be inversely correlated with GDP per capita.

The various EU regions within the Danube river basin have a share of employment in the public administration of around 20%, with Hungary slightly above and Romania slightly below.

Globally, the region is not an innovation leader, with the exception of Germany and, to an extent, Austria. The business conditions in the region show some difficulties, related *inter alia* to corruption.

Demographic projections based on current trends suggest that the Lower Danube may witness a generalized reduction of population, with a stronger effect in non-EU Member States. This trend is likely to be accompanied by a systematic ageing, where all EU Member States of the Danube region expected to have 50% or more of their population above 65 years old by 2070.

Water resources in the Danube region:

The economic sector accounting for the largest share of water use is energy production (44%). Domestic water use accounts for 13%, industry for 17% and food production (agriculture and livestock) for 26%.

Water availability has important implications for navigation on the Danube River, as transport is significantly affected by water levels. Evidence shows a connection between water levels and transport prices, thus impacting the total volume of goods transported and the degree of use of the available transport capacity.

About 50% of the surface water bodies do not achieve good water quality status yet, and are unlikely to achieve it by 2021. The same can be said for some groundwater bodies.

The three significant water management issues (SWMIs) in the Danube are organic pollution, nutrients and hydromorphological alterations. Chemical pollution is also a SWMI, but knowledge about this issue is still building up.

According to the Danube River Basin Management Plan (DRBMP), untreated wastewater represents 64% of the total biochemical oxygen demand (BOD) discharge in the Danube river basin. Industry contributes with additional organic pollution in the order of 10% of the urban wastewater pollution.

Nutrients come primarily from urban wastewater and agriculture. For nitrogen, agriculture accounts for about 80% of the loads, while for phosphorus it accounts for about 2/3 of the total.

Point source pollution from organic matter and nutrients will be addressed through the gradual equipment with appropriate wastewater treatment systems; for industrial emissions, standards of "best available techniques" will be applied insofar as possible.

Diffuse pollution from agriculture is expected to decrease thanks to the implementation of the European Nitrates Directive.

Hydromorphological alterations in the stream network mainly pertain to morphology (river depth and width variation, riparian zone and substrate), river continuity (presence of barriers) and hydrology (hydro-peaking, impoundment, abstractions). The DRBMP has adopted a prioritization of stream barriers for the restoration of river connectivity necessary to fish migration.

Compared to organic pollution and nutrients, pollution from hazardous substances is still largely unknown due to significant knowledge gaps at the Danube-wide scale. The pollution reduction measures to be implemented are essentially left to the individual Member States compliant with the European legislation in place. Areas of action include the adequate management of pesticides; application of sewage sludge in agriculture; industrial and urban point sources.

Four scenarios to 2040

The DRBMP embraces a vision of gradual diffusion of good water management based on the implementation of the EU water legislation. This vision rests on the assumption of a stable engagement of policies throughout the region. However, different socioeconomic and geopolitical drivers may affect the effectiveness, or even the persistence of water policies as stipulated by this vision.

We have imagined four possible, albeit extreme, socioeconomic and political scenarios under which we tried to identify emerging challenges for the management of the river basin. These scenarios were discussed with a group of experts from the region, convened at a workshop organized on purpose. The different scenarios, briefly described below, reflect different trajectories along the following dimensions:

- Financing (preference for large or small projects);
- Economic redistribution and solidarity;
- National governance, government efficiency;
- Community engagement;
- Capacity, knowledge, innovation;
- Entrepreneurial initiative; and
- Societal responsiveness, awareness, participation.

Scenario 1 "Large scale coherence" benefits from a good level of technology and infrastructure but carries risks of low societal engagement; all regions are on a level playing field but competition between centre and peripheries may still exist. It is a scenario

with strong reliance on technology, large infrastructure leaning towards "grey" rather than "green", strong urbanization and an accelerated depopulation of rural areas.

Scenario 2 "Tailor made solutions" relies less on technology and infrastructure, but suggests better societal engagement; collaboration among regions; smart specialization may unroll but do not emerge automatically. It is a scenario with smaller and greener infrastructure, with a much higher degree of rural development. It stipulates an active role of communities and the responsibilization of people both as citizens and as consumers.

Scenario 3 "Multinationals rule" reveals an emergence of the supply chains as a key organizer of the economy, with weakened role of the government and society. Supply chains trigger tug-of-war competition among cities, regions and countries. Technology and infrastructure are mostly controlled by large corporations. National governments are de facto conditioned by the rules imposed by the global supply chains. The fate of cities is strongly inked to their status as supply chain nodes, and rural areas are de facto subject to intensive, industrialized agriculture, or outright abandoned.

Scenario 4 "Small scale interventions" shows a trajectory away from globalization, with nation-states turning inward and relying on a more local, less dynamic economy. In this scenario, technology and infrastructure are less developed, but society is more responsive although not necessarily more capable to drive decisions. It is a scenario of nation-states in a multipolar world, with urban and rural development limited by the capacity, wealth and attractiveness of each country and region.

Under each scenario, we have elicited possible challenges for water management and, particularly, for the three categories of measures (wastewater treatment, agricultural diffuse pollution and mitigation of hydromorphological alterations) foreseen in the RBMP to tackle the SWMIs. The challenges are summarized in the following table.

Scenario	***Wastewater***	***Diffuse pollution (agriculture)***	***Hydromorphology***
1 - Large scale coherence	Large WWTPs too complex to manage locally? Decentralized plants too small for funding?	Lack of enforcement capacity? Rebound effect of high-productivity agriculture ?	Competitive agendas (e.g. hydropower, navigation) limiting restoration only to iconic sites?
2 – Taylor-made solutions	Difficult to finance ambitious advanced treatment plants (e.g. pharmaceuticals) ?	Risk of „race to the bottom"?	Ambitious projects (e.g. dam removal) difficult to finance?
3 – Multinationals rule	Worsening of scenario 1	Industrialization of agriculture?	Lacking motivation of investors?
4 – Small scale interventions	Worsening of scenario 2	Between scenario 2 and scenario 3	Lack of basin-wide perspective?

Key recommendations

Drawing in part on the outcomes of discussions with experts at the workshop, we identify possible ways to address the abovementioned challenges. In particular, we propose three main areas for actions to improve long-term water management in the Danube River Basin:

1) **Effective and empowered communities** may buffer the impacts of centralized decision making, mitigate the harshness of competition in the global supply chains and voice their needs more audibly. When communities hold important decision powers, their capacity to look forward and face sustainability challenges is stronger.

2) **Basin-wide integration** is a cross-cutting need of the economy of the Danube, due to the dependency of the various economies on shared water resources. Measures to ensure continuation of basin-wide management of certain issues are needed irrespective of how the society and economy will evolve. Addressing regional disparities by harmonizing planning and implementation, investments are public or private and regardless of their scale. Strengthen Danube River Basin management - acting according to an overarching water management plan at the scale of the whole basin would also maximise coherence of actions by all actors along the river and would generate the most synergies.

3) **Bringing nature protection to the core of strategies** helps escaping the inefficiencies of "impair-then-repair" cycles, by shaping more robust and sustainable solutions and focusing investments on the integrated promotion of the quality of life. Climate change is projected to reduce the availability of water resources and quantitative models identify a trend of increasing floods induced by climate change. To cope with these conditions, robust nature-based solutions may take even higher importance. Increased policy coherence and integration, taking into account the strong links that water management has with other policies (e.g. industrial, tourism, transport, energy) and recognising the benefit of acting at the scale of the whole river basin, may substantially increase synergies and reduce trade-offs. This would offer a large advantage on the road towards sustainable development.

Sharing and strengthening capacity, meant in cultural, technical and financial terms, is a precondition to avoid marginalization and impoverishment of regions within the Danube. Education of the youth in schools and universities (including through student exchanges and harmonization of educational programmes) is essential to create a more ecologically aware society.

The Danube region shows **strengths and weaknesses, opportunities and threats** for the development of the above areas for action. Among the strengths, all countries are on a (more or less steady) path to structural reforms, have relatively good environmental performances and can benefit from the synergies with global or regional leaders under several technological and organizational dimensions. This provides favourable conditions for capacity building/knowledge transfer.
Another strength is the still relatively high abundance of pristine natural environment, and the relatively low impact of agricultural activities in the lower river basin. This provides ample opportunities for the development of green economic activities, also considering that forest areas are generally stable if not expanding, while the population tends to concentrate in urban centres.
Most of the Danube countries have a large public sector, which may be a strength when planning public and community actions, although it may revert to a weakness if bureaucracies take a conservative attitude and resist innovation. Re-valueing their large public sector appears an opportunity for all countries but requires dedicated investments. The relatively poor innovation performance may be a weakness for most countries, although there are signals of vitality in certain innovative sectors in the region.
Agriculture in the region does not contribute enough to the gross domestic product, suggesting a weakness due to the limited value of agricultural production. However, access to a large and stable market such as the EU offers apparent opportunities particularly for tourism and specialized agricultural production. Small farmers and their families may

develop typical products with high added value and marketability that can benefit from the Protected Designation of Origin and other EU quality labels. The regions can support this by attracting tourism from elsewhere, deploying good public transport and logistics infrastructure, cultivating capacity for better agricultural management, etc.
Rural tourism to diversify sources of income might both benefit from environmental improvements, and become a driver of further ecological transition due to the demand for high quality organic produce, calling for a reduction of pesticide use and the adoption of agro-ecological practices. These opportunities seem to be underexploited for now, with the region still lagging behind the EU top players in the field in spite of assets such as a relatively well preserved and varied agricultural landscape.
An overall threat in the region is the apparent ageing of population and the trend of depopulation, particularly in lower Danube countries. If policies to counter these trends are not put in place, societies may soon become very different and their capacity to plan any development may be undermined.
Equally dangerous threats come from rising inequality in most Danube societies, and particularly in the lower Danube, and corruption, which has shown to correlate well with the difficulties of doing business. Foreign investors and the EU partner Member States may have aligned interests in combatting both phenomena in order to secure a better business environment and a higher overall prosperity in the region.
Finally, significant opportunities come from the European structural funds, the existence of frameworks for the development of transboundary investments, and the relative ease of access to financing through financial institutions.

List of abbreviations

Best Available Techniques (BAT)

Biochemical Oxygen Demand (BOD)

Chemical Oxygen Demand (COD)

Common Agricultural Policy (CAP)

Danube Flood Risk Management Plan (DFRMP)

Danube River Basin Management Plan (DRBMP)

Entrepreneurial Discovery Process (EDP)

Environmental Impact Assessment (EIA)

Environmental Impact Bonds (EIBs)

European Commission (EC)

European Investment Bank (EIB)

European Pollution Release and Transfer Register (E-PRTR)

European Union (EU)

European Union Strategy for the Danube Region (EUSDR)

Floods Directive, 60/2007/EC (FD)

Framework Agreement for the Sava River Basin (FASRB)

Global Innovation Index (GII)

Gross Domestic Product (GDP)

Integrated Pest Management (IPM)

International Commission for the Protection of the Danube River (ICPDR)

International Sava River Basin Commission (ISBRC)

Joint Research Centre (JRC)

Nederlandse Waterschaps Bank (NWB)

Nomenclature of Territorial Units for Statistics 2 (NUTS2)

Pay-for-Success (PFS)

Significant Water Management Issues (SWMIs)

Small and Medium-sized Entreprise (SME)

Sustainable Development Goal (SDG)

Trans-European Networks - Transport (TEN-T)

Water Framework Directive, 60/2000/EC (WFD)

1. Introduction

We live in times of unprecedented global instability[3]. The European Union (EU) faces challenges related to severe geopolitical crises in the eastern and southern neighborhoods, as well as the emergence in most Member States of political movements promoting the restoration of sovereign nation-states and borders, and a loosening of European ties. These have sprouted on the wave of the economic and financial crisis since 2007, hardened by immigration (viewed by many as a threat to the welfare state and employment) and terrorism. Immigration alone is recognized to be among the main motivations for British citizens to vote for the United Kingdom to leave the EU, in June 2016[4].

In these times of crisis and change, the EU is often perceived as not fully capable of delivering on the protection, security and well-being of its citizens in fields such as employment, welfare, territorial cohesion and development. This calls into question the EU's own legitimacy. Yet, the EU represents a major source of financing for most of the economic sectors in the Member States and the European funds are an important asset, particularly for the development of macro-regions spanning borders between Member States and less favoured areas[5]. This fact alone illustrates the value for Member States and regions to cooperate in the EU context. But EU funding alone may not deliver all the benefits of transnational collaboration, face to the many strategic challenges ahead, affecting the economy and society at broad.

The European Union has launched "macro-regional strategies". Its aims were nurturing regional transboundary projects, developing better national policies while incorporating EU concerns, "making more with less" by sharing budgets and pursuing value-for-money initiatives in times of budget restrictions, promoting greater integration and coordination, tackling inequalities and promoting cohesion in the macro-regions, stimulating multi-level governance and finally enhancing cooperation with neighboring countries[6].

The European Union Strategy for the Danube Region (EUSDR)[7] is one of the EU macro-regional strategies and is built on 4 pillars - "connecting the region", "protecting the environment", "strengthening the region", and "building prosperity" - for which 12 priority areas of action are organized (Figure 1). The EUSDR is backed by the Interreg VB fund of the "Danube Transnational Programme"[8].

The protection of water resources is a cross-cutting aspect of the EUSDR, as water management affects, and is affected by, many societal, environmental, economic, geopolitical, and industrial dimensions of a system as complex as the Danube river basin. As such, the Danube is a very instructive case for other macro-regional strategies in Europe. Water resources management has more generally been identified as a key

[3] Foreign Policy interview with Z.Brzezinski, July 2014: http://foreignpolicy.com/2014/07/21/a-time-of-unprecedented-instability/
[4] See e.g. https://www.euractiv.com/section/uk-europe/news/immigration-top-concern-for-brexit-voters/
[5] See e.g. https://cohesiondata.ec.europa.eu/funds
[6] COM(2013) 468 final: Report From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions Concerning The Added Value Of Macro-Regional Strategies {Swd(2013) 233 Final}
[7] http://www.danube-region.eu/
[8] http://www.interreg-danube.eu/

contribution to "smart, inclusive and sustainable growth"[9], and needs to inform the agenda of regional development in a pervasive, cross-cutting way[10].

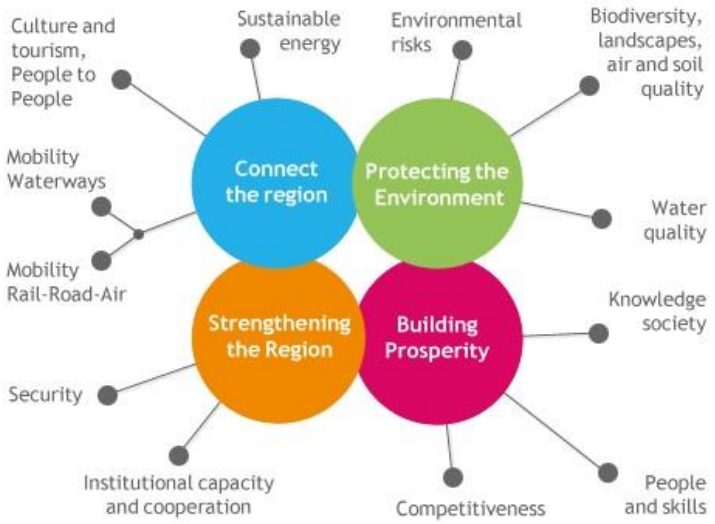

Figure 1 – The EUSDR pillars and priority areas (www.danube-region.eu)

In the context of the JRC's scientific support to the Danube strategy, the Danube Water Nexus Flagship cluster of activities has generated input to decision-makers and managers in the region about the future of water resources availability and the main aspects of water quality by developing quantitative simulation models. These are a valuable tool to understand the main drivers and possible evolution of water resources, under the impact of climate and land use change or different levels of water demand and consumption. The analysis presented here complements quantitative modelling by analysing mid-term water scenarios taking into account how the full context may evolve, in order to identify the possible relevant factors driving pressures on water bodies, and the corresponding threats and opportunities for the future updates of the river basin management plan.

In this report, we present a foresight exercise[11] on possible emerging issues, associated threats and opportunities for the Danube river basin, and we propose possible actions to address them. The study harnesses the knowledge of a group of policy-makers, academics and business representatives from the Danube region convened at a workshop held in Budapest in October 2016[12], who were prompted to elaborate on the possible evolution of water management in the Danube region under a set of extreme, broad socioeconomic and political scenarios.

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[9] *"Developing efficient water management goes hand in hand with fostering innovation and knowledge (**smart** growth) […]. Working towards ensuring availability of good quality water for all users contributes to the **sustainable** growth of the EU […]. Finally, efficient water management can help bring about **inclusive** growth, fostering a high-employment economy while delivering economic, social and territorial cohesion" (*http://europa.eu/rapid/press-release_MEMO-12-866_en.htm)

[10] See the "Blueprint to safeguard Europe's water resources": http://ec.europa.eu/environment/water/blueprint/index_en.htm

[11] *"Foresight is the disciplined exploration of alternative futures. Policy makers use foresight techniques and conduct studies to explore different scenarios in a structured way to confront complex challenges and help create a better future."* (https://ec.europa.eu/info/research-and-innovation/strategy/support-policy-making/support-eu-research-and-innovation-policy-making/foresight_en)

[12] Details on the workshop may be found in Bontoux et al., 2018. http://publications.jrc.ec.europa.eu/repository/bitstream/JRC114803/jrc114803_danube_workshop_flash_report_online_final.pdf

Informed by quantitative hydrological modelling of the implications of socio-economic, land use and climate change and the qualitative narratives of the scenarios, this report discusses the challenges to water management that can be anticipated in the Danube river basin. Subsequently, the report identifies areas where attention should be focused in order to be prepared for these challenges.

While this report builds extensively on the workshop, the wealth of considerations emerging from the discussion was further elaborated in a relatively free way. Hence, the report cannot be regarded as the proceedings of the workshop itself but is meant to be an autonomous contribution.

The report is organized as follows. Section 2 sets the scene by recalling evidence on the socioeconomic conditions of the Danube region, as well as on the availability and use of water resources and their trends following climate and land use change. Section 3 provides an overview of the Danube river basin management context and the significant water management issues to be addressed.

Section 4 describes the scenarios that have been designed to define possible socioeconomic trajectories of the region until 2040, and elaborates on the workshop's outcomes to identify what each trajectory may imply for water resources.

On the basis of the scenario discussion, Section 5 summarizes the challenges emerging under the different scenarios. These may help identifying key factors hampering or undermining the effectiveness of the Joint Programme of Measures Implementing the Danube River Basin Management Plan[13] (DRBMP).

Finally, Section 6 elaborates recommendations on possible areas for actions to improve long-term water management in the Danube River Basin.

[13] https://www.icpdr.org/main/activities-projects/implementation-drbm-plan

2. Setting the scene

The Danube Region covers parts of nine EU Member States (Germany, Austria, Hungary, Czech Republic, Slovak Republic, Slovenia, Croatia, Bulgaria and Romania) and five non-EU countries (Serbia, Bosnia and Herzegovina, Montenegro, Ukraine and Moldova).

2.1 Socioeconomic signals from the Danube countries

The Danube countries show very diverse economic conditions. EU Member States are generally in better economic conditions than non-members. Furthermore, Member States in the Upper Danube have markedly stronger economies than Lower Danube countries.

The **European Semester process**[14] sheds light on the general conditions of Member States' economies and provides a picture of the Danube countries. The Country reports for the year 2017 highlight the following features (See Annex 1):

- In 2016, the region shows higher growth than the rest of Europe and unemployment is decreasing, although the quality of jobs is often poor (e.g. due to part-time or temporary work). Significant gaps persist e.g. related to gender.
- Most countries have engaged structural reforms with diverse intensity and effectiveness. A general economic convergence can be observed but is unequal.
- Inequality and risks of exclusion emerge across the whole region, although in different forms: the capacity of governments in the Lower Danube to provide social protection is weak and poverty is an issue, whereas inequality in the Upper Danube tends to take the form of a relative difficulty of access to certain opportunities (e.g. higher education).
- The gaps in wealth among countries are mirrored in governance, the delivery of public services and capacity of the public administration to manage investments, with Upper Danube countries achieving a usually higher efficiency.

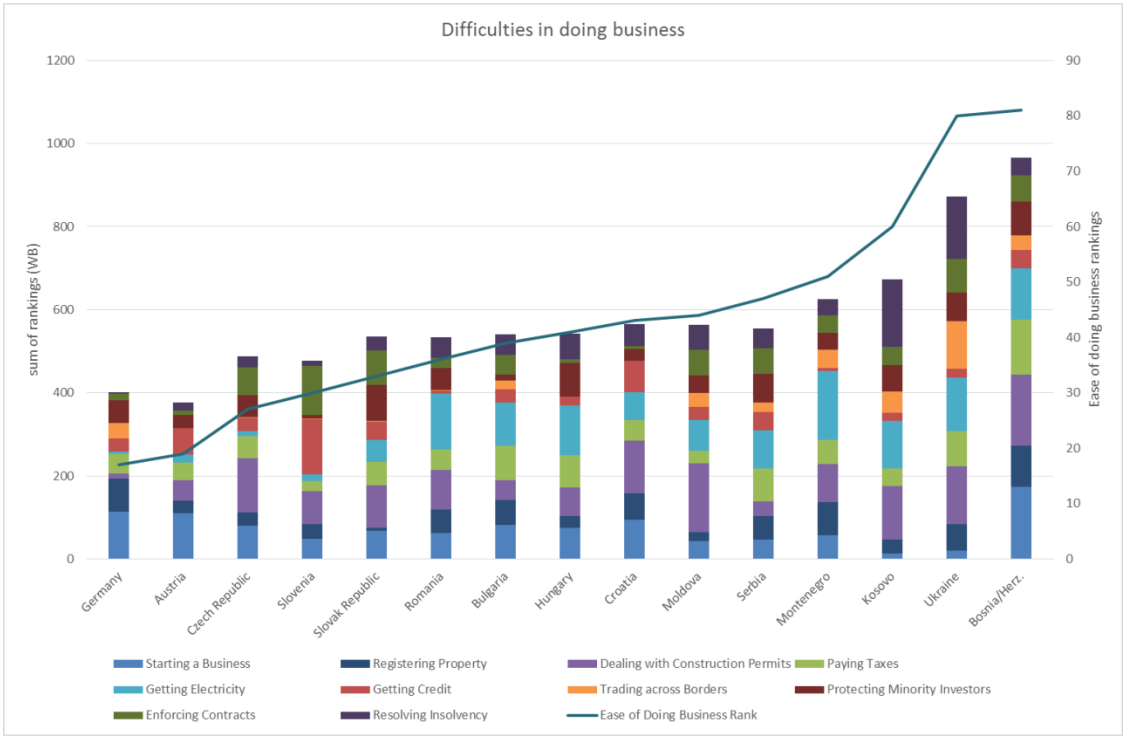


Figure 2 – Ease of Doing Business Rankings for 2017, World Bank. The rankings are on a range 1 (best conditions) to 190 (worst conditions in the World). The sum of rankings highlights the contribution of the different criteria to the final judgment on the ease of doing business in a country (Kosovo reported as per the original data). http://www.doingbusiness.org/rankings

[14] https://ec.europa.eu/info/strategy/european-semester_en

Non-EU Member States seem to align with these general trends and are the worst-off countries of the region in many respects. The Danube countries show a clear trend of increasing difficulty for doing business (Figure 2) when moving from the Upper Danube (Germany and Austria ranking among the World top 20) towards the lower Danube[15]. Non-EU countries show worse 'doing business conditions' than EU countries.

The issues driving **ease of doing business** depend on the country. Starting a business may require more complex procedures in wealthier countries, while the enforcement of "business rules" (protection of minority investors, resolving insolvency, enforcing contracts) tends to weaken from Upper to Lower Danube countries and from EU to non-EU countries. The same applies to administrative procedures (e.g. getting an electricity connection, paying taxes, obtaining a construction permit). Public sector corruption is reported as an issue in many countries with a correlation of the corruption perception index (CPI)[16] with GDP per capita (Figure 3). **Corruption** is perceived as decreasing over in the last 5 years in all countries except Hungary and Bosnia-Herzegovina. A clear correlation emerges also between CPI and ease of doing business.

