Developing hydropower plants in nature protected areas – the case of hydropower complex in Jiu Gorge, Romania

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Abstract

Despite being promoted as 'green' energy, hydropower plants have a strong negative impact on the environment mainly due to irreversible habitat alterations and species loss. The situation is even worse when small and medium plants are constructed in nature protected areas, established with the goal to safeguard species and habitats of community importance. This article presents the case of the hydropower complex built in the middle of Jiu River protected areas, without a proper consideration of the environmental legislation. We argue that, based on technological progress, other renewable energy sources such as wind and solar energy, coming with far lower costs for the environment and economy, should be promoted in the future.

Background

Aquatic biodiversity and freshwater ecosystems are of particular importance worldwide, due to their essential role for life and provisioning of numerous ecosystem services to human society. Yet, a report of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES 2018) highlights that biodiversity, including in aquatic ecosystems, is under serious threat in Europe.

Although freshwater ecosystems play a key role in enhancing resilience to global environmental challenges and are protected particularly by the requirements of the EU Water Framework Directive, Nature Directives and Biodiversity Strategy 2030, aiming among others to restore at least 25,000 km of EU rivers to a free-flowing state (COM 380, 2020), rivers are subject to multiple pressures such as habitat fragmentation (by hydrotechnical constructions, land use change), water abstraction, pollution, climate change (altering temperatures, precipitation regimes and frequency of extreme weather events), etc.

The development of hydropower plants, strongly promoted as 'green' energy in the past decades by ignoring the high environmental costs for the freshwater ecosystems, mainly in terms of habitat destruction and species loss, represents a major threat to European rivers. The Living Planet Report for Migratory Fish emphasizes that at European level, the migratory freshwater fish declined by 93%, one prominent cause being habitat fragmentation and the lack of free-flowing rivers in Europe (WFMF 2020).

In this context, continuing to develop small-to medium-sized hydropower plants in protected areas will have a devastating effect on the already endangered species and habitats sheltered by these ecosystems as both, rivers and their adjacent environment, are drastically affected by e.g. disruption of river continuum and sediment transport, change of lotic to lentic habitats (upstream the dam), altered discharge (downstream) and groundwater level, etc. (Bunn & Arthington 2002; Schmutz & Moog 2018). The energy production of these small hydropower plants does not contribute significantly to renewable energy production in the context of a sustainable energy strategy to mitigate climate change. In addition, their significant contribution to greenhouse gas emission and hindering of carbon sequestration is largely ignored (Deemer et al. 2016; Maavara et al. 2017).

In Romania, the implementation of the EU Renewable Energy Directive triggered a significant boom of small hydropower plants, mainly due to state subsidies. Despite the fact that small hydropower plants account for 70% of the total number of hydropower in Romania, they produce only 11.1% of total hydropower energy, i.e about 3% of Romania's total electricity production (Eurostat 2019, cited by Costea et al. 2021). Yet, they generate severe negative impacts on ri-

