DANUBE UNDER PRESSURE – A PERSONAL ANALYSIS

*JÜRG BLOESCH**

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Key pressures in the Danube River Basin (DRB) caused by human activities are listed and updated. A list of principles to be applied by water managers and politicians are given and explained to ensure implementation of measures to prevent or mitigate human impacts to river ecosystems. Key examples in the DRB are presented in more detail, encompassing navigation (Bala Branch, Green Corridor), hydropower (Iron Gate dams), flood protection in the Lower Danube (hydromorphological assessment and sediment balance). Major conclusions are: The difficult process of public participation and major infrastructure projects were and still are biased towards users and economic interests, and it is hard to protect aquatic and terrestrial ecosystems. Science must provide safe facts on ecosystem function, environmental NGOs as observers in the ICPDR must further influence large infrastructure projects, and in the long term a paradigm change is inevitable to break the primacy of economy.

Key words: Human activity, science, ecosystem function, water management, scaling

INTRODUCTION

Drivers, pressures and threats to riverine ecosystems are well known and not specific to the Danube River Basin (DRB). These encompass mainly pollution, hydropower, navigation, flood protection, water abstraction, overexploitation, invasive exotic species, land use, new infrastructure, and global climate change. **Table 1** presents specific examples in the DRB.

Basically, human uses or the results there of interfere with ecosystem services (ES) when considering the technology invented and developed by humans. There is some contradiction in the official definition (based on COSTANZA et al. 1997) and four categories of ES as used in the EU (MEA 2005, TEEB 2010): while supporting/habitat and regulating services reflect true ES (i.e. independent of humans, such as pollination), the provisioning and cultural services reflect basically human uses and needs (such as ecotourism). In my opinion, the two terms should be clearly distinguished, although the boundary between service and use is not always sharp. Human use often ends in exploitation of ecosystems and over-consumption of natural products and, hence, is not sustainable (**Table 1**). Scaling of such pressures matters and many local to regional effects of human activities interact and sum up to threaten the whole DRB and even the global ecosystem. At the end, the philosophical dimension about nature and sustainability also must be stressed (BLOESCH 2016a).

In the context of national environmental law and implementation of the EU-WFD, some guidelines or principles should be used to mitigate the pressures on aquatic ecosystems (BLOESCH et al. 2012):

– integrative water management, i.e. respecting political borders and the catchment encompassing aquatic and terrestrial ecosystems,
– conservation has priority over restoration: this is generally cheaper and more effective as exemplified by the floodplains in the Upper and Lower Danube,
– best available technique or practice: outdated methods rarely yield good results, and methodological mistakes matter,
– fight the cause, not the effect: end-of-pipe-solutions do not solve the problem,
– polluter (causer) pays: this fosters individual responsibility for common goods,
– work with, not against nature, e.g. by restoring rivers for flood protection,
– cooperation between different experts and managers, i.e. executed inter- or even trans-disciplinarity,
– public participation is more than open access workshops and information: use NGOs and local people (inhabitants, citizens) as expert partners (according to the Espoo Convention),

* Emeritus Eawag Dübendorf, Stauffacherstrasse 159, 8004 Zürich, Switzerland, e-mail: juerg.bloesch@emeriti.eawag.ch