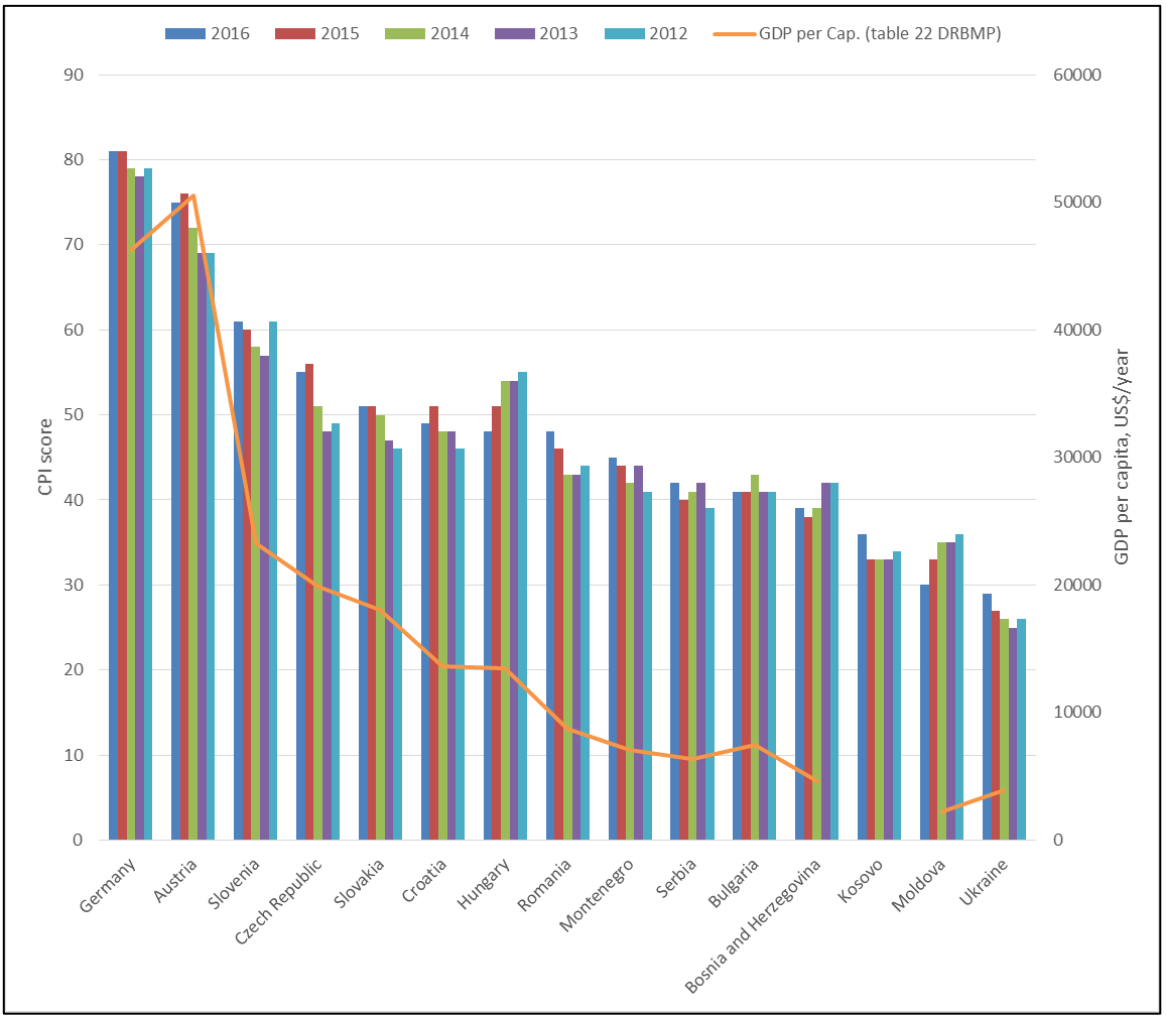


Figure 3 – Corruption Perception Index (CPI) 2012-16. Danube countries (Kosovo reported as per the original data). Higher values indicate lower perceived corruption. The graph also plots the GDP

[15] We refer to the popular "Ease of doing business" index developed by the World Bank. Further details available at http://www.doingbusiness.org

[16] The CPI reflects the perception of corruption in the public sector; further details can be found at: https://www.transparency.org/research/cpi/overview

per capita in 2013 (in US$) from the Danube river basin mabagement plan (DRBMP), 2015 update (table 22). http://www.transparency.org/news/feature/corruption_perceptions_index_2016

Industry accounts for a large share of GDP for all Danube countries except Bosnia-Herzegovina; much less agriculture (Figure 15) which tends to be inversely correlated with GDP per capita. In Moldova, the Danube country with the lowest GDP per capita, agriculture accounts for almost 30% of GDP.

Regarding **employment** (see Annex 2), the EU regions within the Danube river basin have a share of employment in public administration of around 20% (Hungary slightly above, Romania slightly below). The employment share of agriculture is usually much below 10% (and frequently less than 5%) with Romanian regions and Vzhodna Slovenija at higher levels; the employment share of industry reaches 30% in the most industrialized regions such as Czech Republic and Hungary with a good diversification of the sector across the Danube region. The tertiary sector is dominant (services and public administration), at around 60% or more, except in some regions of Romania..

Globally, the region does not excel in **innovation**, with the exception of Germany and, to a lesser extent, Austria. It also has a relatively good environmental performance although it tends to lag slightly behind other European regions (see Annex 3 for further details).

Finally, the Danube countries have some typical agricultural products (Figure 6), although they generally lag behind the top EU players in this field. Germany is a partial exception in this regard.

2.2 Demography and land use

The Danube region is losing population and this trend is expected to continue. According to European Commission projections (Figure 5), Romania, Bulgaria and Croatia will lose between 20 and 30% of their 2016 population by 2070 (between 5 and 10% for all other countries). Only Austria is expected to gain almost 20% on top of its 2016 population. This suggests that the Lower Danube will witness a generalized population reduction, expected to be worse for non-EU countries. This trend is accompanied by a systematic ageing, with all Danube EU Member States having 50% or more of their population aged 65 years or older by 2070 and 20% or more above 80 years old (Figure 7).

Bisselink et al., 2018, present projections of urban and forest land use, indicating a clear urbanization trend (mostly +10 to 20%, but a 147% increase in Montenegro!). Moldova and Ukraine are expected to have almost no increase. The expected growth of forest areas is quite divergent, with only Serbia and Bosnia-Herzegovina projected to witness a small decrease (Figure 8).

2.3 Water resources and their use

A large part of the surface and ground water in the Danube region is generated in the Upper Danube, especially in the western and southern subbasins in Germany and Austria (Karabulut et al., 2016). For example, Austria, with 10% of the basin area, has 25% of the water provisioning capacity while, Romania, with 29% of the area, only has 17% of the capacity. Water use, on the other hand, occurs mainly in the valleys and downstream plains (Figure 7 and Figure 8), shared between energy production (44%), agriculture and livestock (26%), industry (17%) and domestic water use (13%) (see Figure 9).

Water availability has also important implications for navigation on the Danube river (Scholten and Rothstein, 2016). Data reveal a complex but clear connection between water levels and transport prices, impacting the volume of goods transported and other related aspects (such as the shift from large ships to a larger number of smaller ships when levels are low). Every 10 cm decrease in water level at a reference location results in a 0.6% decrease in capacity utilization (approximately 1700 t). This can be limited to some extent by switching to smaller ships, adaptating the shape and materials of ships, or engaging in hydraulic engineering works, thereby impacting river hydromorphology.

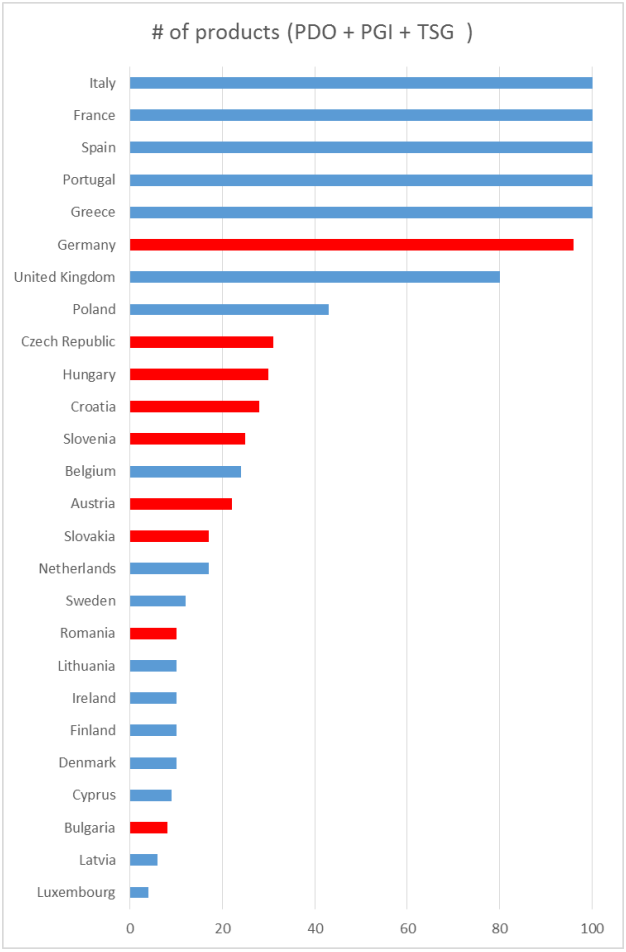
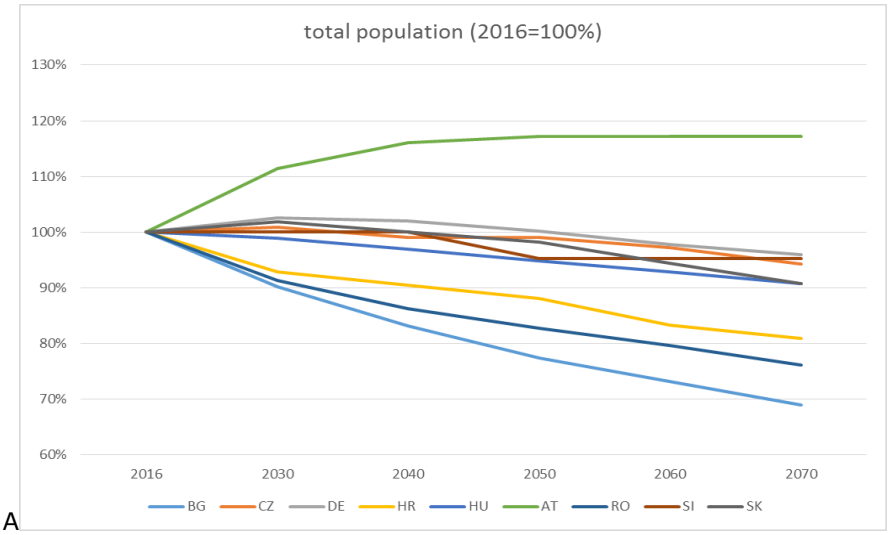


Figure 4 – Designations of products in the EU (blue bars) and Danube (red) countries. Includes applications, published and registered products (PDO = products with Protected Designation of Origin; PGI = with Protected Geographical Indication; TSG = Traditional Specialities Guaranteed, as per EU Regulation No 1151/2012).[17] Bisselink et al., 2018, present projections of water demand for energy, industry, households and livestock sectors. These projections indicate relatively large increases in Hungary, Slovenia, Germany, Bulgaria, Romania and the Czech Republic, mostly driven by energy production. Industry use is also expected to increase in Germany and the Czech Republic, and domestic use in Germany. The population of the Danube is projected to decrease particularly in the South-East of the basin, and the corresponding household demand follows this trend.

[17] Source: http://ec.europa.eu/agriculture/quality/door/list.html?locale=en, last accessed 23/11/2018



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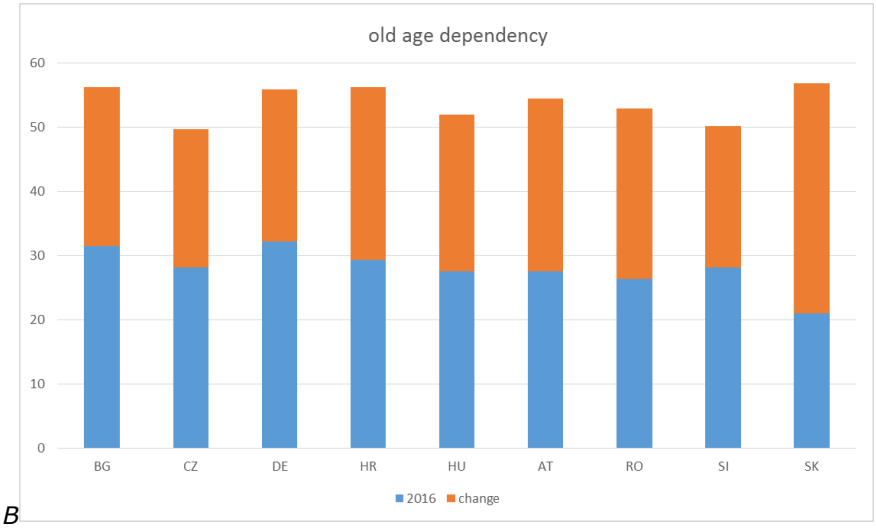

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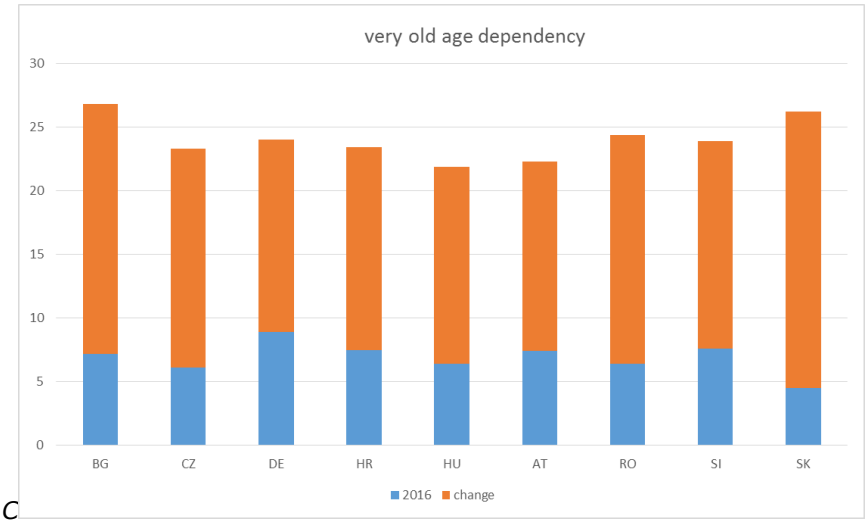

C

Figure 5 – projected demographic evolution for the EU Danube countries. Source: EC, 2018. A: trends in total population; B: % population above 65 years; C: above 80 years. "2016" indicate the most recent data, "change" is difference between 2016 and 2070.

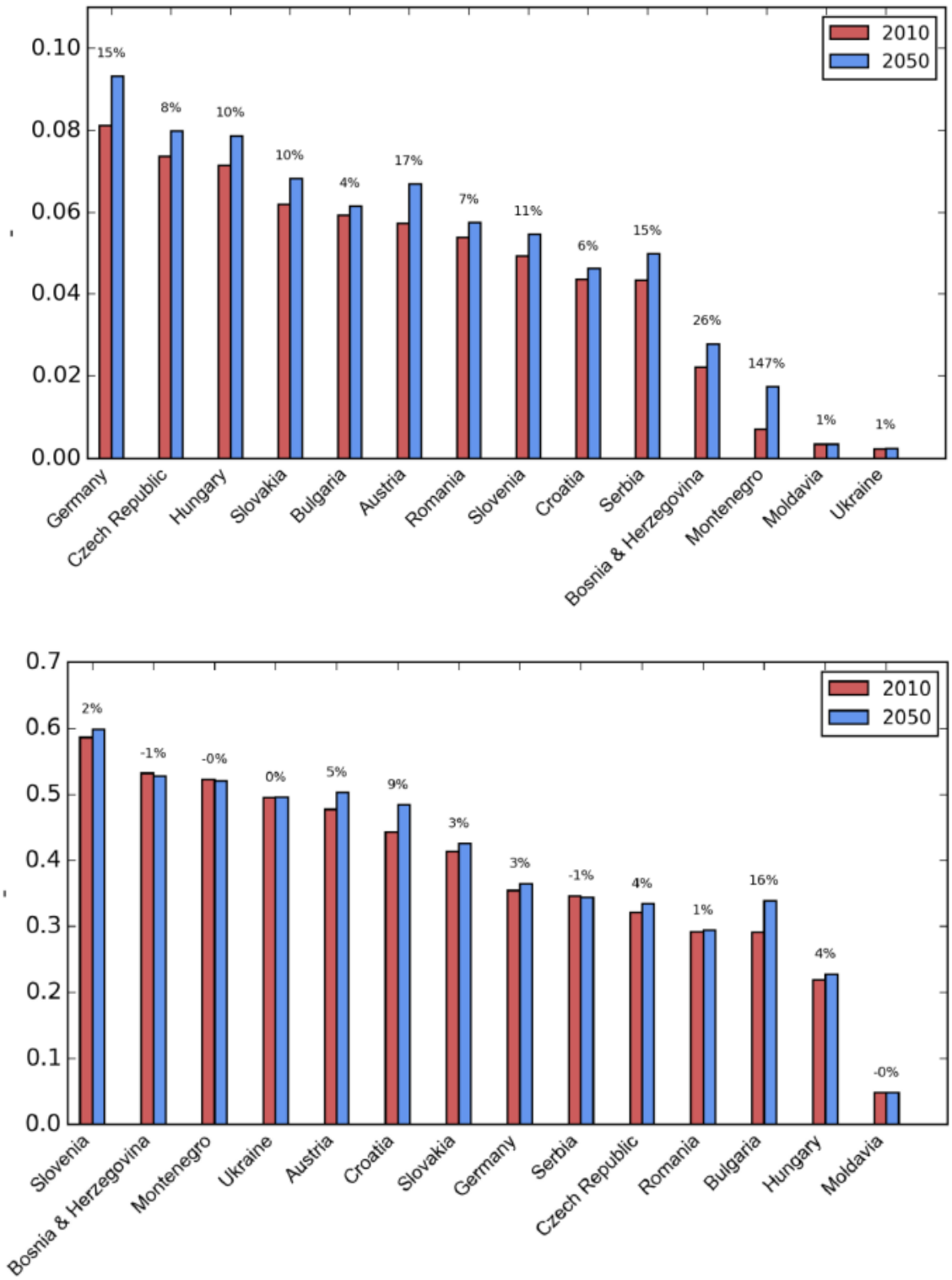

Figure 6 – current and projected urban (above) and forested (below) land use in the Danube. From Bisselink et al., 2018, reused under Decision 2011/833/EU.

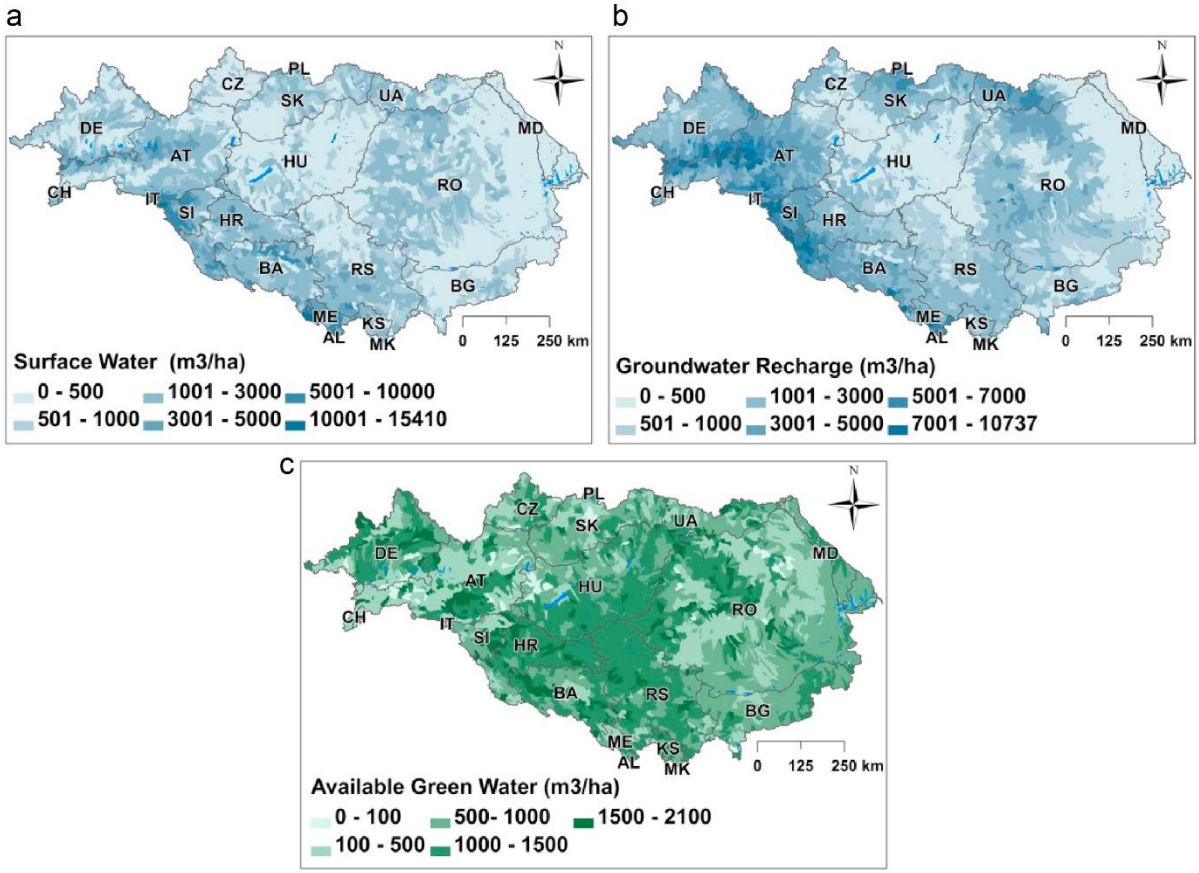

Figure 7 – Renewable water in the Danube river basin estimated by the model SWAT. From Karabulut et al., 2016 (http://dx.doi.org/10.1016/j.ecoser.2015.08.002) under CC BY NC ND license

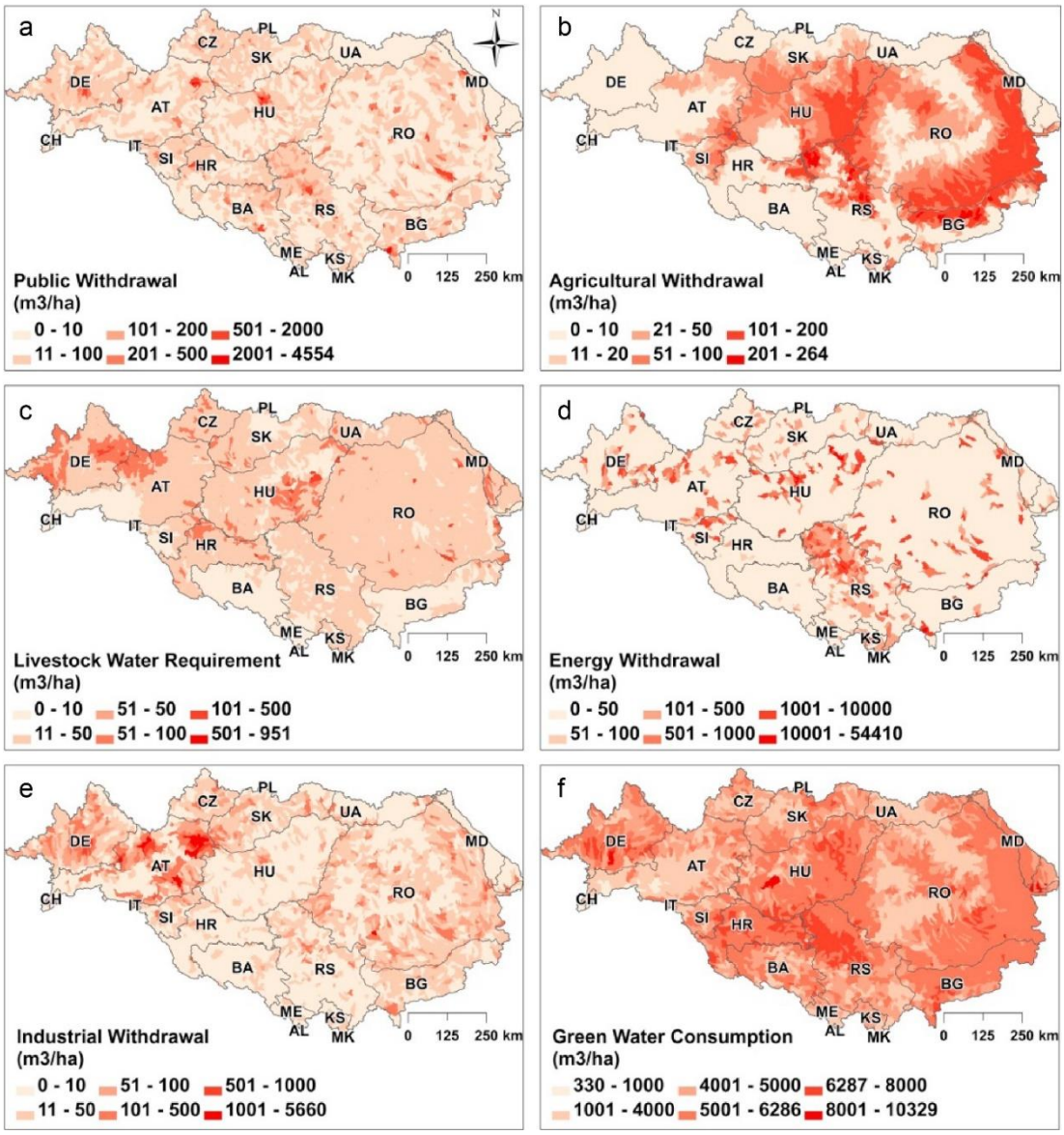

Figure 8 – Water provisioning for different uses in the Danube river basin. From Karabulut et al., 2016 (http://dx.doi.org/10.1016/j.ecoser.2015.08.002) under CC BY NC ND license