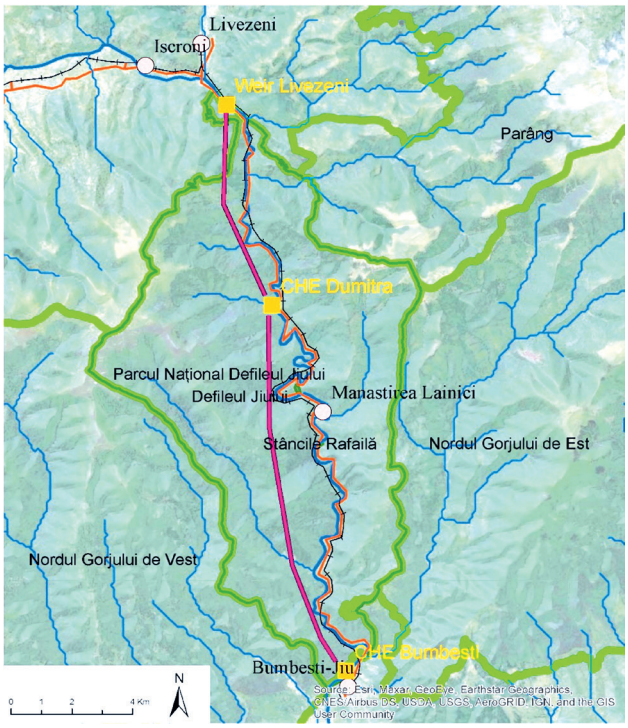

Figure 1. *The projected hydropower plants within the Jiu breakthrough in the protected areas: In light green the boundaries of Natura 2000 areas (in thin dark green the national park boundaries); in orange the planned facilities of the hydropower plant complex (the hydroelectric plants CHE Dumitra and CHE Bumbesti, the weir Livezeni is completed but out of operation so far, the planned parallel headrace tunnel is shown in purple, CHE = Centrala Hidroelectrica).*

vers, as e.g. in case of hydropower plants built on headwater streams, the trout *(Salmo trutta fario)* and bullhead *(Cottus gobio)* populations often disappeared completely, remaining in only 38% of the stream reaches, isolated either upstream or downstream of the plants (Costea et al. 2021).

The case of hydropower complex in Jiu Gorge National Park

The Jiu River is among the largest rivers in Romania and one of the main tributaries of the Danube River. The Jiu Gorge, located in the Southern Carpathians between Valcan and Parang Mountains, is approximately 30 km long and encompasses several minor tributaries flowing into Jiu River (Telcean et al. 2017). Due to its high biodiversity, Jiu Gorge was declared a National Park in 2005, and two years later, after Romania's accession in the EU, the area was included in Natura 2000 network as site of community importance ROSCI 0063 Defileul Jiului.

The hydropower complex is located at the heart of the National Park Jiu Gorge and Natura 2000 protected area *(fig. 1).* The development of the first stages of this project started in 2004, but despite the severe environmental impact expected due to the river flow alteration and habitat fragmentation, construction permits were issued in 2008, 2012 and 2016 without a proper environmental assessment procedure, the project being accomplished about 72 % (according to the Romanian Government) by ignoring the environmental requirements. Consequently, the Romanian Appeal Court annulated the last two permits in December 2017, rendering the whole construction illegal.

The hydropower complex encompasses two hydropower plants and several hydrotechnical constructions along Jiu Gorge *(fig.1).* The first hydropower plant, Dumitra, includes an intake dam at Livezeni *(fig.2),* a 7 km long headrace tunnel, a penstock and Dumitra powerplant, the whole ensemble covering roughly one third of the Jiu Gorge. The second hydropower plant collects the water from Dumitra hydropower plant plus the water from the Jiu secondary inlet and Dumitra River, passing through a 12.5 km headrace tunnel, to the end of Jiu Gorge, where Bumbești powerplant is located. A second tunnel aims to capture the flow of Bratcu River, a right tributary of Jiu River, and bring it to the powerplant.

Based on the water management permit released in 2003, an ecological flow of only 2.7 m^3/s will remain in the Jiu River, representing roughly 10% of the natural flow. According to the National Forest Administration (Romsilva 2010), it is expected that the average water depth downstream Dumitra will decrease dramatically to levels far too low to sustain the life of the protected species and habitats sheltered by Jiu Gorge, increasing the risk that the river will completely dry-out during the dry season.

The Standard data form (https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=ROSCI0063) lists the key habitats and species for which ROSCI 0063 Defileul Jiului was declared a protected area. The flow reduction of about 90% along the entire length of the gorge (Telcean et al. 2017) will severely affect habitats located along the river, such as e.g. Alpine rivers and the herbaceous vegetation along their banks (habitat code 3220), Alpine rivers and their ligneous vegetation with *Myricaria germanica* (habitat code 3230), Alpine rivers and their ligneous vegetation with *Salix eleagnos* (habitat code 3240) and priority habitat Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae)* (habitat code 91E0*).