Pressures (selected)	Key threats	References (selected case studies)	Status (2018)
Pollution: Nutrients, persistent organic pollutants (POPs), nanoparticles, micropollutants, hormone-active substances, toxic heavy metals	Eutrophication, sublethal and lethal effects on biota, biasing food chains, decrease of biodiversity	MONERIS-Model by Behrendt & Venohr (ICPDR 2015a)	Eutrophication (phosphorus) diminished, nitrogen still a problem; new emerging substances are a great challenge
Hydropower: Iron Gates (IG) I and II; Gabčíkovo; Many planned hydropower plants in Danube tributaries	Disruption of fish (sturgeon) migration and sediment transport; change of flow, hydro-peaking; shift from lotic to lentic communities	De BRUIJNE et al. 2014); Feasibility Study (FS 2014). Terms of References ready by ICPDR, but FS not yet started	No significant progress since 2004; political will is weak, no financing as solidarity within DRB is not applied
Navigation: Former ISPA I and II Projects in the Lower Danube	Reduction of habitats and biodiversity; endangered sturgeon populations	Submerged sill and side-channel at Bala Branch bifurcation (AFDJ 2018)	Bala Bifurcation still subject to evaluation; Green Corridor impact at its beginning
Flood protection: along the Lower Danube and the Danube Delta	Disconnection of floodplains, riprap bank construction; reduction of habitats and biodiversity	Flood risk management plan (ICPDR 2015b)	Long-term and large scale problem that is accentuated by climate change
Water abstraction for agriculture and drinking water supply, and even navigation	Lowering the ground water table; alteration of discharge; drying out of floodplains	Gabčíkovo Old Danube anabranching system: slow drying out of floodplains is evident by changing vegetation	Sustainable water use is the global challenge as water is life
Overexploitation of fish/ sturgeons and sediments	Diminishing sturgeon populations to near extinction; destroying habitats for biota	CITES quota are regulating caviar trade to counteract the black market and faking labels (CITES 2018)	Significant poaching; not effective fishery bans (lack of control and incentives for local fishermen); poor sediment management
Neozoa, Neophyta: Invasive exotic species	Competition with, and extinction of domestic species	Main-Rhine-Danube-Canal favors introduc-tion of non-native species; by 2010: 141 non-native and cryptogenic taxa in the DRB (SOMMERWERK et al. 2010)	Increasing problem due to excess transport and travel, as well as climate change
Land use and new infrastructure	Loss of protected areas and floodplains; creating new pollution sources	European Strategy for the Danube Region (EUSDR) fosters economy in Middle/Lower Danube (EUSDR 2018)	Increasing pressure due to further development of society, greed and financial power
Global climate change by excess consumption and release of greenhouse gases	Increase of temperature and change of discharge, both affecting aquatic biota; more frequent and more intense periods of floods and droughts	Alpine glacier melt influences even the Danube Delta (HUSS 2011); GLOWA-Danube (MAUSER and PRASCH, eds. 2016)	A global challenge that needs regional and national solutions; new energy strategies are required

Tab. 1 Recent pressures threatening the Danube River ecosystem.

– non-deterioration of the present status as given by the EU-WFD,
– precaution, prevention and solidarity, though politically debated issues.

Beyond these general recommendations, we should think about the contributions of individuals (bottom-up approach). Personal skills, commitment, courage and patience are prerequisites. Scientists should closely link with environmental NGOs. The role of science is to investigate and understand complex ecosystems, teach about their function at all levels (particularly managers and politicians), and perform quality controls of projects.

My DRB analysis is based on over 20 years of experience in the IAD (International association for Danube Research). Here, I will elucidate various case projects covering navigation, hydropower, flood protection, and sediment management. My focus is on summarizing key facts and procedures, while combining this with a personal critical comment.

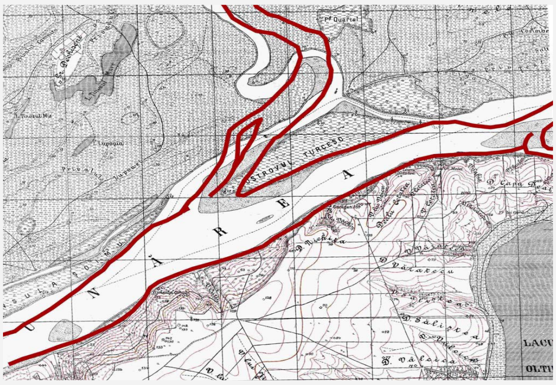

Fig. 1 Bala Branch, Danube rkm 346. Hydromorphological alterations from 1920 (background) to 2016 (bold/red contours) (Source: AFDJ 2018). The entrance angle has turned to an acute angle and the meander -like bent smoothed, together with river bed incision. It is hypothesized that these changes, apart from other influencing factors, were a major effect of diminished sediment load due to the construction of the Iron Gate dam I in 1974.