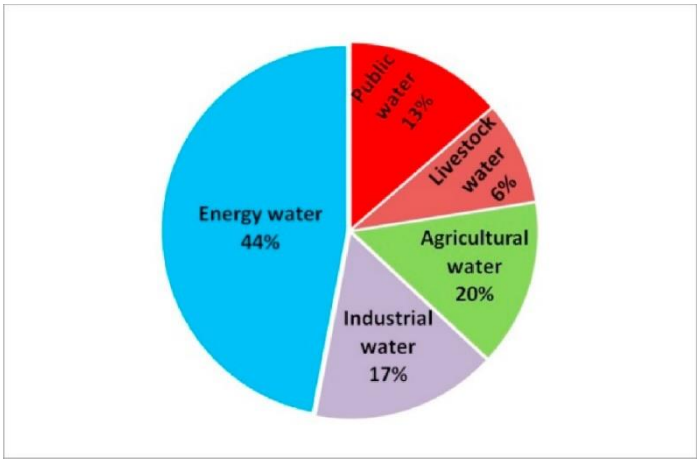

Figure 9 – Share of demand among the different uses in the Danube river basin. From Karabulut et al., 2016 (http://dx.doi.org/10.1016/j.ecoser.2015.08.002) under CC BY NC ND license

2.4 Climate scenarios and implications for water resources

Climate change is expected to significantly affect the water cycle in the Danube. Climate models lead us to expect a general increase in temperature with increasing precipitations in the north of the basin, less precipitations in the south (possibly variations in the order of 70 mm/year), and a narrow, less impacted, transition zone (Pistocchi et al., 2015). Mean annual temperatures could go up by 5°C, especially in the south-east. Most model projections seem to agree on a decrease in the number of days per year with precipitation >0.1 mm (by about 10% in the southern and eastern Danube basin) (*ibid.*) and an increase in the number of days with precipitation above 20 mm (*ibid.*). This suggests that the hydrological cycle might experience more or longer dry periods and more intense precipitation events.

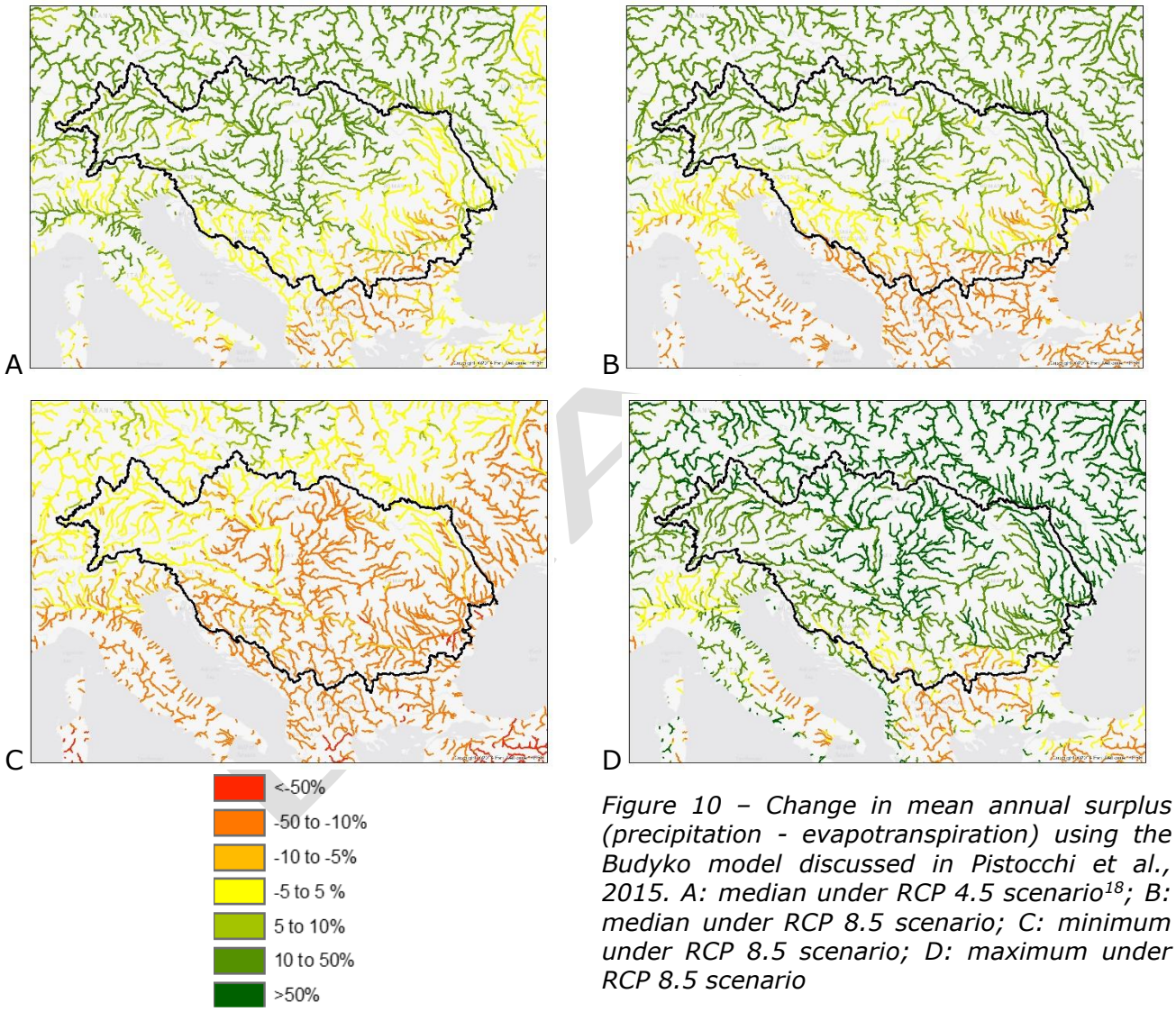

Figure 10 – Change in mean annual surplus (precipitation - evapotranspiration) using the Budyko model discussed in Pistocchi et al., 2015. A: median under RCP 4.5 scenario[18]; B: median under RCP 8.5 scenario; C: minimum under RCP 8.5 scenario; D: maximum under RCP 8.5 scenario

Observed river water temperature increases in the Tisza and Danube rivers between 1950 and 2010 and observations that the period of ice formation on the Danube in Hungary has shortened from the whole winter at the end of the XIXth century, to only a part of the month of January around year 2000 confirm these general trends. There are also

[18] RCP=Representative concentration pathway. RCP 4.5 represents a moderate change of climate due to reduction of greenhouse gas emissions; RCP 8.5 represents a more severe climate change with lesser reduction of emissions. See Pistocchi et al., 2015, and Bisselink et al., 2018, for additional details.

suggestions that soil moisture could follow a decreasing trend over the XXth century (Pistocchi et al., 2015).

The estimates of evapotranspiration presented in Pistocchi et al., 2015 can be interpreted in terms of changes in mean annual water surplus, i.e. precipitation in excess of evapotranspiration, across the river network (*Figure 10*). Usually, climate projections indicate an increase in annual water surplus, except in the southernmost edge of the river basin (*Figure 10* A, B, D), implying less water availability for economic uses there. However, the most pessimistic climate scenarios predict significantly lower water availability for most of the Danube (*Figure 10* C).

This analysis is confirmed by a more recent and comprehensive simulation of water resources in the Danube considering projections of land use and water demand under two climate change scenarios, one based on an increase in mean global air temperature of 2°C and one corresponding to the IPCC RCP 8.5 scenario (Bisselink et al., 2018). In these simulations, while most of the Danube is projected to have higher average streamflow during winter (December-February), the picture is unclear in the other seasons, indicating that an increasing scarcity of water resources may not be excluded (*Figure 13*). Another conclusion of this work is that the impact of change in land use and water demand on water availability is likely to be very small compared to that of climate change in the Danube region. The analysis highlights that climate change can be expected to reduce water availability and increase water stress for the eastern and southern part of the river basin, particularly during summer.

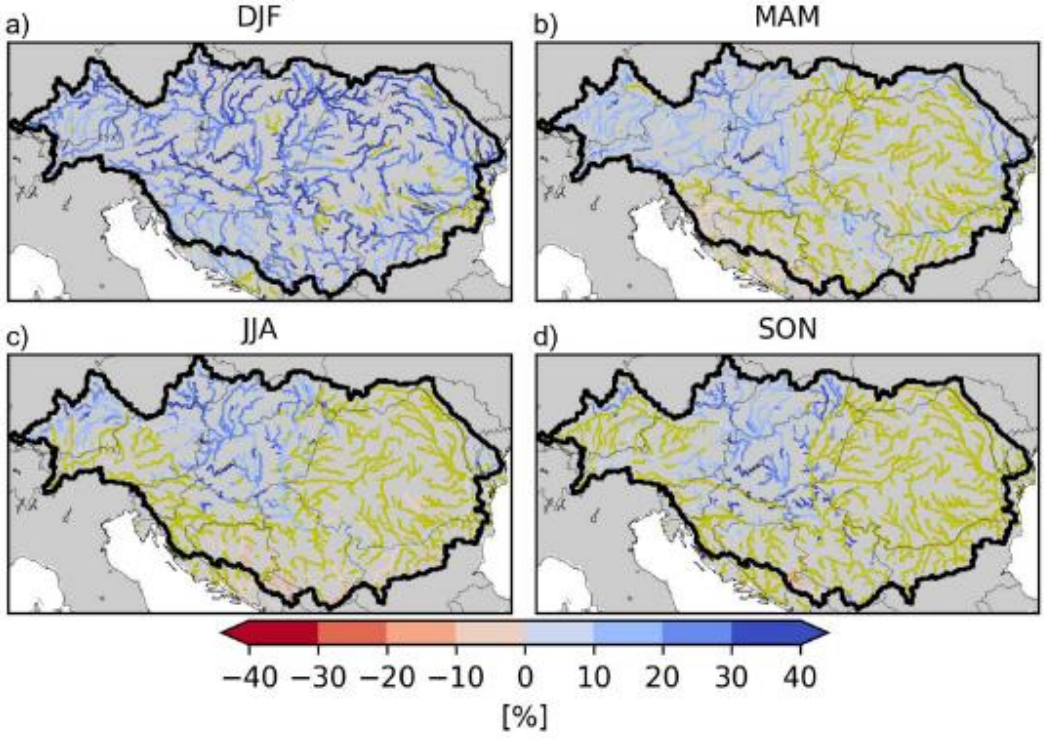

Figure 11 - Impact of 2 degree climate change on mean seasonal streamflow, as compared to the 1981-2010 climate. The green colour indicates rivers where the uncertainty in the results is large. From Bisselink et al., 2018, reused under Decision 2011/833/EU.

3. River basin management and policy making in the Danube region

3.1 Policy and regulatory basis

The **Danube River Protection Convention**[19] is the legal instrument regulating the cooperation of the contracting parties on the management of waters in the Danube River Basin (DRB). It involves 15 parties, including the European Union (through the European Commission) and its executive body - the International Commission for the Protection of the Danube River (ICPDR)[20] - in charge of the Danube River Basin Management Plan (DRBMP[21]) and of the Danube Flood Risk Management Plan (DFRMP). These plans must respect the European Water Framework Directive (WFD, 60/2000/EC) and the Floods Directive (FD, 60/2007/EC).

The DRMBP is organized at three levels: a "roof level" (part A) providing an overview at the scale of the whole basin, and national/sub-national levels (parts B and C) addressing specific issues of local interest and implementing in practice the measures agreed-upon at the "roof level". Part A of the plan (hereinafter simply named the DRBMP) concerns the 61 surface water bodies identified on the Danube river, the 699 surface water bodies of the tributaries (with a catchment area of more than 4000 km2), 6 lakes, 6 transitional and 5 coastal water bodies, and the 11 transboundary groundwater bodies of basin-wide importance.

Within the Danube river basin, the basin of the large Sava tributary is managed under the coordination of the International Sava River Basin Commission (ISRBC)[22] in the context of the Framework Agreement on the Sava River Basin (FASRB) among the riparian countries of Slovenia, Bosnia-Herzegovina, Croatia and Serbia.

3.2 Status of water bodies

About 40% of the length of the Danube basin streams is designated as *heavily modified water bodies* and 3% as artificial. 69% of the Danube river alone is heavily modified, and similar figures apply to major tributaries (Sava, Prut, Olt and Tisza). The **ecological status** (or potential) of rivers is unknown for almost 10% of the stream network length; it is good or above for only about a quarter of the length, and less than good in the other cases. Good ecological status is usually found in the Carpathians, Dinarides (Sava and tributaries) and Alps (mainly in tributaries Mur, Drau, Lech and Isar). The judgments on the ecological status are still not completely harmonized due to incomplete data or methods not fully compliant with the WFD in some countries.

The **chemical status** is not good in about 20% of the total length and, in water bodies representing 18% of the total length, the environmental quality standards for mercury in biota are not met (no information for the rest). Problem areas are in the Danube upstream of Ulm, from Serbia to the junction with the Danube-Black Sea canal in Romania, in most Czech tributaries, throughout the Tisza basin and in the lower Sava.

The **status of groundwater bodies** of transboundary importance is generally good, with some groundwater bodies at risk of poor status with caveats due to significant heterogeneities in aquifer conditions or to knowledge gaps.

3.3 Significant Water Management Issues

The DRBMP addresses nutrient, organic and hazardous chemical pollution and hydromorphological alterations.

[19] https://www.icpdr.org/main/icpdr/danube-river-protection-convention
[20] https://www.icpdr.org/
[21] The documents of the DRBMP are accessible at https://www.icpdr.org/main/activities-projects/river-basin-management
[22] http://www.savacommission.org/

Organic pollution from point sources

Organic pollution results primarily from discharges of poorly treated or untreated wastewater. Collected, untreated wastewater represents 64% of the total biochemical oxygen demand (BOD) discharge in the Danube river basin[23]. These situations occur predominantly in Serbia (more than 60% of the load), and in sizable proportions in Slovenia, Croatia, Bosnia-Herzegovina, Montenegro, Romania and Bulgaria. While Ukraine and Moldova do not treat most of their wastewater (>70% and >80% respectively), they also don't collect it. The contributions to BOD discharge from Germany, Austria, the Czech Republic, Slovakia and Hungary seem to be marginal as virtually 100% of their wastewater is treated. When wastewater is collected, the only possible solution is wastewater treatment at the end of the pipe which poses issues with investment, operation and maintenance costs and expertise required.

The organic pollution load from industry[24] adds in the order of 10% to the urban wastewater pollution, and almost half of it comes from Austria, mainly by the waste and industrial waste water management sector. Most of the rest comes from Romania, Slovakia and Germany in approximately equal shares (mostly from chemical and wood and paper industries), followed by Hungary and Bulgaria. All other countries have much smaller contributions.

Nutrients from point and diffuse sources

In the case of nitrogen, diffuse emissions dominate (>80%), while for phosphorus the share is approximately 2/3, with 1/3 from urban wastewater. Atmospheric deposition is only significant for nitrogen, and comparable with industrial emissions, but still much less than urban waste water. Urban runoff accounts for a bit more than 10% of diffuse emissions for nitrogen, and almost 30% for phosphorus. Table 1 summarizes the contributions of point and diffuse sources to nutrient pollution in the DRB.

Sources	**Total N (tonnes/year)**	**Total P (tonnes/year)**
Urban waste water	88081	12402
Industry	7324	224
Diffuse emissions	497352	25555
Atmospheric Deposition	12309	301

Table 1 – sources of nutrient pollution in the DRB (data from ICPDR, 2015).

With reference to **urban wastewater**, Slovenia, Croatia, Bosnia-Herzegovina, Montenegro and Serbia contribute unit loads of nitrogen (tonnes/year per population equivalent) 50% to 100% higher than the other Danube countries, and for phosphorus about 2 to 4 times those of the other countries. In absolute terms, nitrogen emissions are largest in Romania and Serbia (about 20% each), followed by Germany (about 15%), Austria and Hungary (about 10% each). For phosphorus, Romania and Serbia account for almost half of the total (20% and 27% respectively). In general Lower Danube countries account for comparatively higher shares and Germany and Austria for lower shares, reflecting the different levels of treatment (especially tertiary treatment).

For **rural diffuse emissions**, nitrogen unit contributions from Germany (>15 kg/ha per year) are significantly higher than for Slovenia (> 10 kg/ha per year), Austria, Czech

[23] ICPDR, 2015, Table 3 and Figure 8.
[24] ICPDR, 2015, refers to emissions from the industrial plants reporting to the European Pollutoin Release and Transfer Register (E-PRTR), covering larger facilities of selected sectors. The picture may therefore be incomplete and underestimate the total load, as smaller facilities and facilities in non-covered countries are not counted.

Republic, Slovakia and Croatia (in the range 5-10 kg/ha per year). The other countries have contributions per hectare of about 5 kg/year or less. The relative entity of emissions is similar when referred to phosphorus.

Hazardous substances from point and diffuse sources

Pollution from hazardous substances is still wrapped in considerable uncertainty due to significant knowledge gaps. For 33 chemicals or groups of chemicals reported in the European Pollution Release and Transfer Register (E-PRTR) it is possible to track emissions from the different industrial activities (Annex 4 of the DRBMP[25]). For the priority substances of Directive 2013/39/EU, the EU Danube countries have completed or are developing inventories of emissions.

Hydromorphological alterations

The DRBMP relies on an extensive knowledge of hydromorphological alterations in the river basin based on morphology (e.g. river depth and width variation), river continuity (presence of barriers) and hydrology (e.g. abstractions) and on an analysis of the degree of connection of floodplains and wetlands with the stream network. Only about 10-45% of it is classified as near natural or slightly altered (depending on the countries).

Barriers are mostly hydropower generation dams, followed by flood protection and water supply. Few, particularly in Hungary and Romania, are associated with navigation. A relatively large number of barriers are of unknown origin in Germany and Austria. More than a half of the barriers are not passable by fish. The Iron Gates (RS, RO), Gabcikovo reservoir (SK) and dam chains in Austria and Bavaria are the main habitat discontinuities in the Danube.

The DRBMP devotes particular attention to the connection of floodplains and wetlands with the main river, considering that less than 19% of the XIXth century floodplains are still functional. About 70,000 ha of wetlands and floodplains with a potential for reconnection exist in Romania, followed by Ukraine, Moldova and Serbia with about 43,000, 33,000 and 26,000 ha respectively.

Among hydrological alterations, hydropeaking, i.e. the release of water pulses to increase hydroelectric power production at hydroelectric dams is reported particularly in Austria and Germany. Oscillations above 1 m/day are also reported in Hungary, Croatia and Montenegro. Impoundments affect approximately 12% of the length of rivers considered, and those corresponding to the main longitudinal discontinuities (Iron Gates, Gabcikovo and the Austrian and Bavarian dam chains) are clearly the most important. The DRBMP identifies 144 abstractions causing significant alterations on the Danube in Germany, Hungary, Slovakia (the Gabcikovo bypass canal) and Bulgaria. Significant abstractions on tributaries are also identified in Austria and Romania. The main reasons for these abstractions are hydropower and, less frequently, irrigation, while domestic supply and power plant cooling.

The DRBMP identifies 39 future infrastructure projects with a potential to affect the status of water bodies. Many, mostly located on the Danube river itself, relate to navigation, less frequently to flood protection (in Bavaria) and in four cases to hydropower generation (in Montenegro, at the Slovenia-Croatia border and in Ukraine).

3.4 Objectives and measures of the DRBMP

The DRBMP acknowledges that half of the water bodies not yet achieving good status will not achieve it by 2021. In 3% of the cases (along the Iskar and Yantra rivers in Bulgaria, and Olt in Romania) less stringent objectives need to be set anyway. The same applies to some groundwater bodies. It also indicates general measures to address so-called

[25] The Danube River Basin District Management Plan (DRBMP) – Update 2015 https://www.icpdr.org/main/sites/default/files/nodes/documents/drbmp-update2015-annexes.pdf

"Significant Water Management Issues" (SWMIs), i.e.organic, nutrient and chemical pollution, alteration of river continuity, floodplain/wetland connection and flow regime.

Point source pollution from organic matter and nutrients will be addressed through the gradual equipment of human settlements with appropriate wastewater treatment systems. For industrial emissions, "Best Available Techniques" will be applied as far as possible; the reference targets are those set in the European Urban Wastewater Treatment Directive[26] and Industrial Emission Directive [27]

Diffuse pollution from agriculture is expected to decrease thanks to the implementation of the European Nitrates Directive (ND)[28], requiring to reduce nutrient losses, and to the adoption of good agricultural practices, the latter driven by European financial incentives under the Common Agricultural Policy (CAP).

The DRBMP pursues a "mid-term" and a "vision" scenario where urban wastewater is increasingly treated at tertiary level for all plants serving 10,000 population-equivalents (PE) or more. Plants between 2,000 and 10,000 PE should be equipped with secondary treatment and smaller plants should have appropriate decentralized levels of treatment. For nutrients, in addition to adequate wastewater treatment, the "vision" scenario corresponds to sustainable agricultural development (with surpluses of N limited to 25 kg/ha per year except for Germany, with 50 kg/ha/year, erosion control for sloping catchments and the establishment of riparian buffer strips in hilly sub-catchments.

Chemical pollution is by far less understood and remains an area of further investigation. The measures to be implemented are essentially left to the individual Member States in compliance with the European legislation in place. Key areas of action include:

- *Pesticides* –EU Member States must implement national action plans according to the Sustainable Use of Pesticides Directive, and must prescribe integrated pest management (IPM) as the standard practice in agriculture;
- *Application of sewage sludge in agriculture* – Member States must comply with criteria, standards and restrictions set out in the Sewage Sludge Directive[29];
- *Industrial point sources* - besides application of the Best Available Techniques (BAT) for nutrients and organic pollution, facilities are subject to the Industrial Accidents (Seveso)[30] and Mining Waste[31] Directives where applicable;
- *Urban point sources* - for some chemicals, implementing the Urban Wastewater Treatment Directive may abate pollution significantly, although many other chemicals would require a tertiary or more stringent level of treatment.

The DRBMP has also prioritized stream barriers for the restoration of river connectivity for fish migration. Besides taking stock of measures necessary to address morphological alterations at various scales, it highlights the need to reconnect wetlands and floodplains larger than 500 ha to the river whenever possible as a measure of Danube-wide importance. For what concerns the alteration of flow regimes, the plan notes that measures have been included in river basin management plans at country level, acknowledging that these measures are expected to yield Danube-wide benefits.