The impact on species is expected to have even more far-reaching consequences, considering that water diversion will affect not only the aquatic and semi-aquatic species, but entire food webs, including the terrestrial species inhabiting the gorge slopes. The aquatic species will be the first impacted by the dam construction and drastic flow reduction as their lotic habitat will be dramatically changed. Besides four Natura 2000 fish species with acknowledged conservation value: *Barbus balcanicus* (code 5261), *Cottus gobio* all other (code 6965), *Romanogobio uranoscopus* (code 6145) and *Sabanejewia balcanica* (code 5197), an endemic species only present in Romania in a very limited range inhabits this area, *Sabanejewia romanica* (Telcean et al. 2017). *Alburnoides bipunctatus* (code 2500), a fish species protected under Bern Convention An. II, will also be impacted. Further, herpetofauna species such as e.g. *Bombina variegata* (code 1193), *Rana dalmatina* (code 1209), *Rana temporaria* (code 1213), *Salamandra salamandra* (code 2351), *Triturus alpestris* (code 2353), *Triturus cristatus* (code 1166), *Natrix tessellata* (code 1292), will be negatively affected by the water uptake, most species requiring aquatic habitats for reproduction, development of young stages of life and feeding. Among other species harmed by habitat degradation are the semi-aquatic beetle *Carabus variolosus* (code 4014) and a primeval forest relict beetle species *Agnathus decoratus* protected in countries from Central Europe (Eckelt et al. 2017).

Due to the severe decline of fish populations, it is expected that another priority species, the otter *(Lutra lutra,* code 1355), will also decline. Another protected species, *Austropotamobius torrentium* (code 1093) inhabiting the Jiu riverbed, is also expected to register a sharp decline. The same decline will take place for the lynx *(Lynx lynx,* code 1361) population in Jiu Gorge National Park (as proven by similar experiences in Macedonia), along with other large mammals living on the forested slopes of the gorge. Also, bat species feeding around the river, such as *Barbastella barbastellus* (code 1308) will record a drastic decrease if the hydropower project will be completed.

The legal problem

A rapid analysis of the development of this hydropower complex shows that at least 3 environmental directives were already or will be breached when the complex will become operational.

Environmental Impact Assessment Directive 2011/92/EU. The directive on the assessment of the effects of certain public and private projects on the environment (EIA directive) stipulates that environmental considerations shall be taken into account at the earliest possible stage and integrated into the project's design. However, it was not the case for this project, as public and environmental expert comments were roughly ignored. Given the fact that valuable protected habitats were already destroyed by the constructions and endangered species were already affected by this project, we consider the attempts to issue a new environmental permit for this construction as obsolete: an EIA cannot be performed after completing the biggest part of the project.

Water Framework Directive 2000/60/EC. The Water Framework Directive (WFD) requires the assessment of the ecological status of freshwater bodies based on chemical, biological and hydromorphological quality elements. The significant change of the river discharge (up to 90 % of the flow being diverted from the river into tunnels), the regulation of Dumitra River and the construction of the dams, fragmenting river habitats, altering migration and sediment transport, and changing the upstream sections into lentic ecosystems while downstream section will suffer from insufficient flow, especially during seasons with low precipitation regime, will significantly alter the biological components (especially fish, macroinvertebrates and macrophytes communities), hydromorphological parameters (hydrological regime, river continuity, morphological conditions, in particular as large reaches (60%) fulfill currently reference conditions), and even the chemical quality elements (mainly oxygen regime). It is expected that, if the complex will become operational, the ecological status of the river will drop significantly for at least two or even three classes, representing a violation of the non-deterioration principle of the WFD and a breach of Art. 1a & 1b, Art. 4.1a, para (i), Art. 4.1c.

Habitats Directive 92/43/EEC. The Habitats Directive requires the establishment of Natura 2000 network of protected areas to preserve species and habitats of community importance in each EU member state. Along the Jiu River, the National Park Jiu Gorge and the Natura 2000 site (ROSCI 0063) with the same name were established with the support of the Romanian Ministry of Environment to protect the biodiversity of this free-flowing river stretch. However, the planned uptake of up to 90 % of the river flow will have a severe negative effect on several sensitive habitats, located along the river banks and directly dependent on the river flow. It is expected that water diversion, leading to a drying river bed over long periods of time, will affect not only the alpine river habitats but could lead also to changes in water availability for the riparian forests leading to a decline of 80-90% of these habitats. Of particular concern is the priority habitat 91E0 (alluvial forests), as according to Habitats Directive, projects impacting priority habitats should be allowed only in very special conditions. Hence, we consider that articles Art. 6.2, Art. 6.3, Art. 6.4, Art.10 of Habitats Directive will be breached by this project.