CASE STUDIES

Navigation at Bala Branch

Navigation is a traditional activity and an important political issue in the Danube River, regulated by the Danube Commission. Within the Trans-European Transport Network (TEN-T, established at the beginning of the 1990s (https://ec.europa.eu /transport / themes / infrastructure_en) the Pan-European Corridor VII for navigation connects the Black Sea with the North Sea through the Rhine-Main-Danube-Canal. The plans to improve navigation conditions in the Lower Danube date back to 2000 (Project ISPA I, Calarasi-Braila, rkm 375 – 175, www.afdj.ro/ro). The EIA in 2004 was of insufficient quality even after major revision ordered by the EU Commission. Nevertheless, it was approved by the Romanian authorities, and the engineers continued to meliorate hot spots for navigation while trying to respect nature conservation. A major point of conflicting interests is the Bala Branch bifurcation (**Fig. 1**).

The original project contained the construction of a guiding wall and a submerged sill in Bala Branch to divert some 30 % of discharge into the Old Danube. The main aim was to stop river bed incision in Bala Branch, to mitigate the siltation in the Old Danube (also beneficial for the expanded nuclear power plant Cernavoda), and to make it navigable for big ships (convoys) so as to have a shorter and cheaper transport way from the Black Sea harbor in Constanta. The NGOs criticized the exorbitant basic needs requested by navigation, such as minimum draught of 2.5 m at all stretches, navigable fairway width of 150 – 180 m, and navigability during 365 day per year. This is clearly not *adapting the ships to the river*, but *adapting the river to the ships* and conflicts with the non-deterioration requested by the EU-WFD. After the EIA, also the monitoring program at the hot spots was debated: many parameters with low importance for impacts such as noise, soil, and pollutants were intensively investigated, while crucial parameters to be affected by the planned water diversion were not or only poorly treated (e.g. water birds inventory, large-scale and long-term hydrological modelling, groundwater tables and floodplains downstream of Bala bifurcation, flow across the submerged sill).

During 2013-2016, there was an intensive dispute about the crucial question, whether sturgeons using Bala Branch for upstream spawning migration could pass the sill crest featuring increased currents (BLOESCH 2013). The debated monitoring of sturgeon migration (DEÁK and MATEI 2015) revealed that few males had passed the partly built sill; however, for sturgeon experts this is not a convincing proof that sturgeon migration is not affected by the full sill, in sharp contrast to the author's interpretation. Thus, a clear result is still missing due to a lack of local measurements that could be compared with modelled flow velocities across the sill crest, and because of various misinterpretations and misunderstandings. A proposal for an unfeasible sturgeon fish pass was discarded (BLOESCH 2014). Finally, the concept of simultaneous construction and monitoring turned out to be disadvantageous for both navigation and sturgeons, and from 2015 alternatives were evaluated by a new consortium with doubtful methods. At present (2018), the construction of a large side-channel to be used by ships and migrating sturgeons is in evaluation. Again, the IAD review was not greatly respected, and many essential questions remain open.

Navigation conditions in the Green Corridor of the Lower Danube

Along the Green Corridor there are numerous bottlenecks for navigation, essentially shallow stretches where sandbars and new islands are being formed naturally. Since dredging of sediments is an endless and costly task, engineering constructions to influence currents and riprap bank stabilizations are in the main focus. However, these bottlenecks are also hot spots of biodiversity and mostly situated within protected Natura 2000 areas (**Fig. 2**).