4. Scenarios

In order to explore and understand the implications of possible societal, political and economic developments in the Danube, we designed four possible, albeit extreme,

[26] http://ec.europa.eu/environment/water/water-urbanwaste/index_en.html
[27] http://ec.europa.eu/environment/industry/stationary/ied/legislation.htm
[28] http://ec.europa.eu/environment/water/water-nitrates/index_en.html
[29] http://ec.europa.eu/environment/waste/sludge/
[30] http://ec.europa.eu/environment/seveso/
[31] http://ec.europa.eu/environment/waste/mining/index.htm

socioeconomic and political scenarios[32] with a time horizon of 2040, a roughly 25 year (one generation) perspective. Under these scenarios, we tried to identify emerging challenges for the management of the river basin.

How different were things 25 years ago? To get a sense of this time perspective, let's recall how different things were in 1992. The Soviet Union had collapsed recently and the internet was making its debut. The British pound and the Italian lira were expelled from the European Exchange Rate Mechanism. The Danube river basin was home to a very different geopolitical set up from today. In 1992, Yugoslavia ceased to exist and Czechoslovakia still existed. The Yugoslav wars and the Kosovo war a few years later redefined countries and borders as we know them today. While China had embarked on its industrialisation and had started opening to the world, Hong Kong was still British (until 1997). Furthermore, the 1990s represented continuing social liberalization in most countries. Finally, the European Union itself was being born (the Maastricht Treaty was signed in 1992). On the technology front, personal computers started to become popular and Microsoft launched Windows 3.1. Apple produced its first laptop: the MacIntosh Power Book, a clunky grey object with very little autonomy compared to today's laptops. Mobile phones were on the horizon, but few people used one. Internet was not yet present in everyday life and emails were not known to the public.

The four scenarios were created following a classic deductive scenario making methodology (the "2-axes method"[33]). After extensive brainstorming and based on previous experience from work in the Danube river basin, we selected 'Decision-making context' and 'Intervention mode' as the two axes to build the scenario logic:

'Decision-making context' relates to the overarching driver in the political-economic world and to the cooperation level. It ranges from 'Euro-cooperation' to 'Local perspectives.'

- Under **'Euro-cooperation'** all countries in the Danube river basin would collaborate extensively, trying to find common, mutually beneficial solutions. In this context, countries would be ready to make concessions for the greater good of the river basin.
- Under **'Local perspectives'** countries in the Danube region would focus on themselves and compete with each other, each trying to maximise their own development, with limited regional or European cooperation.

'Intervention mode' relates to the perspective taken to deal with investments. This axis does not infer anything regarding the overall level of investment, which can be similar at both ends, but the way investments are made differs. 'Intervention mode' ranges from 'Large scale infrastructure' to 'Targeted interventions.'

- **'Large scale infrastructure'** means that countries and companies concentrate their investments on few large scale projects that can be trans-national.
- **'Targeted interventions'** means that investment is carried out in many small scale and local projects.

Figure 14 illustrates the scenario logics, which led to a partition into four *extreme scenarios* whose proposed titles are displayed. Albeit deliberately extreme, these scenarios represent possible endpoints (by 2040) of trajectories starting from today's conditions. Their characteristics are briefly outlined below.

[32] The scenarios used for this work were initially developed in the MSc thesis of Mr Augustin Gallot-Lavallee, *The use of scenarios in water futures planning applied to the Danube River Basin*, Centre for Environmental Policy, Faculty of Natural Sciences, Imperial College London, 2016.
[33] http://forlearn.jrc.ec.europa.eu/guide/2_scoping/meth_scenario.htm

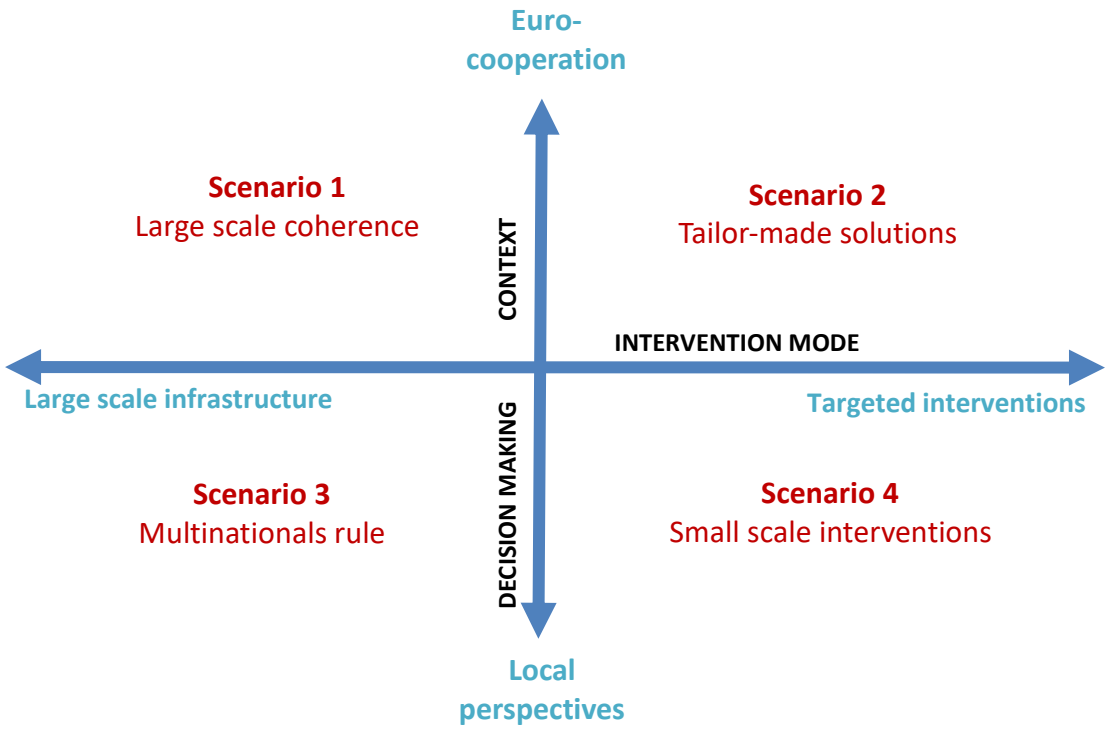

Figure 12 - axes used for the definition of the scenarios

Scenario 1 "Large scale coherence" corresponds to a good level of technology and infrastructure, but carries risks of low societal engagement. All regions are on a level playing field but competition between centre and peripheries may still exist. It is a scenario with strong reliance on technology, large infrastructure leaning towards "grey" rather than "green", strong urbanization and an accelerated depopulation of rural areas.

Scenario 2 "Tailor made solutions" may cater for less technology and infrastructure, but better societal engagement. Collaboration among regions and smart specialization may unroll but do not emerge automatically. It is a scenario which relies on behaviours, smaller and greener infrastructure, with a much higher degree of rural development.

Scenario 3 "Multinationals rule" reveals an emergence of the supply chains as a key organizer of the economy, with weakened role of the government and society. Supply chains trigger tug-of-war competition among cities, regions and countries. Technology and infrastructure are easily mobilized by large corporations. National governments are de facto conditioned by the rules imposed by the global supply chains. Cities form and dissolve as supply chain nodes and rural areas are *de facto* abandoned or subject to intensive, industrialized agriculture.

Scenario 4 "Small scale interventions" shows a lower degree of globalization, with nation-states turning more inward and a slowly developing economy. In this scenario, technology and infrastructure are less developed, but society is more responsive although not necessarily more capable to drive decisions. It is a scenario of nation-states in a multipolar world, with urban and rural development limited by the capacity, wealth and attractiveness of the different countries and regions.

The four scenarios reflect different trajectories along the following dimensions:
- Type of financing (preference for large or small projects);

- Economic redistribution and solidarity;
- National governance, government efficiency;
- Community engagement;
- Capacity, knowledge, innovation;
- Entrepreneurial initiative; and
- Societal responsiveness, awareness, participation.

In the following sub-sections, we discuss each scenario more in depth, examine inherent challenges and elaborate on the required preparedness. The scenarios were discussed with a group of experts from the region, convened at a workshop organized on purpose[34], which helped refining the initial assumptions and the characterization of trajectories under each scenario.

4.1 Scenario 1 - Large scale coherence

In this scenario, the European Union does not just remain a single market, but strengthens political, social and economic integration significantly. It represents a further development of "Scenario 5: Doing much more together" in the European Commission's White Paper on the Future of Europe[35].

The political centre ("Brussels") has a capacity to plan and fund directly investments at a large scale across Europe. Member States devolve significant powers to the Union. Signals in the direction of Euro-cooperation can be seen in the pleas for a stronger Union e.g. in European Commission President Juncker's State of the Union Address 2017[36], or French President Macron's "Discours de la Sorbonne"[37] as well as in initiatives such as the looming intensified cooperation between Germany and France, potentially open to other EU Member States[38].

A new EU treaty has been adopted, and social protection accrues to EU competences - a basic social protection package is extended to all EU citizens. The EU budget gains a large level of autonomy thanks to new "own resources," reducing the traditional bargaining among Member States around the multi-annual financial perspectives. Concerns linked to the remaining divergences among Member States lead to a reinforcement of the structural funds and redistribution mechanisms, and strong cooperation fostered by the EU helps lower Danube countries catch up with upper Danube peers. Efforts are made to reduce unemployment and inequality. Controlled and managed immigration from non-EU countries mitigates a rapidly ageing population.

Coordination makes the EU stronger on the international scene: it has put its own house in order and has reduced its dependency on raw materials and energy sources from other areas of the world. Thanks to the EU's internal strength and coherence, its diplomacy is strong and pushes its core values on global issues. Nationalism has subsided and people feel more European, live in big cities and benefit from an overall flourishing economy. EU level coordination of investments optimizes the development of large scale infrastructure, many of them connected to the Trans-European Transport Networks (TEN-T)[39], renewable energy generation and its efficient distribution across the EU, in a fully achieved Energy

[34] See, for further details on the workshop, Bontoux et al., 2018. http://publications.jrc.ec.europa.eu/repository/bitstream/JRC114803/jrc114803_danube_workshop_flash_report_online_final.pdf

[35] COM(2017)2025: https://ec.europa.eu/commission/sites/beta-political/files/white_paper_on_the_future_of_europe_en.pdf

[36] http://europa.eu/rapid/press-release_SPEECH-17-3165_en.htm

[37] http://www.elysee.fr/declarations/article/initiative-pour-l-europe-discours-d-emmanuel-macron-pour-une-europe-souveraine-unie-democratique/

[38] See e.g. https://www.ifri.org/sites/default/files/atoms/files/edito_vers_un_nouveau_traite_de_lelysee_avril_2018.pdf

[39] See e.g. http://www.connectingeu.eu/documents/Delivering_TEN_T.pdf

Union[40], with a strong cooperation among countries. Large companies work in publicly funded projects, with high labour and environmental protection standards enforced directly by the EU.

Trajectories

Under this scenario, the socioeconomic environment of the Danube is believed to evolve along the following trajectory:

- Financing (preference for large or small projects): mainly centralized and favoring large projects.
- Economic redistribution and solidarity: there is an efficient mechanism of redistribution across the EU.
- National governance, government efficiency: the central government is strong and efficient.
- Community engagement: local community ties are weak.
- Capacity, knowledge, innovation: overall high capacity and knowledge, concentrated in the "centres" away from "peripheries".
- Entrepreneurial initiative: usually low. The economy is driven by large corporations.
- Societal responsiveness, awareness, participation: usually low.

Challenges

Lower Citizens' commitment to environmental stewardship hinders the effectiveness of measures relying on good behaviors. While the EU is strong internally, its uniform top-down approach can be stifling for diversity and local democracy. Centrally designed solutions are sometimes not optimally adapted to local circumstances. The EU leans towards paternalism and both societal initiative and entrepreneurship are depressed. Local interests cannot be voiced sufficiently, and are *de facto* not protected when not apparently in line with the broad strategies designed at the central level. This may cause deresponsibilization of the citizens and weaken their participation to the stewardship of environmental resources. For instance, technological standards may rise, but measures relying on responsibilization towards correct behaviours may be less successful (e.g., home taps and flushes have high water efficiency standards, but people tend to not take up responsible consumer attitudes, such as water saving).

A more selective agenda is influenced by powerful lobbies, choking bottom-up innovation. A tendency in the centralization and uniformation of decisions, with reduced entrepreneurship, tends to limit the capacity to invent innovative solutions and spread good practices. Moreover, while protecting the immediate well-being of citizens, European policies can be more easily influenced by large and powerful organizations, such as corporations or NGOs, causing a bias towards the values they promote. For instance, energy security and mitigation of climate change may push for actions potentially damaging biodiversity, such as large hydropower schemes particularly in the Western Balkans and other areas with still significant development potential.

In agriculture, competitiveness and food security may weigh more in the EU agenda than environmental sustainability, leading to e.g., large investments in irrigation and water reuse schemes coping with climate change, but little improvement on the side of diffuse pollution and loss of biodiversity despite pleas for efficient fertilization and integrated pest management. This may be of concern particularly for the Lower Danube basin, where agricultural land still receives relatively low nutrient and pesticide inputs but has prospects of expanding business and is a key European reserve. An energy and ecological transition may be more difficult under a centralized strategy where investments are planned on

[40] https://ec.europa.eu/commission/priorities/energy-union-and-climate_en

schemes favouring large plants over distributed generation, and maintaining a role for gas supplies instead of pushing for bold decarbonization[41].

Low priority is given to measures yielding community benefits at local scale. Actions that need local political endorsement pushed by citizens' support are less likely to be taken up. In the implementation of the Water Framework Directive, for instance, while pollution control at point sources is effectively enacted and pollution improves broadly insofar as it depends on technical measures, hydromorphological restoration also leading to local benefits (e.g. amenity and recreation) is often downplayed as a lower priority *vis-à-vis* other investments.

Infrastructure is well managed in the "centre" but "peripheries" are at risk. The situation is exacerbated by the drain of competences from the "peripheries" to the "centre," which further reduces the capacity of local communities to define and voice their own agendas. This may cause difficulties in the operation and maintenance of complex infrastructure especially in some regions, uncovering lack of robustness of technical large scale solutions. For instance, under this scenario it would be possible to build large, cutting-edge wastewater treatment schemes, but some communities might fall short of properly managing them, or at least of reaping the additional benefits besides sanitation.

4.2 Scenario 2 - Tailor-made solutions

In this scenario we assume that the European Union becomes stronger (as in the previous scenario), but its mode of action is less top-down (more subsidiarity).

Regions and cities gain autonomy and have more responsibility for the implementation of strategies and investments. It is a "Europe of regions," where nation-states give in to territorial associations, sharing not only language or pre-EU history, but also economic and environmental interests and sometimes culture and local governance. In this scenario, regional shared agendas (*gesellschaft*) influence a feeling of regional community (*gemeinschaft*) and, *vice versa*, regional identities more rooted in geography than in national belonging stimulate the design of shared agendas.

In fact, Europe has had a strong regional or urban basis for most of its history. The Roman Empire was essentially an area of self-governed cities under an umbrella authority ensuring uniformity of the legal base, military protection and the security and effectiveness of trade and supplies (Price and Thonemann, 2010). In the following centuries, cities and regions engaged in harsh conflicts (e.g. the fights among medieval Italian *Comuni*) and in alliances (e.g. the Hanseatic cities or the United Provinces of the Netherlands). This occurred sometimes under overarching authorities (such as the Habsburg rule in the upper Danube until World War I), but always on a regional basis until the emergence of nation-states in the XIXth century.

More recently, the strengthening of European ties has unleashed aspirations for regional autonomy throughout Europe – Scotland, Flanders and Catalonia being prominent examples. These and other regions have sought self-government and autonomy from the national government, while never questioning their European Union membership and, on the contrary, supporting a strengthened role for the EU (e.g. in defense and foreign policy).

In this scenario, the EU acts as an overarching political body guaranteeing homogeneous and safe conditions to develop interaction among regions ("incubator"). Some regions have already experienced this situation in the past years, including Northern Ireland and the Republic of Ireland, and Austria's Land Tirol and Italy's Südtirol.

The EU remains a single integrated market with a redistribution of funds between richer and poorer regions so as to ensure more uniformity in the conditions of citizenship.

[41] As an example of concerned voices over low prioritization of energy and ecological transition in the EU budget, see https://www.euractiv.com/section/energy/opinion/eu-budget-wheres-the-climate-and-environment/

However, investments happen at a local scale, following decisions taken at regional or city level. Reinforced powers of the regional level eventually deflate the nationalist waves across the EU. An EU system is adopted in health care and social security, an area close to the everyday concerns of EU citizens. Tax and pension systems are similar for all EU Member States.

Strong regions may organize a very collaborative local economy, with many innovative small private players acting locally or regionally in an open source spirit. Micro-investment can be fully harnessed and the public sector can still be strong through services. Local economies may stimulate short material loops and local currencies[42]. Coordination at EU level works well thanks to community level instruments and key principles are respected; However, a large degree of autonomy means that policies are implemented with flexibility using specific solutions adapted to local circumstances and success or failure depend very much on local conditions. Some regions are likely to become more successful than others, with the possibility of economic migration across regions and a tendency for large cities in successful regions to keep growing. More marginal and weaker regions may undergo brain drain and loss of capacity and competence along with emigration to the advantage of more attractive regions.

EU diplomacy on global issues pushes its core values but the EU's more circular economy and shorter material loops have decreased its clout in international trade.

Trajectories

Under this scenario, the socioeconomic environment of the Danube is imagined to evolve along the following trajectory:

- Financing (preference for large or small projects): financing is managed regionally and favors small scale projects.
- Economic redistribution and solidarity: efficient redistribution and solidarity mechanisms are in place.
- National governance, government efficiency: the central government is efficient but has limited responsibility; regional governments are efficient.
- Community engagement: generally high.
- Capacity, knowledge, innovation: generally high and distributed in all regions.
- Entrepreneurial initiative: high.
- Societal responsiveness, awareness, participation: high.

Challenges

Difficulties in addressing basin-wide priorities. While ensuring uniformity of internal rules and a common foreign policy, the context is not automatically favourable to regional coordination as regions are empowered to address local problems. This may reflect negatively in the targeting of real basin-wide priorities, with the better-off regions achieving excellent environmental standards and those less well-off still struggling. Some regions would be able to invest even in lower-priority actions, while others might fall short of addressing even top issues due to lack of capacity or funding. Long-range environmental issues (which are ubiquitous in Danube river basin management) requiring a large-scale coordinated approach, especially regarding flood control, pollution and fish ecology, may not be effectively developed by regions without a strong overarching coordination.

Duplication of efforts and races to the bottom. Lack of coordination may also increase the potential for competition among regions and duplication of efforts. The degree to which regions push environmental protection versus short-term economic activities may be expected to vary in spite of common EU standards and political decision makers in regions will often come to terms with the need to ensure prosperity in the short run at the expenses

[42] Such as the "Bristol pound" contributing to this city being awarded the title of Europe's green capital in 2015. See https://en.wikipedia.or?g/wiki/Bristol_Pound

of sustainability in the long run in order to secure votes. Some regions may lower environmental standards in the hope to attract investments.

Solutions too small for large problems. Investments are predominantly local, small, lacking scale. Therefore, it may be difficult to trigger disruptive developments, making Europe dependent on foreign innovation leaders. Projects requiring massive investments, and sometimes guarantees such as public finance-backed reinsurance[43], may become difficult to implement or even impractical. In the water management sector, for instance, this may result in difficulties to develop or upgrade wastewater treatment in large agglomerations, to create large wastewater reuse projects and irrigation schemes, to adapt to climate change by strongly expanding water storage capacity and to engage in river restoration projects affecting large parts of the stream network.

4.3 Scenario 3 - Multinationals rule

In this scenario we assume that the EU gives up on the process of an ever closer political union but wishes to preserve the Single Market. While the latter is essential to preserve Europe's economic relevance in a globalized world, the EU Member States have separate and sometimes diverging or even conflicting agendas. The issues on which the EU maintains an effective action relate mainly to standardization and ensuring uniform rules across the Single Market. This corresponds to an elaboration upon "*Scenario 2: Nothing but the Single Market*" in the European Commission's White Paper on the Future of Europe[44]. The difficulties in agreeing on a bolder common political project among EU democracies after the 2007 crisis, coupled to the emergence of sovereignist political movements across the EU may be indicative of this scenario.

With increased policy competences under a new subsidiarity regime, Member States may be lobbied by multinational corporations. These corporations can also influence the public through social (and other) media. Global supply chains are the main organizing structure of the economy: multinationals promote the development of infrastructure (e.g., for the transport and distribution of energy, telecommunications, large scale freight and industrial ports, inland navigation, high speed trains and hyper-connected megacities) required for a global market of goods and services. Countries, regions and cities struggle and compete to be part of the "supply chain world", upon which their success critically depends (Khanna, 2016). While the stronger and more knowledge-based EU economies remain core nodes and house their own multinationals, the less advanced economies depend on direct foreign investment[45] and are more exposed to the impact of an increasing volatility of the assets (*ibid*.).

While economically stronger countries maintain decent standards in public services, education and welfare, poorer countries struggle. There, multinational corporations impose the conditions required by their operations and supply chains. Besides infrastructure, they support public services and education in so far as to ensure labour productivity and engage in social protection to control social anger and opposition to the liberal economic order[46].

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[43] A case in point is the Thames Tideway Supersewer (https://www.tideway.london) designed to reduce combined sewer overflows in the river across London. Its exceptionally high costs and complexity of the undertaking would make low-probability risks non-reinsurable without a public guarantee.

[44] https://ec.europa.eu/commission/white-paper-future-europe_en

[45] A significant debate in this respect has risen around the plan for a Belgrade-Budapest high speed railway, to be developed through Chinese investments. See e.g. https://www.forbes.com/sites/wadeshepard/2017/02/25/another-silk-road-fiasco-chinas-belgrade-to-budapest-high-speed-rail-line-is-probed-by-brussels/#2a1cfa123c00 and https://www.forbes.com/sites/salvatorebabones/2017/11/27/chinas-bid-to-buy-eastern-europe-on-the-cheap-the-161-group/#4ba3d6b83467.

[46] These are the grounds of Bismarck's *Staatssozialismus* in end-XIX Century Germany, considered as the origin of the modern welfare state. See e.g. https://en.wikipedia.org/wiki/State_Socialism_(Germany)

Fiscal dumping enacted by poorer countries to attract the supply chains triggers a vicious circle putting public services under pressure. Industrial automation leads to increasing losses of low-qualified jobs and further pushes migration towards richer countries and larger, more connected cities.

While the EU's own budget is reduced compared to today, the European Investment Bank (EIB) and other European financial institutions support investments in large infrastructure. This opens opportunities mostly for large companies, often resorting to local subcontractors only for less qualified tasks.

The Common Agricultural Policy (CAP) is also downsized and agriculture turns ever more into a market-based business strongly influenced by seed, agrochemical and food conglomerates. With climate change affecting water availability, irrigation water turns into an expensive commodity supplied by large industrial companies. International investors grab significant swaths of the best crop lands to engage in intensive production, particularly in the Eastern plains of the region, where cereal crops for food and fodder are very profitable. Small farmers cannot compete with large agribusiness, and many small farmland owners are forced to sell their property and move to the city to make their living.

The EU remains a key market for the global economy with an overall high demand for goods and services, but does not have a strong geopolitical influence. The Danube remains at the forefront of external European borders, while the process of enlargement is virtually stopped and the Western Balkans remain outside the EU. Migration pressure from the Middle East, Africa and Central Asia towards Upper Danube countries is still strong and the lower Danube is a transit region. Individual countries enact their own migration policies, thus fuelling political tensions among EU countries.

Trajectories

Under this scenario, the socioeconomic environment of the Danube is imagined to evolve along the following trajectory:

- Financing (preference for large or small projects): multinationals and investment banks are the main actors, and favor large scale investments instrumental to the global supply chains.
- Economic redistribution and solidarity: generally low.
- National governance, government efficiency: generally weak.
- Community engagement: generally low.
- Capacity, knowledge, innovation: concentrated in nodes of the global supply chains.
- Entrepreneurial initiative: generally low.
- Societal responsiveness, awareness, participation: generally low.