Quo vadis biodiversity conservation in Romania?

As a consequence of the war in Ukraine and the momentum to gain energetic independence from Russian fuel sources, the Romanian Parliament adopted recently a controversial law (PL-x 132/2022) allowing the modification of nature protected areas limits and giving green light for the finalization of hydropower plants constructed over 60%, considered projects of overriding public interest and of national security, until the end of 2025. As a compensatory measure, the Ministry of Environment, Water and Forests will propose for protection a new area, with similar biodiversity as the one occupied by the hydropower plant construction. Such projects are considered exceptional situations regarding the environmental impact assessment. The law was challenged for unconstitutionality by Union to Save Romania (USR), a ruling being expected soon.

This law conflicts with the requirements of the EU environmental directives, in particular with the non-deterioration principle of Water Framework Directive. The ruling of the European Union Court of Justice C 461/13 states the binding force of WFD Art. 1 on the Member States to prevent deterioration of water bodies and to protect and enhance the status of aquatic ecosystems and terrestrial ecosystems directly depending on the aquatic ecosystems. It also conflicts with the Romanian Constitution, which guarantees the right to a safe environment. Considering the projected impacts of climate change on the southern part of Romania, with decreasing precipitation levels and water scarcity (ICPDR 2019), it is expected that the discharge of Jiu River will decrease, while water demands from all the consumers (households, tourism, hydropower plants, etc) will increase, reducing the efficiency of energy production. Moreover, the construction of new reservoirs will increase the local emission of greenhouse gases, counteracting the efforts to mitigate climate change impacts.

Taking into account the low amount of energy production estimated for the hydropower complex in Jiu Gorge, compared to the major environmental losses in the protected areas, this project cannot be considered of overriding public interest, to benefit from exemptions under Water Framework Directive or Habitats Directive. Moreover, the fact that the project was developed without proper environmental considerations is even more aggravating, as allowing its continuation means encouraging similar behavior from other stakeholders. The stretch of Jiu River in Jiu Gorge National Park is the area with the highest degree of protection by law. If species sharply decline or disappear from such a strongly protected area, it is a clear signal that they can also disappear from other river stretches with a lower degree of protection.

In addition, due to the development of other renewable energy sources, hydropower lost its advantage of being the cheapest energy source. The power generation costs for solar and wind energy have fallen sharply over the past decade (IRENA 2021), mainly due to technological

Energy type	Levelised cost of electricity (2020 USD/kWh)		
	2010	2020	Percent change (%)
Bioenergy	0.076	0.076	0
Geothermal	0.049	0.071	45
Hydropower	0.038	0.044	18
Solar photovoltaic	0.381	0.057	-85
Concentrating solar power (CSP)	0.340	0.108	-68
Onshore wind	0.089	0.039	-56
Offshore wind	0.162	0.084	-48

Table 1: Levelised cost of electricity trends by technology, 2010 and 2020. Source: International Renewable Energy Agency (IRENA, 2021).

improvements and competitive supply chains, becoming increasingly attractive and accessible for new energy investments. Between 2010 and 2020, the global weighted-average cost of electricity from onshore wind fell by 56 %, while for solar energy the cost dropped by 85%; over the same period, the hydropower generation costs increased by 18%, surpassing the costs for onshore wind energy *(tab.1)*.

Considering that hydropower energy comes with dramatic environmental costs and is losing its price attractiveness due to the current progress of other renewable energy sources, we consider that a revision of the energy policy of Romania is needed, based on current developments at the international level and state-of-the-art data and projections, not on reviving projects abandoned for decades and breaching environmental legislation.