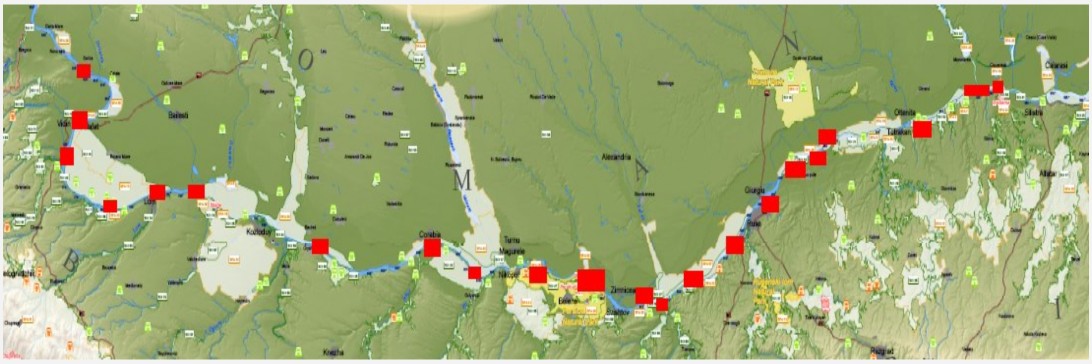

Fig. 2 Project *FAST Danube* (formerly ISPA II): Improving navigation on the common Romanian-Bulgarian Danube sector (Calarasi – Calafat, rkm 845-375). All critical sectors (squares) are in or close to protected areas (white). Sources: Technum, Belgium (bottlenecks) and WWF (map protected sites).

After a first phase of controversy followed by an intervention and advice of the EU, the process of concrete project definition has started slowly in 2016. Learning from mistakes and painful experiences in the ISPA I Project, this project named *FAST Danube* (formerly ISPA II) tries to focus more on NGOs opinions to conserve biodiversity and EU environmental standards. However, since Natura 2000 areas are not fully protected (as proven overriding interests may allow impacts and engineering constructions, Art.4(7) of WFD), it remains open whether environmental issues and river ecosystem function will gain the respective attention and implementation. By all means, the non-deterioration principle of the WFD is questioned also here.

Iron Gate I and II hydropower dams

When the Iron Gate dams I and II became operational as hydropower plants in 1974 and 1982, disrupting the river continuum and fish pass construction were not an issue. Consequently, sturgeons got stuck during their spawning migration at Iron Gate 1 dam (IG) and their accumulation triggered an exorbitant catch over some years in the 1970s until the population was diminished significantly (REINARTZ and BLOESCH 2006). When the EU-WFD came into force in 2000, the longitudinal continuum, amongst other, became an important issue to achieve *Good Ecological Status*. Hence, all dams should be equipped with functional fish passes (SCHMUTZ and MIELACH 2013). This was rated as first priority measure in the Danube Sturgeon Action Plan 2005 (BLOESCH et al. 2005). After a long period of passivity, the foundation of the Danube Sturgeon Task Force (DSTF) in 2012 initiated some projects within the Program *Sturgeon 2020* (SANDU et al. 2013). The preliminary study by a Dutch consortium created the basis for further work (DE BRUIJNE et al. 2014), and the ICPDR as well as the EU released political statements to support Danube sturgeon protection. However, a critical analysis by international experts was not considered by the authorities (BLOESCH 2015). By the beginning of 2018, the ICPDR (International Commission for the Protection of the Danube) could manage to publish a Terms of Reference (TOR) for the needed Feasibility Study (FS) and to designate an European Program for financing. While the TOR even after revision features significant weaknesses, e.g. not encompassing all potential solutions, and the lacking application of a continuous long-term monitoring of sturgeon behavior downstream of the IG II dam, including insitu physical modelling based on etho-hydraulics (ADAM and LEHMANN 2011) to evaluate the best place for the fish pass entrance, financing of such a political project by a standard EU Program seems not very promising. Instead, my recommendation to apply the principle of solidarity and to share the costs by the 8 riparian Danube countries was blown in the wind. There are definitively more political statements than political will for on site action (BLOESCH and SANDU 2013). And beyond the IG dams, considering the numerous plans to establish hydropower plants in tributaries such as the Sava and the Drava, it is questioned if the guidelines elaborated by an expert group will be fully implemented in the Danube River Basin (ICPDR 2013).