Challenges

A world of grey infrastructure? In this scenario, the game is led essentially by large companies. This generally implies that technologies and infrastructure are well developed and the water sector is highly industrialized. Water management relies on engineering measures while nature-based solutions exploiting ecosystem services are less extensively exploited because they yield no or limited revenues to investors. For example, artificial flood defences tend to be preferred to floodplain reconnection or large industrial wastewater treatment plants are preferred to natural treatment systems. Technologies enable pollution reduction and resource efficiency improvements, but they also induce rebound effects as they promote increased use of the same resources. All aspects of water and environmental management that rely on people's awareness of good practices (e.g. water-saving household behaviour or not disposing pharmaceuticals down the drain) are difficult to be brought forward. Investments are targeted towards maximizing corporate revenues and not necessarily towards applying the most cost-effective solutions for the environment. For example, engineered flood defences might be oversized and not designed to minimize impacts on floodplains and vegetation. In other cases, centralized

wastewater treatment with large development of sewage networks would always take precedence over decentralized systems and nature-based solutions. Moreover, while the contracts for the construction of large facilities may be profitable for large companies, their maintenance and operation may be much less profitable, which can turn them into expensive "white elephant" installations.

Hard times for nature? Local communities become less relevant due to the break down of the relationship between cities and their countryside. While city centres improve and house the headquarters of the economy, peripheries and the hinterland fall prey to urban decay, with less and worse public services. Ecological protection and restoration are only implemented where they serve the real estate, tourism or recreation industries. However, people continue to aspire to a "green" lifestyle. Therefore, the demand for nature conservation is still strong, but from a much more utilitarian perspective. Ecosystem services such as recreation in natural water bodies tend to either be marketed (e.g. by privatizing riparian land and access to lakes and beaches) or surrogated by artificial landscapes (e.g. green urban areas or landscaped swimming pools). The lack of investment in multifunctional water management solutions such as public green infrastructure in cities deepens the hiatus between human communities and water ecosystems. Ecological conditions improve significantly in marginal and mountainous areas of the Lower Danube where insufficient land productivity hinders investments in large scale farming and land is abandoned[47]. Exodus from poorer regions may allow the countryside to recover a certain degree of naturalness but forests in the plains of the Lower Danube are often turned to productive farmland. Navigation is still important, both for freight and for tourist cruises, which creates a demand for maintenance and development of infrastructure with associated ecological impacts on the Danube river system.

As an illustration, when the competent authorities lack capacity to establish and enforce appropriate permitting conditions for hydropower plants (which can apply in poorer countries, *a fortiori* when these compete to attract investments), they may be unable to impose adequate mitigation and compensation measures during administrative procedures such as the Environmental Impact Assessment (EIA) of projects.

Water privatization? The management of the water cycle, from supply to wastewater treatment, is operated under full cost recovery, explicitly excluding state intervention and limiting the government's action to regulation. This leads to a takeover of the water services by large companies, weakening the democratic control of water management (as for how tariffs are calculated, how vulnerable groups are protected, etc) in those countries where the government does not possess adequate technical expertise and where politics are more permeable to corruption. In principle, national governments must ensure control of the management of public services. However, companies may have the capacity to make their interests prevail: in this case, contrary to the assumptions of neo-liberal economic thinking, tariffs tend to increase, the quality and coverage of services tends to decrease, especially where the quality of institutions is lower and government corruption is higher. Under this scenario, water metering, pricing and trading are the most common tools used to promote water use efficiency under resource constraints. Controlling and charging for water use may lead to significant reductions in industrial, energy and public water use. However, experience has shown rebound effects (water uses tend to increase despite higher use efficiency, e.g. in irrigation: Li and Zhao 2018).

Weaker citizens' stewardship for water. Public perceptions of water as a natural resource, public service or commodity may also have an impact on behaviours, particularly regarding water consumption and saving. The EU Water Framework Directive (2000/60/EC), in its Article 9, requires that Member States ensure the implementation of

[47] An extreme, but informative example of what could happen to ecosystems just through land abandonment is the ecological succession in the post-nuclear disaster Chernobyl (Ukraine): wildlife has bounced back to quasi-pristine conditions, although the impacts of radiation on the different populations and ecosystems remain debated. See http://www.bbc.com/earth/story/20160421-the-chernobyl-exclusion-zone-is-arguably-a-nature-reserve.

pricing policies that provide an incentive to use water efficiently. Article 9 also requires cost-recovery (including environmental and resource costs) for water services, taking into account the 'polluter pays' principle. People collaborate less in what is a more competitive and unequal society. Individuals tend to care less for the environment if this does not generate a direct personal benefit. Therefore, public participation and engagement become generally weaker, triggering a vicious circle. Low awareness and proactivity of citizens and communities generates low societal control of policy decisions and low accountability of the decision-makers, which can cause an overall reduction of resources, particularly for environmental management.

Basin-wide priorities slip out of the agenda. The consistent, integrated management of water resources at the river basin scale is no longer in the agenda. The focus is on ensuring water availability to the nodes of the global supply chains that need it as a critical asset for their operation, irrespective of downstream and transboundary impacts.

4.4 Scenario 4 - Small-scale interventions

The previous scenario of continuing and undisturbed globalization has been sometimes judged less likely compared to that of a more multipolar world, with Europe being one of the poles[48]. In this scenario, we imagine European countries as part of a less global world, a European Union weakened by the unleashing of nationalism and Euro-skeptical forces, and political perspectives becoming increasingly national. It is the EU "à la carte"[49], operating more according to the intergovernmental method (direct negotiations among Member States) than the community method (within the Treaties). EU action is reduced to the lowest common denominator. The general trend is of more inward looking perspectives. The weaker EU framework gives space to Member States to negotiate political and commercial agreements with foreign countries[50] bypassing *de facto* the EU level. As a result, the international standing of the EU weakens, and the rapid development of other economies such as India or China gradually dwarves the EU economies.

The consequence of these weakened EU ties is a smaller integrated market and more competition between Member States. A reduced EU clout has also reduced the ability and desire to redistribute funds from rich to poor countries. EU funding is limited to selected initiatives and Member States have a large leeway in deciding how to use them. Large EU scale projects have been practically abandoned.

National and regional governments want to steer industrial development and attract investments from large companies, but also want investments to generate employment locally. Succeeding in this depends essentially on the attractiveness of a country's business environment, including know-how, infrastructure, public services, fiscal and administrative burden and corruption. Moreover, the scale of individual countries may be too small to finance effective research and development and keep the pace of global innovation. While some regions and countries remain strong and compete successfully at global level, many others decline. In the Danube river basin, only a few regions remain successful. This weakens both the private sector and the capacity of governments to resort to debt to finance public investments. In this context, unemployment grows.

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[48] These are the storylines proposed in two reports by the Credit Suisse Research Institute, "Getting over globalization", 2017: http://publications.credit-suisse.com/tasks/render/file/index.cfm?fileid=BCD82CF0-CF9D-A6CB-BF7ED9C29DD02CB1; and "The end of globalization or a more multi-polar world", 2015: http://publications.credit-suisse.com/tasks/render/file/index.cfm?fileid=EE7A6A5D-D9D5-6204-E9E6BB426B47D054

[49] "[…] *A non-uniform method of European integration which allows EU countries to select policies, as if from a menu, and involve themselves fully in those policies. The EU would still have a minimum number of common objectives. However, different countries would integrate at different levels (variable geometry) or at different speeds (multi-speed). Europe 'à la carte' is already a reality with some countries being part of the eurozone and others not."* http://eur-lex.europa.eu/summary/glossary/europe_a_la_carte.html

[50] A looming model of this kind may be seen in the China-Central and Eastern European Countries Cooperation (http://www.china-ceec.org/eng/)

Investors from both rich European countries and from outside Europe grab highly productive land in poorer countries and snatch contracts for public works or concessions for financially attractive public services. Poorer countries and regions cannot support the development of local business. Many companies disappear or reduce their ambitions, while agriculture remains a relatively healthy sector, attracting new employment. There is a mushrooming of micro-enterprises as people try to make a living for themselves. National governments make efforts to favour the procurement of national products. This leads to many market restrictions and breeds unemployment. The brain drain from poor to rich countries reinforces inequalities across the EU. The lower Danube countries see their population decrease. Underfunded social services and national education systems show signs of disruption.

The civil society is generally able to pressure the government, and public participation in national and regional politics is quite broad. The social fabric is resilient: increased poverty and the reinforcement of national identities stimulate local connections. However, solidarity develops more in the poor than in the rich regions. In the former, lifestyles become simpler and there is less consumerism. This does not necessarily stem from higher environmental awareness, which has decreased in poor regions, but green options often prevail as they are more affordable. This is the case, particularly, for urban agriculture and the re-greening of abandoned industrial sites[51]. Also, thanks to new technologies, renewable energies allow access to electricity and are generally developed at the level of small plants. Hydropower, particularly, grows almost exclusively through micro-plants, while larger plants are only operated by the few large enterprises remaining on the market. Large scale technological innovation is on the decline as people and small companies look for cheap small scale solutions.

Trajectories

Under this scenario, the socioeconomic environment of the Danube is imagined to evolve along the following trajectory:

- Financing (preference for large or small projects): national governments manage public expenditure programmes and seek partnerships with foreign investors.
- Economic redistribution and solidarity: national governments strive to keep a redistribution policy but are limited by their spending capacity.
- National governance, government efficiency: varies, depending on countries.
- Community engagement: varies, depending on countries.
- Capacity, knowledge, innovation: varies, depending on countries.
- Entrepreneurial initiative: generally high.
- Societal responsiveness, awareness, participation: varies, depending on countries.

Challenges

The countryside is relatively healthy but urban areas are under pressure. Environmental impacts tend to decrease in less populated regions, where the demand for resources is less concentrated and it is possible to manage waste through nature-based solutions (e.g. constructed wetlands to treat wastewater, or composting of municipal waste). On the contrary, lack of capacity to develop technological solutions and to fund the operation of complex treatment plants hampers waste and wastewater management in large cities, leading to increased environmental degradation.

A prisoner's dilemma: blunt instruments against long-range issues. Resource consumption decreases in general, due to more limited economic activities. In richer regions, local environmental management is still at high standards but there is far less concern for the effects of externalities and the transfer of pollution to other regions, or the

[51]As in the case of post-industrial Detroit - e.g. http://www.miufi.org/america-s-first-urban-agrihood

depletion of resources at global scale. The systematic allocation of resources within a national logic may lead to inefficiencies and lead to overall higher environmental impacts. For example, one country might decide to build a water intake on a river, even if its value added is largely exceeded by the negative impacts on navigation downstream, which could be borne by other countries. Climate change mitigation cannot be effectively pursued. In this scenario, we are facing a kind of prisoner's dilemma[52]: while everyone benefits from the overall good quality of the Danube River, single actors might want to benefit proportionally more to everyone's detriment.

Poverty traps in environmental management. The general closure of national economies, favouring local against international suppliers of services and goods, may reduce the potential for innovation, reduce the scope for economies of scale and take up of good practices. Smaller and poorer countries and regions may find difficulties in investing in environmental services, thus further reducing their attractiveness in a vicious circle. This vicious circle may have ripple effects on richer countries and regions affected by less stable and wealthy neighbours.

[52] See e.g. https://plato.stanford.edu/entries/prisoner-dilemma/

5. Implications of the scenarios for the Danube River Basin Management Plan

Discussion with the experts convened at the workshop, on the implications of the four scenarios, enabled us to identify emerging challenges relevant to water management. The DRBMP rests on measures that can be classified in three broad categories: wastewater treatment, agricultural diffuse pollution, and hydromorphological alterations. In the following table, we summarize the challenges that we identified for the implementation of measures. These challenges are further discussed with reference to each category of measures.

Scenario	**Wastewater treatment**	**Agricultural diffuse pollution**	**Hydromorphological alterations**
1 - Large scale coherence	Large WWTPs too complex to manage locally? Decentralized plants too small for funding?	Lack of enforcement capacity? Rebound effect of high-productivity agriculture ?	Competitive agendas (e.g. hydropower, navigation) limiting restoration only to iconic sites?
2 – Taylor-made solutions	Difficult to finance ambitious advanced treatment plants (e.g. pharmaceuticals) ?	Risk of race to the bottom?	Ambitious projects (e.g. dam removal) difficult to finance?
3 – Multinationals rule	Worsening of scenario 1	Industrialization of agriculture?	Lacking motivation of investors?
4 – Small scale interventions	Worsening of scenario 2	Between scenario 2 and scenario 3	Lack of basin-wide perspective?

Table 2 – Summary of the challenges anticipated for water management under the 4 scenarios.

5.1 Challenges for wastewater treatment: too small, too complex or only for the rich?

Under scenarios favouring small-scale investments, there may be a shortage of investments in sufficiently large plants enabling to tackle emerging issues such as energy and materials recovery or the treatment of hazardous chemicals. On the contrary, scenarios favouring large-scale investments may generate situations where large and complex plants do not match the actual operation capacity available in the different regions. Scenarios 3 and 4 may generate situations where wastewater treatment, in itself an expensive public service, turns unaffordable for the poorest segments of society.

The DRBMP stipulates a stable programme of financing and implementing wastewater treatment. However, the European Court of Auditors[53] has already stressed that the implementation of the Urban Wastewater Treatment Directive proved difficult and slower than planned (see box below). In each of the abovementioned scenarios, there are threats that wastewater treatment advances less than stipulated by the plan.

Main findings of the European Court of Auditors on wastewater treatment in the Danube:

- The European Regional Development Fund spending during the 2007-2013 programme period played a key role in bringing forward wastewater collection and treatment but was not sufficient to meet the deadlines on waste water treatment.

- The funds available under the programme were absorbed slowly and the indicators in the operational programmes do not allow reconciliation with the progress achieved in implementing the Directive.

- Around one third of the urban wastewater treatment plants co-financed by the EU were oversized (even when taking into account planned future connections).

- All of the wastewater treatment plants examined handled the sludge appropriately, except for one Member State. However, binding requirements on pollutants for all sludge uses were missing.

- The attained degree of financial sustainability of EU co-financed infrastructure was not fully satisfactory.

Under **Scenario 1 "Large scale coherence,"** a centralistic approach prioritizing large infrastructural investments may lead to effective construction of plants, but may run short of competence to manage plants in some regions. In certain areas of the Danube, where centralized wastewater treatment plants are not economically feasible due to the high cost of collecting sparse rural settlements, there may be a lack of capacity to ensure a correct implementation of decentralized plants and individual appropriate systems in smaller agglomerations.

Under **Scenario 2 "Tailor made solutions,"** large investments required e.g. to treat emerging contaminants in existing wastewater treatment plants, or to remove combined sewer overflows in large urban areas would be more difficult due to the generally smaller scale of action. On the contrary, decentralized plants are expected to receive more attention. Securing large budgets for wastewater treatment plants will be generally a challenge. Similar considerations apply also to mining sites, contaminated sites and industrial emissions.

Scenario 3 "Multinationals rule" presents a worsening of the same trends of Scenario 1, while **Scenario 4 "Small-scale interventions"** a worsening of Scenario 2. Contrary to Scenarios 1 and 2, these cannot count on the buffering and redistribution capacity of European cohesion funding. Therefore wastewater treatment is only affordable where it pays off.

5.2 Challenges with diffuse pollution: who cares?

Under the different scenarios, tackling diffuse pollution may be hampered by lack of public engagement and political endorsement, failure to value what it delivers, or reliance on impair-then-repair technological fixes (Vörösmarty et al. 2010).

[53] Special Report EU-funding of urban waste water treatment plants in the Danube river basin: further efforts needed in helping Member States to achieve EU waste water policy objectives, European Court of Auditors, Luxembourg: Publications Office of the European Union, 2015 https://www.eca.europa.eu/Lists/ECADocuments/SR15_02/SR_DANUBE_RIVER_EN.pdf

The plan stipulates a broad uptake of good agricultural practices concerning nutrients and pesticides (although the latter are not presently identified as a significant water management issue). Pollution associated with urban drainage is not specifically addressed. However, the European Court of Auditors[54] has already found that Member States are not applying the Nitrates Directive to full potential nor are they planning much beyond "basic measures" of the WFD, with Nitrate action plans lacking ambition and a difficulty to establish and enforce standards for agricultural practices effectively reducing nutrient pollution.

Impair-then-repair: the environmental Kuznets' curve. The environmental Kuznets curve is a hypothetical relationship between environmental degradation and income (or GDP) per capita according to which pollution emissions and other human impacts on the environment would increase in the early stages of economic growth. Beyond some level of income or GDP per capita, though, the trend would reverse so that, at high income levels, economic growth would lead to environmental improvements. This would impy that environmental impacts (such as pollution emissions per capita) are a bell-shaped function of GDP per capita (*Figure 13*).[55]

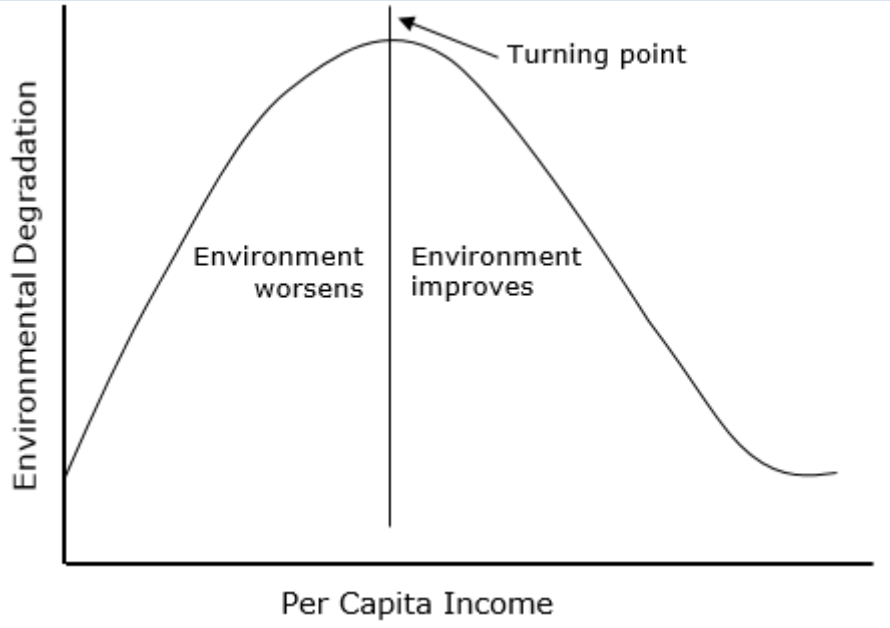

Figure 13 – an environmental Kuznets' curve.Source: Wikipedia, reused under the Creative Commons Attribution (CC-BY) 3.0 License.

Vörösmarty et al., 2010, point at the extreme inefficiency of this impair-then-repair process, arguably to be avoided through "green growth" as a more efficient alternative: indeed, the apparent local environmental improvement referred to by this model is often the result of increased energy use through end of pipe technologies locally (with the known climate change consequences) and transfer of dirty activities to poorer countries thanks to "free trade" (operating at lower environmental standards elswhere) rather than a true improvement.

Any society not incorporating from the onset a wise management of the environment in its economic strategy, when reaching a certain level of well-being is bound to face a

[54]ECA Special report no 23/2015: Water quality in the Danube river basin: progress in implementing the water framework directive but still some way to go. https://www.eca.europa.eu/Lists/ECADocuments/SR15_23/SR_DANUBE_PROGRESS_EN.pdf

[55] Http://oxfordre.com/environmentalscience/view/10.1093/acrefore/9780199389414.001.0001/acrefore-9780199389414-e-401

problematic choice between investing in impact mitigation (highly inefficient) or transferring impacts elsewhere (not sustainable and unfair).

Generally speaking, 'diffuse pollution' can be characterized as pollution without a well-identified individual responsible, in contrast with 'point pollution' which is attributable to a liable subject. Diffuse pollution results rather from a multitude of individual behaviours, and it can only be tackled by modifying those behaviours. Traditional instruments to tackle this include economic incentives and the enforcement of prohibitions.

The centralistic setup of Scenario 1 "Large scale coherence" may lack appropriate capacity to enforce prohibitions at the local scale, and may consequently need to rely on economic incentives. A highly centralized management of the Common Agricultural Policy (CAP), for instance, may be ideal to reward farmers under a strict condition of compliance with good agricultural practices. At the same time, the large scale of investments under this scenario may favour agricultural productivity and competitiveness over sustainability, causing a rebound effect in fertilizer use due to higher quantities applied in spite of compliance with good practices.

Scenario 2 "Tailor-made solutions" seems the most favorable to tackle diffuse pollution particularly from agriculture. A higher circularity of the economy may favor recovery of nutrients from wastewater and a higher overall fertilizer use efficiency.

Scenario 3 "Multinationals rule" is the most at risk that agricultural practices align with standards of high productivity, with a possibility that nutrient pollution increases.

Scenario 4 "Small scale interventions" may positively evolve as Scenario 2, but may also give way to land grabbing by large multinationals in the poorer countries.

5.3 Challenges with hydromorphological restoration: good to have, but just a little

In the different scenarios, hydromorphological alterations may be perceived as less important than water quality and quantity due to the fact that their impacts to the economy are less immediate. The commodification of water ecosystem services may justify e.g. river or floodplain restoration only at sites with a high scenic, touristic or recreational value. In other circumsances the alternative of grey infrastructure to cope e.g. with flood hazards may be preferred and there may be difficulties in the coordinated management of river morphology (e.g. for flood protection and sediment supply) due to lack of transboundary cooperation.

Under Scenario 1, lobbies may push competitive agendas (such as hydropower and navigation), while river preservation or restoration may be limited only to the best sites in terms of natural and scenic richness.

Under Scenario 2, restoration projects may lack scale and ambitious projects (such as dam removal or large scale floodplain reconnection) may be difficult to finance. Moreover, certain regions may be tempted by a "race to the bottom" and accept exemptions to hydromorphological quality objectives in the name of economic development.

Under Scenario 3, hydromorphological restoration may attract limited interest by investors in the absence of a bold and stable funding mechanism. On the contrary, the reasons of the global supply chains may tend to push for logistics (hence possibly navigation and anyway infrastructure in the floodplains) eventually conflicting with habitat restoration goals.

Under Scenario 4, governments may fail to identify common objectives for large scale coordinated actions (e.g. for flood mitigation or fish migration) and hydromorphological restoration unrolls at the local level where conditions may be favourable, but fails to upscale to mainstream practice.

6. Actions to improve long-term water management in the Danube River Basin

The four scenarios examined above are built on a centralization/decentralization axis, and an axis of reliance on large infrastructure/local solutions. These axes do not necessarily have a "positive" and a "negative" extreme. On the contrary, all extremes have some drawback requiring anticipation and mitigation. We may argue that balancing mechanisms that help maintain a mid-way trajectory could be most beneficial to water management in the region.

Balancing mechanisms between centralization and decentralization include empowered local communities (preventing the excesses of central decision making), and basin-wide integration of water management (preventing inconsistency of decisions and conflicts among upstream and downstream regions).

Water management has a technical side, usually catered for by specialists, but also a community side, increasingly recognized as a key component for its success (Pistocchi, 2018, 2019). This has to do with the capacity of people to realize the benefits they can receive from good water management and to steer the water management agenda accordingly through solutions that best meet local needs, possibly delivering multiple benefits. Under scenario 1 (large scale-coherence) and scenario 3 (multinationals rule) decision making is centralized and communities are possibly ousted from their steering role. Under scenario 2 (taylor-made solutions) and scenario 4 (small scale interventions), communities may on the contrary be a key actor and need to be effective. Effective communities may buffer the impacts of centralized decision making (see Scenario 1), mitigate the harshness of competition in the global supply chains (Scenario 3), and voice their needs more audibly (Scenario 4). When communities hold important decision powers (Scenario 2), their capacity to look forward and face sustainability challenges is stronger.

Basin-wide integration is a crosscutting need of the economy of the Danube, due to the dependency of the various economies on shared water resources, particularly in sectors such as such as tourism, inland fisheries, navigation, energy, etc. Continuity of basin-wide water resources management is therefore necessary irrespective of how the society and economy will evolve, and has been a subject of political concern well before the establishment of the ICPDR[56]. The harmonization of social, political and economic conditions in the whole Danube basin may help create the conditions for a broadened market, including for water services; the strengthening of political and economic bonds among Danube countries may support peaceful and collaborative management of resources under all scenarios. Basin-wide organizations and initiatives, including the ICPDR and the EUSDR with associated funding mechanisms, are pivotal for capacity building, knowledge transfer and financing of investments of basin-wide interest.

In order to strike a balance between large and small infrastructure investments, the appetite of investors for large engineering works can be moderated by making investments in nature conservation and nature-based solutions attractive.