References

Bunn SE, Arthington AH (2002): Basic principles and ecological consequences of altered flow regimes for aquatic biodiversity. Environmental Management 30, 492-507

COM 380 (2020): Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions. EU Biodiversity Strategy for 2030 - Bringing nature back into our lives. Brussels, 20.05.2020

Costea G, Pusch MT, Banaduc D, Cosmoiu D, Curtean-Banaduc A (2021): A review of hydropower plants in Romania: distribution, current knowledge and their effects on fish in headwater streams. Renewable and Sustainable Energy Reviews 145. https://doi.org/10.1016/j.rser.2021.111003

Deemer BR, Harrison JA, Li S, Beaulieu et al. (2016): Greenhouse Gas Emissions from Reservoir Water Surfaces: A New Global Synthesis. BioScience 66(11), 949–964

Eckelt A, Müller J, Bense U, Brustel H. et al. (2017): Primeval forest relict beetles of Central Europe: a set of 168 umbrella species for the protection of primeval forest remnants. Journal of Insect Conservation 22,15–28

ICPDR (2019): Climate change Adaptation Strategy. ICPDR Secretariat, Vienna International Centre, Austria, 82 pp

[IRENA] International Renewable Energy Agency (2021): Renewable Power Generation Costs in 2020. Abu Dhabi, 178 pp

[IPBES] Intergovernmental Platform on Biodiversity and Ecosystem Services (2018): The IPBES regional assessment report on biodiversity and ecosystem services for Europe and Central Asia. Rounsevell M, Fischer M, Torre-Marin Rando A, Mader A (eds.). Bonn, Germany, 892 pp

Maavara T, Lauerwald R, Regnier P et al. (2017): Global perturbation of organic carbon cycling by river damming. Nature Communications 8, 15347

Romsilva [Romanian National Forest Administration] (2010): Intimation no. 42/12.01.2010

Schmutz S, Moog O (2018): Dams: Ecological Impacts and Management. In: Schmutz S, Sendzimir J (eds): Riverine Ecosystem Management. Science for Governing Towards a Sustainable Future. Springer, 111-121

Telcean IC, Mihut RE, Cupşa D (2017): The fishes' last stand: the fish fauna of Jiu River Gorge, between decades of coal mining and present day hydroenergetic works. Eco.mont - Journal on Protected Mountain Areas Research 9, 15-21

World Fish Migration Foundation (2020): Living Planet Report for Migratory Fish. Technical Report, 30 pp

Dam removal: just a trend or a fast forward strategy for healthy rivers?

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The importance of river connectivity for biodiversity and ecosystem services of rivers is common knowledge today. River connectivity is perceived in four dimensions: longitudinal, lateral, vertical and temporal. Rivers are pathways not only for water, but also for sediments, organic matter and of course wildlife (Grill et al. 2019; Zeiringer et al. 2018). Rivers have been utilised by man for thousands of years and by doing so river ecology and especially the connectivity were altered in many ways. Already a few centuries ago, the apparent negative effect of barriers, especially on fish, was detected and first mitigation measures like technical fish-ways have been built. Given the enormous degree of fragmentation, the re-establishment of connectivity has become one of the main pillars of river restoration and river basin management.

While dam removal is by far not new to water management (on the contrary, historical evidence shows that deconstruction of weirs and dams happened frequently), it still seems to be the second choice, when it comes to today's river restoration. For example, the river basin management plan for Austria (BMLRT 2021) does not mention dam removal at all, nor does the guideline for fish-passages. This is remarkable, as it is clear that dam removal is by far the most effective, and in the long-run cheapest way to deal with obstacles (BMLFUW 2017). Moreover, it is the only way to fully restore longitudinal connectivity.

There are three excellent reasons that indicate a special focus on dam removal: First of all, recent research revealed that the amount of river fragmentation has been underestimated significantly. By means of field-proofing Belletti et al. (2020) estimate, that only 50% of barriers are recorded in official databases. In total, up to 1.2 million barriers could fragment rivers in Europe. Furthermore, we would require a uniform definition of when a transverse structure is considered a (full) barrier to migration. Secondly, there is clear evidence that dam removal is also a very successful river restoration technique, which has delivered positive results