Similar to the Bala Project, the feasibility study planned for the fish passages across the IG dams need a high level of knowledge about sturgeon behavior and functioning fish pass construction, i.e. a close and fruitful cooperation between fish biologists and river engineers (BLOESCH 2016b).

Flood protection - hydromorphological classification of the Danube River

Classical flood protection performed as river regulation is deteriorating the hydromorphological river structures, important habitat for aquatic biota and, hence, ecosystem function. Since the 1990s, a paradigm change by *giving more space to the river* aimed at using natural water retention and breaking the high peaks of flood events. While this cannot be successfully applied in steep mountain rivers (e.g. in many tributaries of the Danube), it is the best measure in lowland rivers such as the main course of the Danube. Despite significant loss of Danube floodplains (SCHNEIDER 2002), the still existing floodplains in the Green Corridor of the Lower Danube are predestinated to retain excess water during floods. In addition, they provide further ecosystem services such as habitats and water purification similar to the many Danube Delta lakes (SUCIU et al. 2002).

While flow dynamics and hydrological modelling are well recognized by the authorities, sediments are not considered significant water management issues (SWMI) by the ICPDR, although they are an integral part of river ecosystems. An ongoing study tries to establish a Danube River sediment budget which is highly needed for river basin management but very difficult due to methodological restrictions (www.icpdr.org). Sediment erosion, accumulation and transport are important parameters for flood control, but sediments are also habitat for macro-invertebrates, fish, algae and macrophytes.

From the 2005s, several hydromorphological investigations in major tributaries of the Danube have been performed based on the harmonized EU-CEN Method (e.g. SCHWARZ 2008, SCHWARZ 2010 or SCHWARZ 2016). The hydromorphological quality of the Danube has been analyzed in 2015 by the Joint Danube Survey 3 (JDS3) of the ICPDR (ICPDR 2015c). It confirmed existing know-ledge that the Upper and Middle Danube are much more altered than the Lower Danube. The assessment along the Lower Danube (rkm 934-0) revealed stretches of mostly class 2 and 3 (slightly and moderately modified, 42 % and 39 %, respectively; class 1, near-natural, was not found), few class 4 (extensively modified, 16 %), and very few class 5 (severely modified, 3 %). Nevertheless, the Romanian authorities (Apele Romane) designated the stretch of the Green Corridor as HMWB (heavily modified water bodies). Obviously, this classification is not at all justified by scientific evidence. Although this designation is not transparent as the criteria are not officially given, it is politically relevant and apparently approved by the EU. In my opinion, this clearly undermines Danube River protection and the intention of the EU-WFD.

CONCLUSIONS

Danube River protection is a never ending task. Human use respectively exploitation often dominates ecosystem services. The environmental NGOs as advocates of nature have only limited though important influence in economically driven politics. The conflict of interest with economy is unbalanced, as the latter has primacy and, hence, unsustainable development is the consequence despite political statements. While fighting the cause, a global paradigm change seems to be inevitable (post-growth economy). Scientists must constantly promote the importance of research and evidence proven facts as the basis for managerial and political decisions. People should learn how ecosystems work as they are the basis of our lives. Specifically for the Danube, ICPDR features a great deal of hard work to fulfill the demands of the WFD, in particular with respect to hydropower, navigation, hydromorphological alteration, pollution and overexploitation. The main lessons learned are (1) inadequate methods produce wrong results, (2) data must be of good quality, and (3) data interpretation is the most difficult part ending often in an expert debate.

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