Nature conservation is a precondition to halt biodiversity loss, and is acknowledged to be a prime goal of water management. Bringing nature protection to the core of strategies helps escaping the inefficiencies of "impair-then-repair" cycles often triggered under technology-reliant Scenario 1 and Scenario 3, by shaping more robust and sustainable solutions and focusing investments on the integrated promotion of the quality of life. Under less technological Scenario 2 and Scenario 4, nature-based solutions appear more affordable and fit the scale of decision making more efficiently. Finally, climate change is projected to reduce availability of water resources, particularly in summer and for the lower Danube. Moreover, models identify a trend of increasing floods under climate change

[56] For a succinct history of the international agreements for the management of the Danube river since the XIXth century, see e.g. https://en.wikipedia.org/wiki/Commissions_of_the_Danube_River

(see §2). To cope with these conditions, robust nature-based solutions may take even higher importance to increase resilience.

We argue that communities, basin-wide integration and nature conservation are three main areas for actions useful under all scenarios to improve long-term water management in the Danube River Basin. We suggest that coordinated actions in these three areas may substantially strengthen the possibility to effectively implement the Danube river basin management plan and to keep pace with its vision.

Translating these areas of action into concrete policy recommendations requires further elaboration. In the following, we illustrate some possible lines of development. Some require initiatives at higher (EU or global) level but many could be considered for implementation in the Danube also as a frontrunner or pilot for other areas in the EU.

6.1 Developing effective communities

Policy-making and governance: empowering the work of communities. A governance model suggested by some as a good example of community-based water management is that of the Dutch Water Authorities[57]. These are steered by an elected governing board with representatives of all stakeholders (residents, farmers, business, owners of natural areas) and are responsible for flood protection, water quality and quantity control, groundwater protection and other management activities. They have an independent budget and a dedicated financial institution – the Nederlandse Waterschaps Bank (NWB). This structure may enhance people's participation to decisions on water, stimulate networking and the formation of alliances among different stakeholders, eventually supporting the creation of win-win solutions delivering multiple benefits. A strong feeling of community can foster new models of economic development valueing the local natural capital, including water. Good water management has clear potential to support tourism and recreation[58], improve quality of life and attract economic activities. The Dutch model could be suggested for implementation at the scale of aggregates of municipalities (e.g. counties, provinces or smaller sub-basins) throughout the Danube.

Beyond GDP and the ecological transition: the role of communities

Degrowth and post-development theory[59] are gaining ground in economics and provide increasing arguments to orient real-world policy making.

Gross domestic product (GDP) is a well-established indicator used to determine the health of a country's economy by placing monetary value on all goods and services produced over a specific period. Nonetheless, more and more attention is being given to the development of aspects that are more inclusive of environmental and social aspects of progress[60] such as the stock and quality of natural resources (e.g. forests, minerals, agricultural land) and human development (e.g. education, earnings, health).

In a world increasingly characterised by fast environmental change, uncertainty and political instability, the paradigmatic model of consumerism and other market-based solutions is being challenged. The detrimental consequences for the environment, social fabric and the economy of a consumption based economic model are giving rise to new manifestations of ecological transitions largely moved by communities. Dion, 2015 and the

[57] https://www.dutchwaterauthorities.com/wp-content/uploads/2015/05/Water-Governance-The-Dutch-Water-Authority-Model1.pdf

[58] Switzerland features a strong public support for clean rivers also based on their recreational use. See e.g. https://www.limmatschwimmen.ch/

[59] https://en.wikipedia.org/wiki/Postdevelopment_theory

[60] At the level of international institutions, several intiatives exist namely the Beyond GDP initiative, at the European Commisison (http://ec.europa.eu/environment/beyond_gdp/index_en.html) and the Wealth Accounting approach, at The World Bank (http://www.worldbank.org/en/news/feature/2018/01/30/moving-beyond-gdp-to-look-at-the-world-through-the-lens-of-wealth).

documentary *Demain,* 2015[61] showcase concrete examples of solutions from 10 countries to environmental and social challenges in agriculture, energy, economy, education and governance based on a bottom-up approach. Having a rather optimistic outlook, the documentary reveals cities that produce their own food and energy, zero-waste systems, business people and towns creating their own currency to prevent speculation and the appropriation of wealth, citizens rewriting their own constitution and pioneering educational systems.

Well-functioning communities are the natural context where collaborative voluntary agreements, such as river contracts, can be developed. These are voluntary agreements in the form of contracts among public and private actors in a river basin, defining concerted actions aimed at improving the conditions of rivers while securing economic activities (see e.g. Scaduto, 2016). River contracts are a well established part of the French river basin management processes since the 1980s and are spreading in several European countries, including Belgium, Spain and Italy, as a potentially good practice to bring together actors and share responsibilities around concrete river basin management problems. The strengthening of communities is a way to promote collective action which is found to be often effective in delivering public goods and environmental benefits particularly in agriculture (OECD, 2013).

Embedding water in the political agenda of communities. Cities create critical challenges in water management. In view of the ongoing trends in climate change and urbanization, they must increase water resilience, secure water quality and quantity. This requires a long-term commitment of the administrators beyond their specific political mandate and partisan positions. In the context of climate adaptation and renewable energy, the *Covenant of mayors*[62] has attracted considerable attention as a way to stimulate the uptake of commitment and good practices at community level. This action could be expanded to cover water management. One example in this direction comes from the city of Malmö[63].

Promoting healthy lifestyles and a culture of living well within environmental limits. Stronger communities may facilitate the emergence of more circularity by stimulating local recovery, reuse and recycling of resources. In particular, this requires strengthening environmental awareness including sustainable food habits based on diets with more local products and generally more frugal and environmentally friendly consumer behaviours. Promotion of healthy lifestyles, including outdoor recreation and sports, can be an effective instrument to support an agenda of river restoration, e.g. with cycling paths and cyclo-tourism along the rivers.

Promoting healthy lifestyles and outdoor life: a focus on rivers and cycling.

The Danube cycle path runs from the river's source in Germany down to the Black Sea (about 2,900 km). It provides cycling holidays opportunities from leisurely paced cycling to road cycling. It is a spacious cycle path, perfect for solo travellers, families and bigger groups of cyclists (https://www.danube-cycle-path.com).

Progetto VENTO is a cyclotouristic project along the river Po in Italy. With 700 km of bike paths, it plans to be the longest in the country. Its vision is to connect a large territory and regenerate it by reviving economy, identity, dignity, social connections etc. (http://www.progetto.vento.polimi.it/tracciato.html).

EuroVelo is the European Cyclists Federation's cycle route network, managed in cooperation with national and regional partners. It incorporates cycle routes into a single European network of 15 bike routes extending over 45,000 km across Austria, France, Germany, Hungary, Serbia, Slovakia, Switzerland and the UK. It is planned to reach

[61] https://www.demain-lefilm.com/en
[62] https://www.eumayors.eu/
[63] https://malmo.se/Nice-to-know-about-Malmo/Sustainable-Malmo-/Climate-change--Energy/Climate-adaptation.html

70,000 km when completed. The international status of the routes helps with garnering funds and political support for continuing construction (http://www.eurovelo.org/).

The **Social Biking project (S-b)** is an internet based intervention project, coordinated by the European Commission's Joint Research Centre, aimed at motivating European citizens to be more physically active and to use more environmentally sustainable forms of transport. Designed to collect data on biking and social networks and identify the most efficient social-based incentives for physical activity, the project uses a tracking app for bikers, the BikePrints app, which allows users to form interactive groups and track their rides to earn jointly points and prizes (https://socialbiking.jrc.ec.europa.eu).

Looming cross-sectoral alliances to create win-win solutions. While investments typically respond to sectoral agendas (e.g., energy, agriculture, transport, industrial production, public healthcare), communities may be the place where relationships between sectors in the economy are strengthened by recognizing the win-win opportunities of collaboration. For instance, agribusiness may be conflicting with tourism due to the water quality impairment caused by fertilizers. However, combining the sustainability of agriculture with the quality of the landscape can be powerfully attractive for the branding of local products and instrumental for shifting the value of production from mere bulk value to quality (also thanks to a raised awareness on dietary health and responsible consumption).

An obvious example of a possible alliance is flood protection through natural wetlands and floodplain reconnection, which can be linked to regional tourism and recreation.

In drinking water supply, alliances among water utilities and farmers have proven effective in the case of Munich (Grolleau and McCann, 2012), where farmers in the Mangfall valley have been involved in payment schemes to protect drinking water sources.

The Water for Life and Sustainability Fund in the Cauca Valley of Colombia[64] highlights the use of Natural Capital Project tools in the development of water funds. The Water for Life and Sustainability fund grew out of a programme originally implemented in the Cauca Valley in the 1980s as part of a national watershed management strategy. In 2015, it included 20 sub-watersheds along the eastern slopes of the Cauca Valley. In addition to sustainable agricultural water supplies, the objectives of the fund include biodiversity conservation and improved living conditions in participating communities.

6.2 Basin-wide integration

Strengthening the economic sectors more closely related to healthy rivers. Expanding the economic relevance of the activities that rely on overall good status of the whole river basin is one way to reduce conflicts about transboundary issues. The negative effects expected under this scenario may be mitigated if the economic activities of any country depend significantly on the overall good state of the environment in a broad region. This may be the case of environmental tourism and the bio-economy, such as inland fisheries, where good conditions of riverine ecosystems in the whole river basin are in the interest of all due to the need of fish to migrate both upstream and downstream. Similarly, the interest of all operators involved in international navigation for a continuous operation along the whole Danube may stimulate the adoption of appropriate restoration measures aimed at reducing conflicts and securing support from other stakeholders.

Strengthening pluralism through networking. It is essential that policies underpinning investments benefit from intensive consultations with the broadest possible relevant instances of society in order to secure appropriate means to address river basin management issues. For example, if the lobby of the renewable energy sector is strong, it

[64] https://www.naturalcapitalproject.org/wp-content/uploads/2015/11/WaterFund_Case_Study_Cauca_22Sep2015_eng.pdf

is likely that the arguments of climate change mitigation and energy security (pushing e.g. for hydropower development) take precedence over those of nature protection (pushing e.g. for river hydromorphological restoration). In order to ensure that all issues are tabled with adequate voice, basin-wide networks of stakeholders should be encouraged to form and participate to the Danube institutions. Often such networks may involve very different sectors of society and the economy, benefitting from certain initiatives from different points of view. For instance, beneficiaries of nature conservation initiatives may include citizens (recreation and health benefits from access to green areas), tourism, the real estate market witnessing property price rises connected to green areas, the angling sector and inland fisheries. Actors from these areas may be more or less fragmented, but they need to be ready to defend their interests at a centralized level. Therefore it is important to strengthen networks such as associations of citizens or sectorial organizations of entreprises. Networking is also a vehicle to generalise access to competences and capacities.

Entreprises with a capacity to operate beyond their doorstep. Policies entailing large scale investments may be effectively harnessed to implement transnational measures. A stronger European cooperation scenario would guarantee less friction in targeting investments where actually needed, with less or no constraints due to the variations in the legal and regulatory context among countries. This would also help reduce inequalities within the Danube region in terms of capacity to invest in environmental protection. A critical aspect towards distributing opportunities among countries and regions is the size and capacity of entreprises to operate beyond borders. This requires a critical mass which could be achieved through targeted mergers and acquisitions. Also under a scenario where the global supply chains play a strong role, an important aspect of preparedness lies in promoting the capacity of local economic actors by upscaling their activities to compete in the market and to be organized to take action at the formal level (for example, in the form of court cases). This is the case of, for instance, cooperatives of farmers which negotiate sale prices of their produce or purchasing conditions of fertilizers, pesticides, irrigation water, etc. Consortia can also be established with different sectors to promote innovative business models (e.g. agricultural production with treated wastewater reuse). Consortia of small companies or farmers may be able to negotiate access conditions also to the regional navigation infrastructure of the Danube (organization of harbours, logistics etc.).

Stepping up transboundary investments in river basin management. Another aspect of critical importance is the interconnection among countries in terms of infrastructures on the model of energy transmission and oil/gas pipelines. Developing transboundary infrastructure for flood protection and water storage to adapt to climate change may help nudge countries to adopt a more balanced transboundary river basin management. A general issue for the Danube may be the reduced capacity of the river to support navigation due to decreasing water levels projected under climate change (Scholten and Rothstein, 2017). This calls for specific and coordinated adaptation of the navigation sector. The inclusion of sustainability criteria in the public procurement of infrastructure (e.g. through requirements on infrastructure sustainability certification[65]), may speed up the environmental assessment and approval of infrastructural projects. Sustainability criteria may effectively nudge towards more green and multi-functional solutions wherever appropriate.

Boosting the green economy. The technological transition to higher resource efficiency and energy and materials recovery from waste plays an essential role in the narrative of response to climate change, pollution and resources consumption, and the associated risks. As global demand for (and prices of) raw materials increase, technologies need to evolve quickly and "green" investments (e.g. in renewable energies or resource efficiency) are expected to become more profitable. This should push the industry strongly towards a circular economy and help reduce certain environmental impacts. A process of "green

[65] For instance, BREEAM/CEEQUAL: http://www.ceequal.com/; ENVISION: https://sustainableinfrastructure.org/

re-industrialization" linked to more flexible manufacturing technologies may be easier to generalize to the poorer regions.

However, the green/circular economy must be already stimulated today, particularly by committing European legislation (e.g. by setting high recovery/recycling targets, high wastewater treatment and reuse standards, high levies on primary raw materials etc.) and broadening the scope of green procurement. The business sector seems responsive. For example, the World Economic Forum's website[66] shows an abundance of references to the circular economy and sustainability, opening prospects that public-private partnerships might become more effective due to the increasing alignment of interests between public and private actors. However, this still requires adequate market signals.

A reinforced role for international financial institutions. Securing resources to maintain a competitive environment remains critical, if only to provide high level education and training, build the required infrastructures or invest in top notch Research & Development. Even if the EU might not have the means to provide enough financial support to all, organisations such as the European Investment Bank (EIB) may still make lending capacity available. Reinforcing them might be an effective way to cope with lack of investment capacity. The EU's financial institutions already make some technical and administrative capacity available to manage the practical aspects of project appraisal, monitoring and accounting and promote active transboundary cooperation[67]. This could take place even if the EU lacks capacity to manage conflicts between Member States which would be addressed at the inter-governmental level. Macro-regional institutions such as the ICPDR might play a useful role in these cases.

6.3 Nature conservation

Making green infrastructure investments attractive. The attractiveness of investments in nature-based solutions should be increased by developing mechanisms of payment for ecosystem services (e.g. Hejnowicz et al., 2014). With such mechanisms, the financial sector could find suitable conditions for capital remuneration from investments in nature conservation and restoration (e.g. floodplains and wetland reconnection, river restoration, afforestation, etc.) at large scale. The combined push of nature conservation investments and tourism could offset the current attractiveness of hydropower development in relatively pristine river basins, e.g. in the Western Balkans, stimulating the hydropower industry to include ecological aspects when optimizing hydropower plant siting. Experiences of financial investments in the natural capital exist, through mechanisms such as environmental impact bonds[68]: "*Like a typical municipal bond, an Environmental Impact Bond (EIB) provides up-front capital from private investors for environmental projects. Unlike municipal bonds, it embeds a Pay-for-Success (PFS) approach that conditions payback to investors on project performance, which could be used to pilot or scale a new environmental program or intervention. In its most basic form, investors participating in a Pay-for-Success model pay the up-front costs for implementing these environmental projects. Following construction and evaluation, the payor – the public agency or private institution that benefits from these solutions – repays investors an amount linked to achievement of agreed-upon outcomes of the program.*" [69]

[66] https://www.weforum.org/

[67] In particular, though the JASPERS technical assistance partnership: http://www.eib.org/en/products/advising/jaspers/index.htm

[68] https://www.edf.org/blog/2017/07/14/environmental-impact-bonds-next-big-thing-green-investments

[69] https://www.edf.org/ecosystems/environmental-impact-bonds-financing-wetlands-restoration

One example where EIBs are applied is the reduction of stormwater pollution loads in the Chesapeake Bay Area (US)[70]. Another example of a mechanism developed to finance wetland and riparian areas protection is that of "mitigation banks"[71] developed under the supervision of the US Army Corps of Engineers: "*A mitigation bank is an agreement between a regulatory agency or agencies (state, federal, or local) and a sponsor which can be a public agency, non-profit organization, or private entity. In a banking instrument, the mitigation sponsor agrees to provide compensation that will be initiated before credits are approved for release by an Interagency Review Team. These credits can then be purchased or used by permittees instead of providing permittee-responsible compensatory mitigation required under the Corps or a state or local aquatic resource regulatory program. The sponsor does a large, ecologically meaningful project for which it can charge the public per credit or deduct credits if it is a single-user bank for an entity such as a state department of transportation.*"[72]

Arguably, adaptation to climate change cannot be based on traditional engineering measures alone. This opens opportunities to finance nature-based solutions and to preserve ecosystems for the services they provide. Public expenditure on ecosystems may attract the financial sector and make "green bonds" increasingly a standard form of investment for many private and institutional investors, but requires a clear and stable commitment of public money. Ecosystem management may also stimulate the creation of jobs which are necessarily "local," and can compensate the loss of attractiveness of traditional economic activities that become less profitable.

The potential for the development of a green infrastructure at European scale has been analysed in the past, highlighting several opportunities throughout the region[73].

Natural water retention measures in cities and agriculture. Urban land take and soil sealing have visible direct impacts on water (Pistocchi, 2017) as well as collateral impacts on such factors as urban microclimate, energy demand for cooling and air pollution. Urban greening, i.e. the restoration of green areas in cities, is a form of natural water retention measure and may provide multiple benefits. It is usually associated to the amenity of the urban landscape, making it a win-win strategic option for urban management (Pistocchi et al., 2017). In agriculture, maintaining riparian buffers at current levels is expected to secure a reduction of sediment yields and associated pollution of about 8%, while taking only about 2% of the basin's land (Vigiak et al., 2016). Usually, the preservation of vegetated buffers around agricultural fields is expected to yield benefits for pollinators, protection of water bodies from pesticides and filtering of sediments and nutrients, while preserving yields. It is increasingly endorsed in environmental stewardship programmes including from large agrochemical business[74]. In many cases, intensive agriculture may significantly reduce its impacts merely by more careful use of production means, such as fertilizers, suggesting that nature and human activities may be reconciled to a large extent through smarter practices. It is worth mentioning that the European Commission maintains a clearinghouse of natural water retention measures, in support to river basin planning[75].

[70] http://www.cbf.org/how-we-save-the-bay/programs-initiatives/environmental-impact-bonds.html

[71] https://www.forbes.com/sites/ashoka/2014/04/25/how-private-capital-is-restoring-u-s-wetlands/#6fc6bb35e83f

[72] https://www.nae.usace.army.mil/Missions/Regulatory/Mitigation/MitigationBanks/

[73] Exploring nature-based solutions. The role of green infrastructure in mitigating the impacts of weather- and climate change-related natural hazards https://www.eea.europa.eu/publications/exploring-nature-based-solutions-2014

[74] See e.g. Syngenta: https://www.syngenta.ca/docs/Buffer_Brochure_EngCanada_2013.pdf

[75] Nwrm.eu

7. Development of capacities

Widespread capacity, meant in cultural, technical and financial terms, is a precondition to avoid marginalization and impoverishment of regions within the Danube. Education of the youth in schools and universities is essential to create a more ecologically aware society. Under Scenario 1, peripheries capable to interact with the centre on equal grounds are a precondition to ensure large scale policies and investments that meet local needs. Under Scenario 3, regions with good and complementary specializations may become more attractive in synergism than if they were isolated. Under Scenario 2, complementary and smart specialization, based on local *milieus*, supports the virtuous circles of the collaboration among strong regions under the umbrella of a protective Union. In Scenario 4, capacity may provide the necessary elements of resilience to revert to more limited economies (such as at national scale).

The Danube region shows a large variation of capacities among countries, between rural and urban areas and among regions, with large opportunities for the exchange of experiences and transfer of knowledge.

Capacity building and smart specialization. Capacity building usually requires a combination of measures implemented by multiple actors, including the education system, universities, professional organizations and enterprises. The European Union promotes a Smart Specialization Strategy in order to minimize competition and maximize synergism among regions.

Smart specialization.

"*Conceived within the reformed Cohesion Policy of the European Commission, Smart Specialisation is a place-based approach characterised by the identification of strategic areas for intervention based both on the analysis of the strengths and potential of the economy and on an Entrepreneurial Discovery Process with wide stakeholder involvement. It is outward-looking and embraces a broad view of innovation including but certainly not limited to technology-driven approaches, supported by effective monitoring mechanisms. […] A strategy for smart specialisation should be designed around the following key principles:*

• *Smart specialisation […] builds on the assets and resources available to regions and Member States and on their specific socio-economic challenges in order to identify unique opportunities for development and growth;*

• *To have a strategy means to make choices for investment. Member States and regions ought to support only a limited number of well-identified priorities for knowledge-based investments and/or clusters. Specialisation means focusing on competitive strengths and realistic growth potentials supported by a critical mass of activity and entrepreneurial resources;*

• *Setting priorities should not be a top-down, picking-the-winner process. It should be an inclusive process of stakeholders' involvement centred on "entrepreneurial discovery" that is an interactive process in which market forces and the private sector are discovering and producing information about new activities, and the government assesses the outcomes and empowers those actors most capable of realizing this potential;*

• *The strategy should embrace a broad view of innovation, supporting technological as well as practice-based and social innovation. This would allow each region and Member State to shape policy choices according to their unique socio-economic conditions;*

• *Finally, a good strategy must include a sound monitoring and evaluation system as well as a revision mechanism for updating the strategic choices."* [76]

Partnership agreements and twinnings among regions and economic sectors may further enhance the effectiveness of smart specialization and help creating a collaborative

[76] http://s3platform.jrc.ec.europa.eu/what-is-smart-specialisation-

industrial ecosystem in the Danube. Knowledge and capacity may be effectively shared also through public-public partnerships in the field of water management[77].

Consolidate the financial sustainability of water management. An essential component of capacity is the ability to plan and implement investments. There are now ample possibilities for financing but effective funding is still limited by the capacity of water users to pay back. In order to ensure the sustainability of lending capital for water management development, it is essential that water is priced correctly. Therefore, water pricing should be established as early as possible, balancing the political need to keep water affordable for everyone and the capacity to invest. Appropriately priced water is a precondition in any environmental impact bond initiative aimed at creating equitable conditions to achieve sustainable management of water and sanitation for all (Sustainable Development Goal Number 6[78]).

Along with "putting the right price tag for water," water utility companies need to learn to deliver value-for-money services, which may require structural changes in the organization particularly in cases where the management may be driven more by political decisions than by customer satisfaction signals.

Stimulate high-level education, research and innovation in water management in all Danube countries. There is a broad need to secure state-of-the-art higher education in the field of water management. While the region has longstanding tradition in water science and engineering, the history of the late XXth century has caused a divergence between Upper and Lower Danube countries, further exacerbated by a significant brain drain in the last decades only partly countered by recent EU research and education programmes. This trend needs to be reversed, e.g. through broader collaboration within EU scientific networks and the promotion of Lower Danube cases as international case studies.

Strong enforcement mechanisms for rules on the application of fertilizers, including checks on, and economic incentives for farmers, may stimulate both recovery of nutrients and agricultural efficiency, yielding both economic and environmental benefits. Cap-and-trade mechanisms applied to nutrient use may play a role in this respect.

Policy responses to diffuse pollution.

Market-based policy instruments have been proposed to manage diffuse pollution. The Lake Taupo region in New Zealand is an example of a market to exchange nitrogen emission allowances initially allocated to farmers on the basis of appropriate criteria. In 2011, the regional government introduced (1) a cap on nitrogen emission levels within the Lake Taupo catchment; (2) the establishment of the Taupo nitrogen market; and (3) the formation of the Lake Taupo Protection Trust to fund the initiative. This policy experiment is thought to be unique in the world[79]. Although the long lag time of the watershed does not allow appreciating environmental benefits to date, the programme is proving successful in retiring emission allowances steadily from the market.

The National Network on Water Quality Trading (USA)[80] works collaboratively to advance water quality trading as a strategy to achieve clean water goals. Here, point sources can purchase pollution reductions created by land managers using conservation practices. This trading started with 18 organizations in 2013 and reflects the diversity found in most emerging trading programmes in the country, including agriculture, wastewater and

[77] See, for example, https://www.tni.org/files/download/pupinwater.pdf
[78] Sustainable Development Goals, United Nations, 2015 https://sustainabledevelopment.un.org/sdg6
[79] OECD, 2015. The Lake Taupo Nitrogen Market in New Zealand: Lessons in environmental policy reform. https://www.oecd-ilibrary.org/docserver/5jrtg1l3p9mr-en.pdf?expires=1542807231&id=id&accname=guest&checksum=A4FC531052456E634A95A5D1F16EC85A
[80] http://willamettepartnership.org/water-quality-trading/national-network/

stormwater utilities, environmental groups, regulatory agencies, and practitioners delivering water quality trading programmes.

An extensive discussion of various policy options to manage diffuse pollution efficiently is presented in a recent OECD report[81].

Stimulate innovation for the recovery of energy, nutrients and water from wastewater treatment plants. Making wastewater treatment a more attractive business as a pivot of the circular economy requires the development of markets for water reuse, nutrient recovery and energy recovery from wastewater. Valorization of biogas from sludge digestion, for instance, may be stimulated through appropriate feed-in electric tariffs or preferential mechanisms to dispatch bio-methane through gas distribution networks. These conditions would also facilitate synergies between sludge digestion and municipal/industrial organic waste digestion in a single plant for a given area. Explicit (e.g. restrictive primary or secondary legislation) or implicit (e.g. more complex authorization procedures) legal barriers to water reuse and the recovery of nutrients should be removed as far as possible. Nutrients recovered from wastewater (e.g. struvite) could replace in part synthetic mineral fertilizers.

[81] OECD (2017), Diffuse Pollution, Degraded Waters: Emerging Policy Solutions, OECD Studies on Water, OECD Publishing, Paris, https://doi.org/10.1787/9789264269064-en http://www.oecd.org/environment/resources/Diffuse-Pollution-Degraded-Waters-Policy-Highlights.pdf

Win-win solutions for the management of agricultural pollution. Fertilizers are a cost for agriculture and their production often requires a lot of energy (Ramirez and Worrell, 2006). Hence, reducing fertilizer use can help achieve the agenda of the EU climate action.

Udias et al., 2016, show how the reduction of mineral fertilizer use in the Upper Danube may represent a win-win option to reduce pollution while not affecting crop yields or farmers' incomes. They show how optimized nitrogen management reduces pollution significantly, indicating that technical options exist to reduce nutrient pollution without economic prejudice.

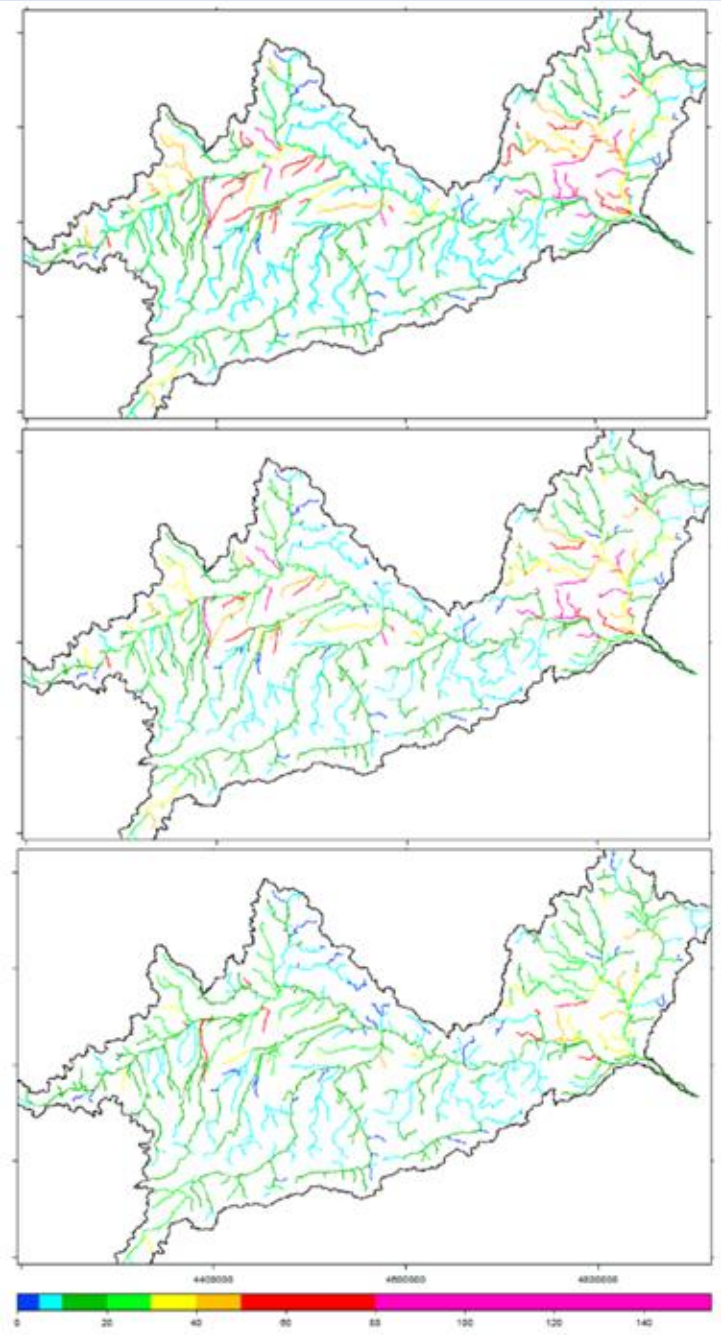

Figure 14 - Average monthly N-NO3 concentration (mgN/L) for a 15-year simulation period in the Upper Danube Basin under current conditions (top), optimized fertilization (middle) and optimized fertilization and wastewater treatment plant upgrade (bottom). From Udias et al., 2016 (doi:10.3390/w8090371) under CC-BY license.

8. Concluding remarks

The Danube region shows strengths and weaknesses, opportunities and threats for the development of the above areas for action. Among the strengths, all countries are on a (more or less steady) path to structural reforms pushed by either the European Semester process (for Member States - see Annex 1) or the convergence with the EU in the perspective of accession (for the Western Balkans) or association (for Ukraine and, in the future, possibly Moldova). Danube countries also have relatively good environmental performances (see Annex 3) and can benefit from the synergies with global (Germany, Austria) or regional (e.g. Czech Republic, Slovenia) leaders under several technological and organizational dimensions. This provides favourable conditions for capacity building/knowledge transfer in the region also through the development of projects of joint interest.

Another strength of the region is the still relatively high abundance of pristine natural environment, and the relatively low impact of agricultural activities in the lower river basin. This provides ample opportunities for the development of green economic activities, also considering that forest areas are generally stable if not expanding, while the population tends to concentrate in urban centres (Figure 6).

Most of the Danube countries have a large public sector (around 20% of employment, see Annex 2) which may be a strength when planning public and community actions, although it may revert to a weakness if bureaucracies take a conservative attitude and resist innovation. Re-valueing their large public sector appears an opportunity for all countries but requires dedicated investments. The relatively poor innovation performance (Annex 3) may be a weakness for most countries, although there are signals of vitality in certain innovative sectors in the region (Figure 19 to Figure 24).

Agriculture in the region does not contribute enough to the gross domestic product, suggesting a weakness due to the limited value of agricultural production. However, access to a large and stable market such as the EU offers apparent opportunities particularly for tourism and specialized agricultural production. Small farmers and their families may develop typical products with high added value and marketability that can benefit from the Protected Designation of Origin and other EU quality labels. The regions can support this by attracting tourism from elsewhere, deploying good public transport and logistics infrastructure, cultivating capacity for better agricultural management, etc.

Rural tourism to diversify sources of income might both benefit from environmental improvements, and become a driver of further ecological transition due to the demand for high quality organic produce, calling for a reduction of pesticide use and the adoption of agro-ecological practices. These opportunities seem to be underexploited for now, with the region still lagging behind the EU top players in the field in spite of assets such as a relatively well preserved and varied agricultural landscape.

An overall threat in the region is the apparent ageing of population and the trend of depopulation, particularly in countries needing the most to develop from the current conditions (all lower Danube countries). If policies to counter these trends are not put in place, societies may soon become very different and their capacity to plan any development may be undermined.

Equally dangerous threats come from rising inequality in most Danube societies, and particularly in the lower Danube (see Annex 1), and corruption, which has shown to correlate well with the difficulties of doing business (see §2). Foreign investors and the EU partner Member States may have aligned interests in combatting both phenomena in order to secure a better business environment and a higher overall prosperity in the region.

Finally, significant opportunities come from the European structural funds, the existence of frameworks for the development of transboundary investments (the EUSDR and Danube Transboundary Interreg Programme[82]), and the relative ease of access to financing

[82] http://www.interreg-danube.eu/

through the EIB or the European Bank for Reconstruction and Development and other financial institutions. In order to keep momentum with the European integration project, it is important to raise awareness of the benefits brought by the EU in the Danube economies.

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Annex 1 – Summary of the Danube EU Member States' socioeconomic conditions (European Semester 2017) and shares of GDP accounted for by agriculture and industry

Country	GDP Growth (2016)	Employment	Competitiveness	Inclusiveness	Pensions and healthcare spending	Innovation, education and skills	Finance, institutions, governance
Austria	1.5%	Unemployment low but increasing; employment growing driven by part-time jobs	High wages undermine price competitiveness; labor productivity stagnating per employee due to part time jobs, increasing per hour. The tax wedge is relatively high.	Risk of poverty is generally quite low but more pronounced for specific groups (e.g. foreign-born and long-term unemployed).	Risks to financial sustainability due to low retirement age and sub-optimal efficiency of the healthcare system	Mid-level skills, hampering innovation leadership; education achievements conditioned by social background.	Government debt <80% and overall good financial stability; banking sector crisis recovered; fiscal framework remains complex; regulatory/administrative barriers hold back growth and innovation; rigidities in service markets and regulated professions.

Country	GDP Growth (2016)	Employment	Competitiveness	Inclusiveness	Pensions and healthcare spending	Innovation, education and skills	Finance, institutions, governance
Bulgaria	3.3%	Unemployment is decreasing and is below EU average. However, high inactivity rates and long-term unemployment are still an issue. Active labor market policies are not sufficiently targeted to the young and long-term unemployed. Undeclared work has high incidence. Services for employment are increasing but show limited effectiveness.	Private consumption drives growth. The rise of wages does not seem to have impacts on competitiveness. The shadow economy remains a key challenge.	Income convergence towards the EU levels continues but the gap persists. Income inequality is at very high levels. Poverty is still to be properly addressed. Roma people appear disadvantaged in the access to services including education. The risk of poverty affects a high share of people, particularly among the elder, children, Roma and in rural areas.	Public healthcare spending is low compared to EU levels. Out-of-pocket payments limit access to the services. Medicals emigrating represent almost 90% of the yearly medical graduates, limiting the supply of qualified workforce in the sector.	Early school leaving is still an issue, while some progress is being made on tertiary education targets. Insufficient provision of quality education persists. Funding for education is low compared to the EU levels. Reforms are ongoing.	The perception of corruption, weak institutions and an unstable legal framework affect the business environment. The efficiency of public procurement remains low, and so is for the efficiency of spending. The insolvency framework is still in need of reform. Judges training and courts capacity remain an issue. Access to finance for the SMEs is difficult although expected to improve thanks to recent initiatives. The robustness of the banking sector has increased, but some institutions (including one systemic bank) require further attention. Issues arise with unsound business practices such as related-party lending and investment in the banking and insurance sectors.

Country	GDP Growth (2016)	Employment	Competitiveness	Inclusiveness	Pensions and healthcare spending	Innovation, education and skills	Finance, institutions, governance
Croatia	2.8%	Among the lowest employment rates in the EU. Unemployment above 12%, mitigated by part-time and temporary jobs, but still very high for the young and long-term. Low job opportunities have stimulated migration outflows.	Productivity lags behind that of regional peers, particularly in state-owned entreprises. Productive investment is low. The regulatory environment for service providers is restrictive.	Levels of poverty and social exclusion, hardened by fragmented and opaque social protection which may result ineffective and not fair. Women are often driven out of the labor market.	The system appears ineffective and not sustainable in the long term. The adequacy of pensions is low and creates poverty risks for the elder.	Workforce underskilled pending educationa system reforms.	Effective public services are hampered by fragmented public administration. Access to finance is still difficult, especially for SMEs.
Czech Republic	2.4%	Among lowest unemployment rates in the EU (4%); employment growing in the last years but expected to slow down, also due to demographic constraints.	Investments discouraged by high administrative burden. R&D investment increasing. Business/research cooperation is still problematic.	One of the least unequal societies in Europe. Inclusiveness of compulsory education still a challenge for certain social groups.	Risk to financial sustainability; the fiscal framework is one of the weakest in the EU	Investments in R&D on track towards Europe 2020 targets.	Corrupion is being addressed but remains a key issue. Administrative simplification is progressing. Public procurement reveals inefficiencies. Fiscal non-compliance is still an issue requiring simplification.
Germany	1.9%	Overall good labor market, but high incidence of part-time jobs and limited incentive for second earners. Population ageing may limit labor supply in the mid term.	Private domestic investment not at full potential, relatively low public investment. Growth fuelled by domestic demand growth. Labor taxation remains relatively high.	The strong economic performance does not benefit all layers of society equally. Relative poverty and exclusion indicators increase.		Investments needed in electricity networks and broadband connections. Service sector investments hampered by regulatory barriers.	

Country	GDP Growth (2016)	Employment	Competitiveness	Inclusiveness	Pensions and healthcare spending	Innovation, education and skills	Finance, institutions, governance
Hungary	1.9%	Employment conditions are improving, and shortages of both skilled and unskilled labor are emerging. The main active labor policy remains public works. Sone reforms are being introuced to improve the labor market and access of women to jobs.	Investment is recovering after a significant drop in 2016. Productive investment (machinery/equipment) needed to improve productivity and competitiveness. Growth is backed by domestic demand and net exports.	Poverty remains high particularly among children and Roma. Social assistance remains weak and limited. The socio-economic background often drives the education outcome of pupils.		Performance in providing basic skills remains weak by international standards.	Lending to the private sector is growing but still low, despite the relative good healthof the banking sector. The structural balance of the government may deteriorate due to the foreseen tax cuts, although financial stability has improved in the last years. Regulatory barriers limit investments and market dynamics in services. The unstable regulatory ennvironment, weak stakeholder engagement and limited evidence-based policy making, all represent barriers to doing business. Corruption remains high and public procurement is not always transparent and competitive.

Country	GDP Growth (2016)	Employment	Competitiveness	Inclusiveness	Pensions and healthcare spending	Innovation, education and skills	Finance, institutions, governance
Romania	4.9%	Employment is improving in line with general economic growth. Active labor market policies now substantially better targeted to inactive groups. Undeclared work remains prevalent, affecting the labor market and fiscal revenues.	Domestic demand is strengthening. Difficulty to secure high skill labor supply vs education system deficiencies and persisting emigration.	General improvement of economic conditions and fight against poverty are at risk of not being sustainable in the long term, especially in case of reversal of structural reforms. Income inequality remains high.	Although subjec tto reforms, the healthcare system has still low effectiveness, offers limited services especially in rural areas, and shows high corruption.	Persistently high early school leaving and low tertiary education attainment. R&D remains away from Europe 2020 targets.	Relatively high deficit (2.8% of GDP), projected to increase to well above 3%. Debt increasing but still at around 60% of GDP. Financial stability improving, but uncertainty in the legislation may undermine investments. Non-performing loans have relatively high incidence. Governance is improving, and so also the fight against corruption, although at risk of being reversed through recent legislative initiatives. Public investment is among the highest in the EU, but the effectiveness is limited by relatively poor infrastructure. Corruption and administrative complexity hold back investments.

Country	GDP Growth (2016)	Employment	Competitiveness	Inclusiveness	Pensions and healthcare spending	Innovation, education and skills	Finance, institutions, governance
Slovakia	3.3%	Decreasing unemployment but still issues with long-term unemployment	Overall positive investment outlook. Relatively high sectorial concentration of the economy; lack of infrastructure hampers investments in large parts of the country; limitations persist on the quality of the business environment, qualified labor. High energy dependency and low energy efficiency.	Indicators of poverty and exclusion risks have been deteriorating although the Europe 2020 objectives appear attainable. Although poverty is not widespread, poverty intensity may be high due to weak social safety nets.	The system appears to be not sustainable in the long term and requires structural adjustments. The pension age is among the lowest in Europe.	The education system appears rather weak. Students‘ performance in basic skills has been deteriorating. Vital SME landscape receiving increasing attention, but still limited R&D, business/research collaboration etc. The social background may give rise to inequalities in education outcomes.	Tax evasion has fallen. Barriers to investments persist (infrastructure, bureaucracy, insolvency arrangements). Problems with municipal waste management. Corruption remains a challenge despite efforts to modernize the public administration. Concerns with the independence of the judiciary.

Country	GDP Growth (2016)	Employment	Competitiveness	Inclusiveness	Pensions and healthcare spending	Innovation, education and skills	Finance, institutions, governance
Slovenia	2.5%	Improving employment conditions (with significant reduction of long-term unemployed) although still below pre-crisis levels. There are opportunities to increase the employment of older workers, thanks to the projected shortage of labor.	Exporting sectors are competitive, less so state-owned companies. Price and cost competitiveness drive high account surplus (7.4%) and low external liabilities (<40% of GDP). Bureaucracy hampers investments. Public investment relies on EU funds while private investment is low and still decreasing. Foreign direct investment is increasing.	Among the lowest levels of wage inequality in the EU. Poverty and exclusion still relatively high, although declining.	Concerns on pension sustainability arise with population aging. The healthcare system shows ample margins of efficiency gains.	Europe 2020 objectives already achieved about tertiary education and early school leaving.	Relatively healthy government debt (83.1% in 2015, decreasing) and deficit (2%, decreasing). Increasing banking sector profitability, thanks to better management. Corporate debt remains relatively high, although financing conditions are improving.

Table 3 – main aspects of the Danube EU countries. Source: EC, European Semester 2017 country reports[83]

[83] https://ec.europa.eu/info/publications/2017-european-semester-country-reports_en

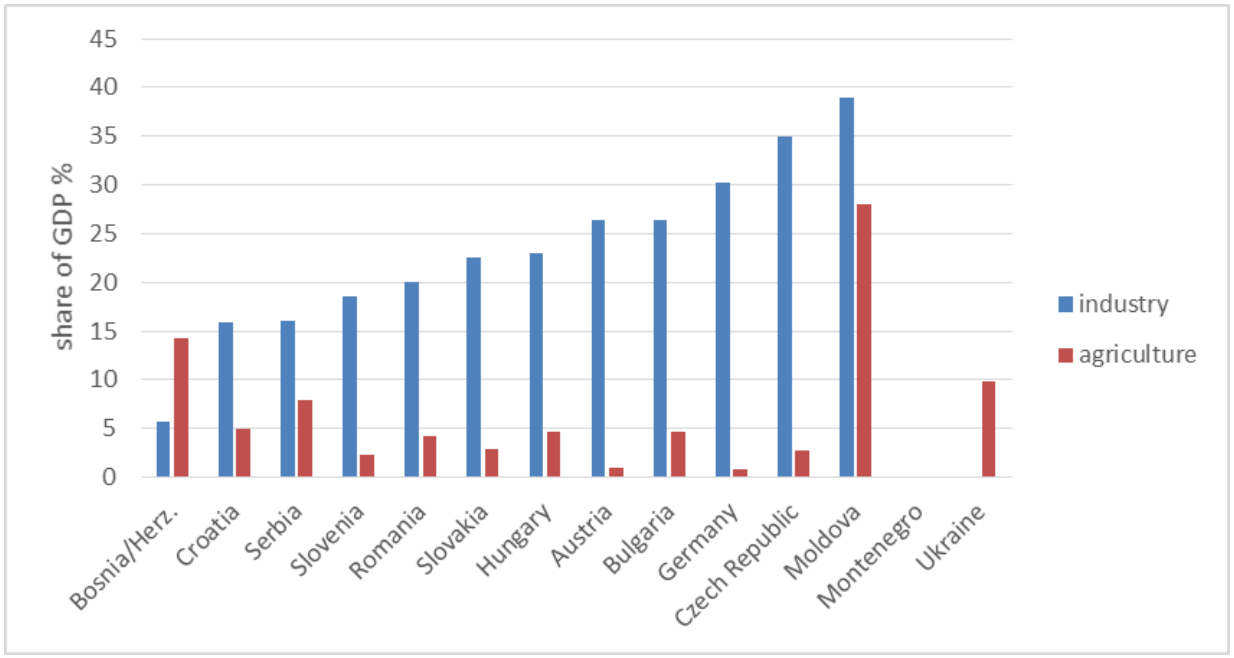


Figure 15 – share of GDP by country accounted for by industry and agriculture (Source : ICPDR, DRBMP 2015).

Annex 2 – Shares of employment in the Nomenclature of Territorial Units for Statistics 2 (NUTS2) regions in the Danube river basin

Figure 16 – NUTS2 level regions (i.e.basic regions for the application of regional policies) in the Danube river basin

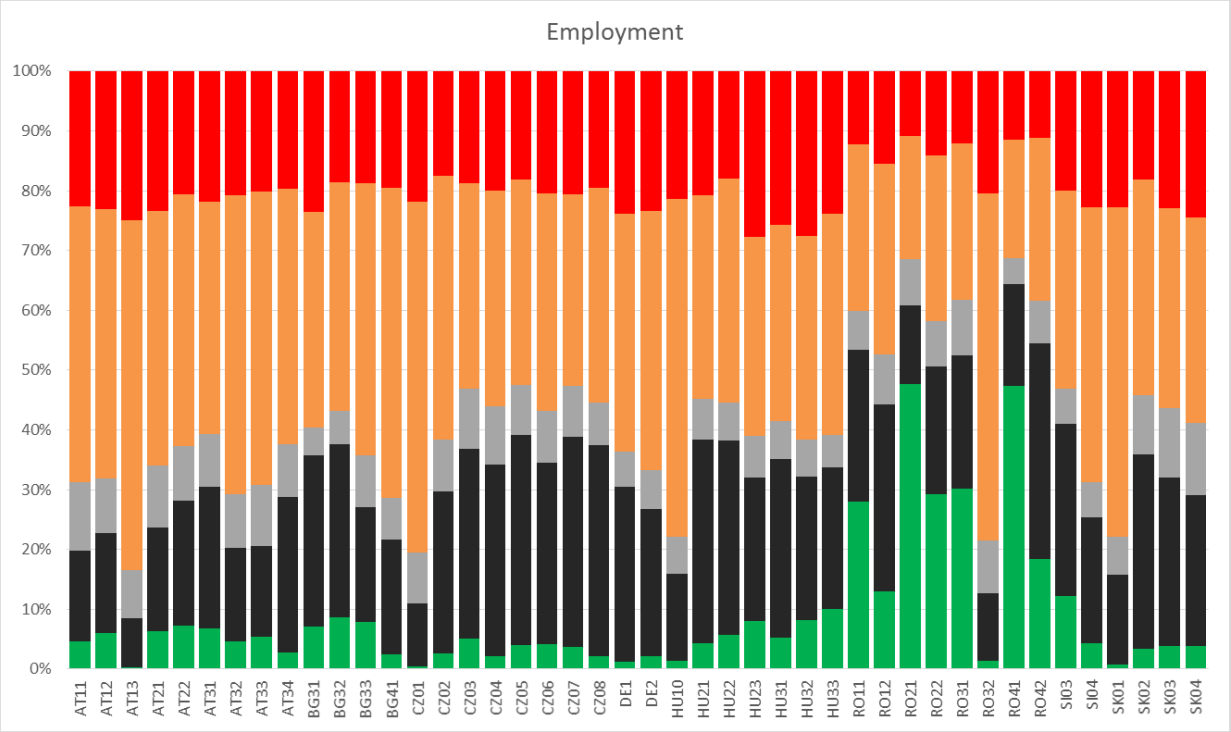


Figure 17 – share of employment in the Danube regions (Region codes mapped in Figure 16): green=agriculture; black=industry; grey= construction; orange= services; red= public administration. Source of compiled data: http://s3platform.jrc.ec.europa.eu/

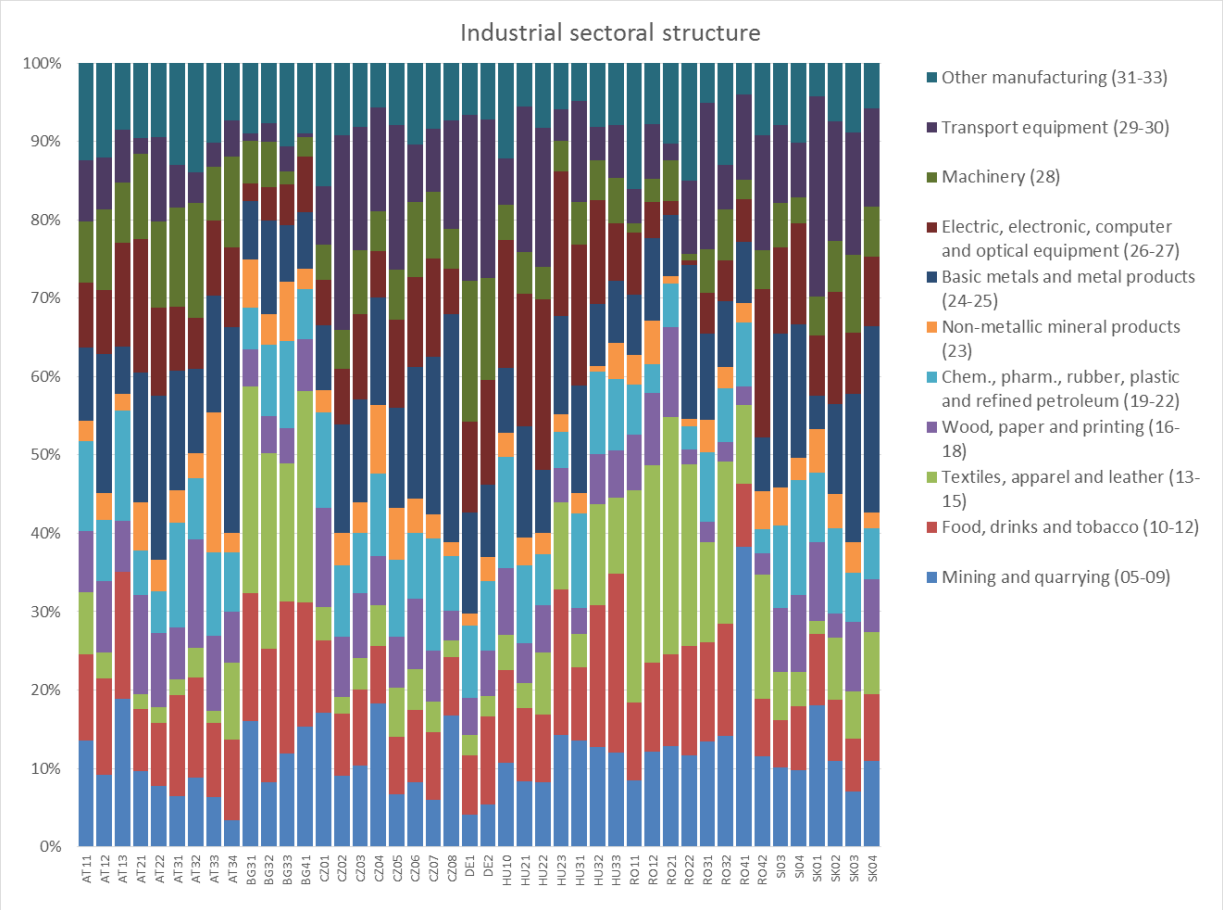


Figure 18 – share of industrial employment in the Danube river basin NUTS2 regions. A map of the region showing the NUTS2 codes is provided in Annex 2.

Annex 3 –Global Innovation Index (GII) and Environmental Performance Index (EPI) in the Danube Countries, 2016

The region does not qualitfy among the leading innovative regions globally, based on the the Global Innovation Index (GII) 2016[84] (Figure 19). The Danube countries (with the exception of Austria, Germany and in to some extent the Czech Republic) are usually in the lowest ranks of the European Union, and non-EU Danube countries lag even farer.

The environmental performance of the Danube countries may be framed by inspecting the results of the University of Yale's Environmental Performance Index (EPI), 2016 report[85] (Figure 20). Compared to the GII, in terms of EPI the Danube countries rank overall quite well, although they still tend to lag behind most of the non-Danube EU countries. In the Danube, the highest EPI is attributed to Slovenia, Croatia and Austria, with the other Danube EU countries slightly behind and the Danube non-EU countries at further distance.

If we look at the evaluation criteria of the GII (*Figure* 21 to Figure 24), we may identify some areas where margins of improvement are concentrated, given the overall innovation ranking of a country[86].

In terms of institutions, Romania, Bulgaria, Moldova, Hungary and Ukraine appear to be worse than their peers.

The regulatory environment (regulatory quality, rule of law, costs of redundancy dismissal) is worse than their peers for Czech Republic, Moldova, Slovakia and Ukraine and, to a lesser extent, for Croatia and Hungary.

The business environment[87] is worse than their peers for Austria, Czech Republic, Hungary, Bulgaria and Ukraine, and to a lesser extent Croatia and Moldova.

For what concerns human capital and research, all countries except Slovenia and Ukraine have a ranking in education worse than their overall ranking; ranking in tertiary education (including the number of inbound tertiary students) is also worse for Bulgaria, Croatia, Hungary, Moldova and Slovakia.

Croatia, Bulgaria, Romania, Moldova, Montenegro and Slovakia also rank worse than their peers in research and development (including the number of researchers, quality of country top universities, and both private and public expenditure).

In terms of infrastructure, the Czech Republic, Bulgaria, Hungary and Slovenia have sizable gaps compared with their peers. Ukraine, Moldova, Hungary, Croatia, Slovakia, Romania and Bulgaria are particularly worse than their peers for general infrastructure; for ecological sustainability, Ukraine and Moldova show the largest gap while Austria, with a good overall environmental performance, lags behind in terms of energy productivity (consumption/GDP).

[84] https://www.globalinnovationindex.org This index, developed by a collaboration among Cornell University, WIPO and INSEAD, ranks countries worldwide based on the following criteria reflecting either conditions for innovation (input) or output providing evidence of innovation: Institutions; Human capital and research; Infrastructure; Market sophistication; Business sophistication; Knowledge and technology outputs; Creative outputs.

[85] The EPI score (https://epi.envirocenter.yale.edu/) is a weighted combination of indicators reflecting Environmental Risk Exposure, Household Air Quality and Air Pollution, Unsafe Sanitation, Drinking Water Quality, Wastewater Treatment, Nitrogen Use Efficiency and Balance, Change in Forest Cover, Fish Stocks, Protected Areas and Species Protection, Trend in Carbon Intensity and CO2 Emissions.

[86] In the following discussion, we systematically refrain from referring to Germany, as the Danube part of the country may not be faithfully depicted by the national scale indicators of the GII.

[87] Measured here by the World Bank "Ease of doing business" indicators Ease of starting a business, Ease of resolving insolvency, Ease of paying taxes.

The GII output indicators reveal gaps in knowledge creation[88] for Bulgaria, Hungary, Montenegro, Romania, Slovakia, Slovenia; in the production of creative goods[89] in Bulgaria, Croatia, Moldova, Montenegro and Ukraine; in online creativity[90] for Slovenia, Slovakia, Moldova. Gaps in knowledge impact[91] and knowledge diffusion[92] are rather widespread among the Danube countries considered.

[88] Patents, publications.
[89] Cinema, publications, etc, and their export.
[90] Number of domains, WikiPedia edits, Youtube uploads.
[91] Growth rate of GDP per person engaged, New business density, Total computer software spending, ISO 9001 quality certificates, High-tech and medium high-tech output.
[92] Intellectual property receipts, High-tech exports, ICT services exports, Foreign direct investment, net outflows.

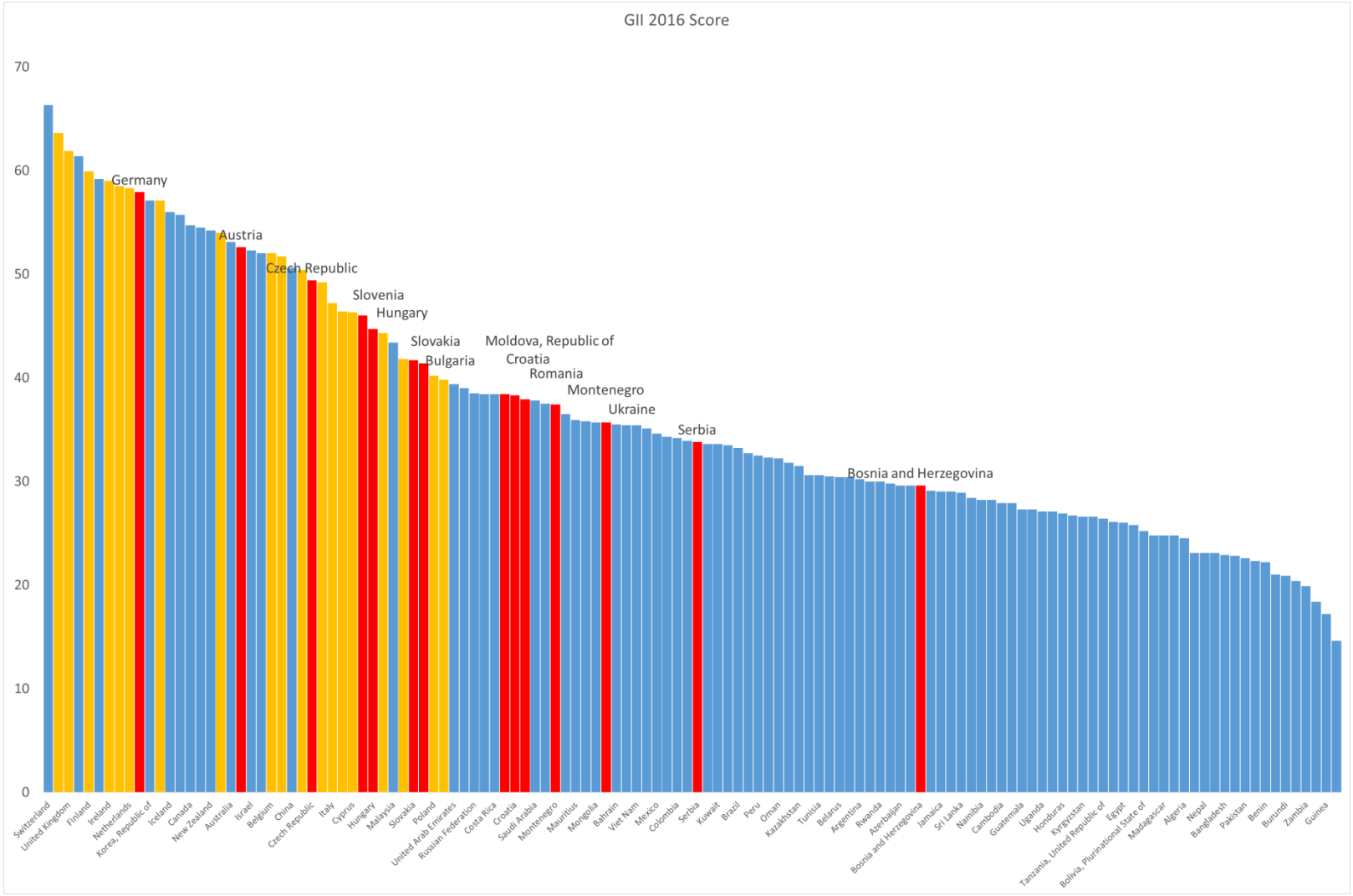
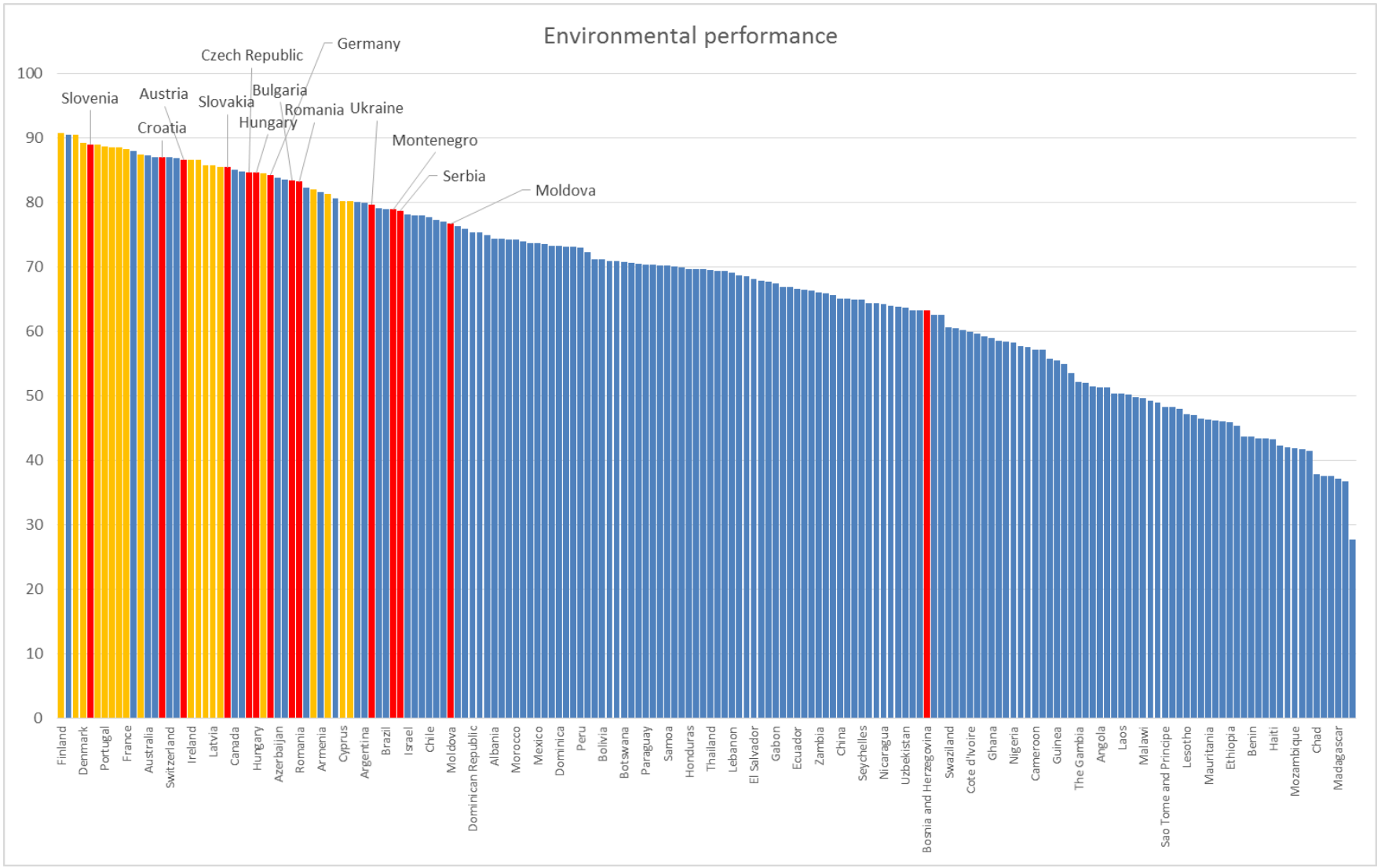


Figure 19 –Global Innovation Index, 2016 scores[93]. In yellow we highlight non-Danube EU countries, in red the Danube countries

[93] https://www.globalinnovationindex.org/analysis-indicator



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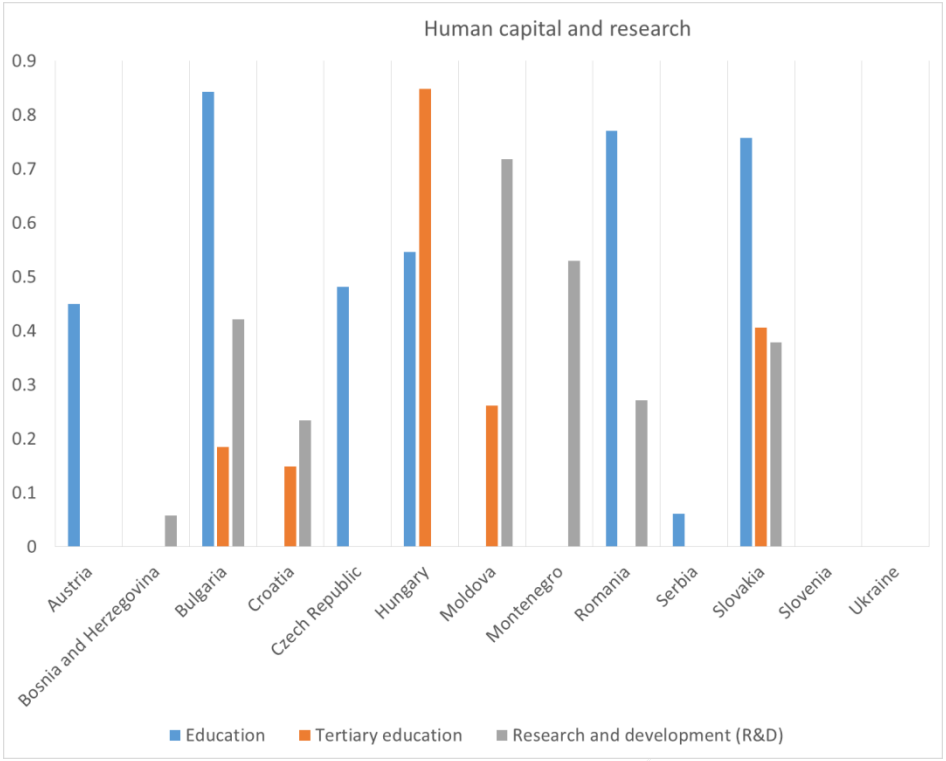

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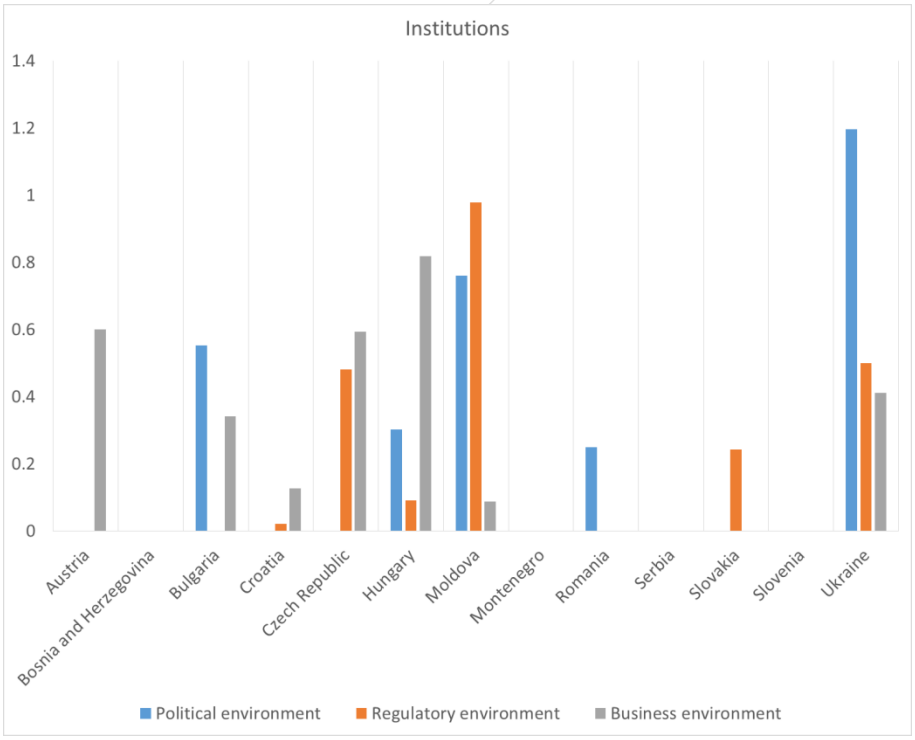

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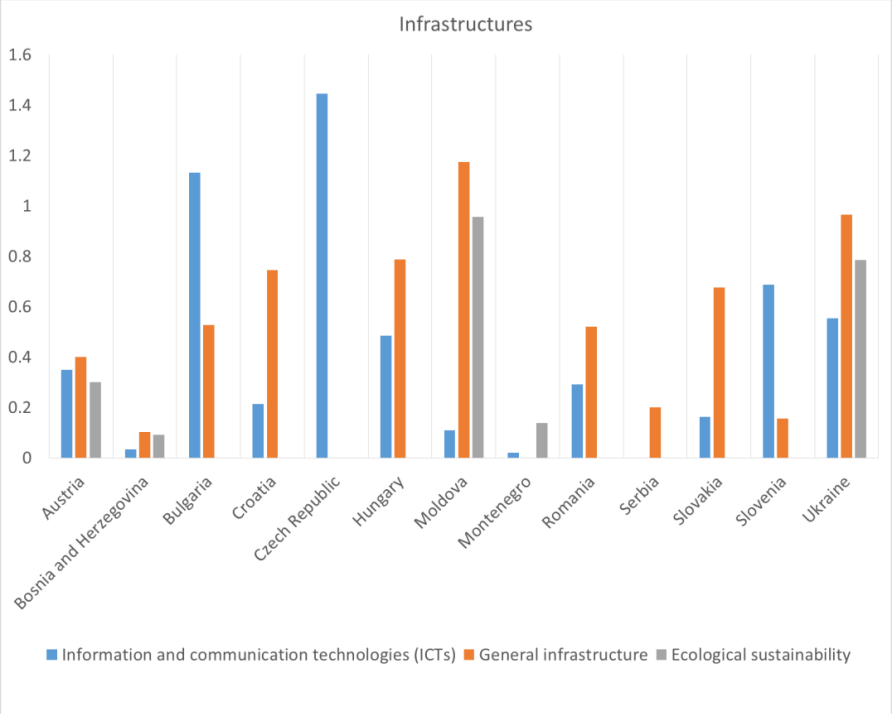

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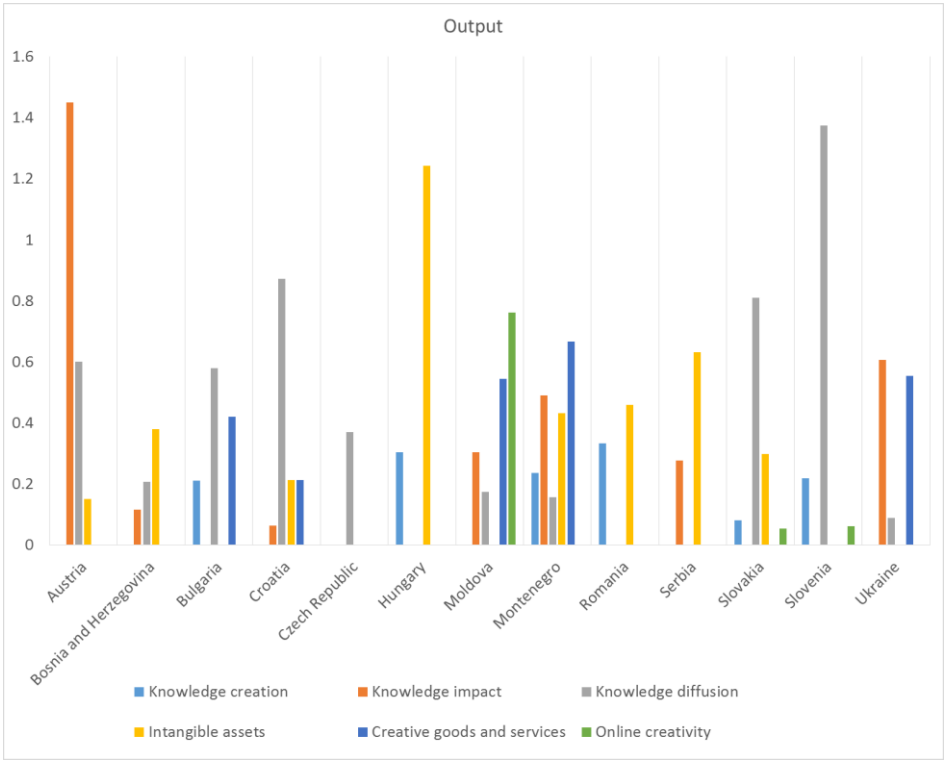

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doi:10.2760/134358

ISBN 978-92-76-14177-8