

TRADING-OF FRESHWATER BIODIVERSITY AND HYDROPOWER IN A UNIQUE BALKAN HOTSPOT (VJOSA RIVER WATERSHED, ALBANIA)

SPASE SHUMKA, FERDINAND BEGO¹, SAJMIR BEQIRAJ¹, ANILA PAPARISTO¹,
LULEZIM SHUKA¹, LEFTER KASHTA², ALEKO MIHO¹, LAURA SHUMKA³, SOTIR
MALI⁴

Department of Natural Sciences, Agricultural University of Tirana, Koder Kamza

¹Department of Biology, Faculty of Natural Sciences, University of Tirana.

²Research Center of Flora and Fauna, Faculty of Natural Sciences, University of Tirana.

³Albanian University, Tirana, Albania

⁴University "A. Xhuvani" Elbasan, Albania

e-mail: sprespa@gmail.com

Inland waters and freshwater biodiversity in Albania constitute a valuable natural resource, in economic, cultural, aesthetic, scientific and educational terms. Amongst them Vjosa River watershed represents a unique feature, while its conservation and management are critical to the interests of local population, national and regional one. This review explores the special features of Vjosa River as one of the last living wild rivers in Europe. Along more than 230 kilometers in Albania it is untamed and free flowing, characterized by beautiful canyons, braided river sections and meandering stretches. Together with its tributaries, the Vjosa River creates a dynamic near-natural ecosystem, a true regional natural heritage. However, eight dams are foreseen along its course in Albania. These dam projects would destroy the unique river system. The river itself, from delta to upland flows, is migration corridor for European eel (*Anguilla anguilla* Linnaeus, 1758) and many other marine species.

Key words: ecosystem, inland water, faunal migration, ecological integrity, degradation.

Bioraznolikost nasuprot hidroenergetici u slivu rijeke Vjose (Albanija). Slatkovodni ekosustavi i njihova bioraznolikost u Albaniji predstavljaju vrijedne prirodne resurse u ekonomskom, kulturnom, estetskom, znanstvenom i obrazovnom smislu. Među prirodnim vrijednostima nalazi se i sliv rijeke Vjose, čije očuvanje i upravljanje su od ključnog značenja kako za lokalno stanovništvo, tako i na nacionalnom i regionalnom nivou. Ovaj rad iznosi posebne značajke rijeke Vjose, kao jedne od posljednjih divljih rijeka u Europi. Na više od 230 kilometara toka u Albaniji, odlikuju je prekrasni kanjoni, razvedenost korita i meandri. Zajedno sa svojim pritokama, rijeka Vjosa stvara dinamičan prirodni ekosustav i istinsku regionalnu prirodnu baštinu. Međutim, u albanskom dijelu toka predviđena je izgradnja osam brana, koje mogu uništiti ovaj jedinstveni riječni sustav. Sama rijeka, od delte do uzvodnog dijela, je migracijski koridor za europsku jegulju (*Anguilla anguilla* Linnaeus, 1758) i mnoge druge morske vrste.

Ključne riječi: slatkovodni ekosustav, migracija faune, ekološki integritet, degradacija.

INTRODUCTION

Albania is located in the western part of the Balkan Peninsula. Its hydrographic territory has a surface of 44,000 km square, with an average height of the hydrographic territory of about 700 m above the sea level.

It has more than 152 rivers and streams that form 8 large rivers (*Buna, Drin, Mat, Ishëm, Erzen, Shkumbin, Seman, Vjosë*) flowing from southeast to northwest, mainly discharging towards the Adriatic coast. The

average perennial total inflow of Albanian rivers is about 1,245 m³/s while the amount of water running to the sea is about 40 billion water cubic meter/year [1]. About 65% of their watershed lies within the Albanian territory [2]. Following [3] in

Albania there are identified a total of 432 hydropower plants, 361 of which are planned to be developed, 27 are in the constructing process and 44 currently exist (Tab.1; Fig. 1).

Table 1. The number of hydropower plants for each of the basins in Albania
Tablica 1. Broj hidroelektrana u riječnim bazenima Albanije

Basins	Existing	In construction	Planned	Total
Drin	16	3	140	159
Ishem/Erzen	1	0	10	11
Mat	2	0	57	59
Seman	6	5	68	79
Shkumbin	2	7	65	79
Vjosa	12	12	21	45
TOTAL	44	27	361	432

The principal intention of this review is to address the current state of biodiversity of Vjosa aquatic ecosystems through counting different threats that jeopardize protection and survival of freshwater species and ecosystems. It examines already published record (scientific papers and reports), and conducted experts surveys with aim to: (i) assess the current knowledge on biological diversity; (ii) threats to Vjosa River system (native) biodiversity; (iii) summarize existing conservation activities and strategies, and (iv) outline future conservation and research needs for Vjosa River as a crucial part of its watershed. Particularly important aspects to sustaining biodiversity and the health of Vjosa freshwater system, the needs for preserving or restoring the natural variability in its main riverbed and stream flows are addressed, too. Biodiversity within inland water ecosystems in Albania is both, highly diverse and of great regional importance to livelihoods and economies. However, development activities (particularly hydropower plants) are not

compatible with the conservation of this diversity and it is poorly represented in the development planning process (Fig. 1). One of the reasons for inadequate representation of biodiversity is referred as a lack of readily available information on the status and distribution of inland water taxa [2, 4], while the Albanian Red List (2013) approach seems to be not compatible with standard International Union for Conservation of Nature (IUCN) species determination practice.

Among the biggest current threats to the natural heritage of the Balkan region is the large number of planned hydropower plants. Hydropower dams have a significant impact on the river ecosystem and the longitudinal continuum for living organisms and sediments [2, 4]. They can also negatively impact wild terrestrial animals including large carnivores living in mountain fringes within the Dinaric Arc. This leads to a loss of ecological integrity, river degradation, and consequently a decrease in biodiversity [4].

Hydropower plants in Albanian rivers

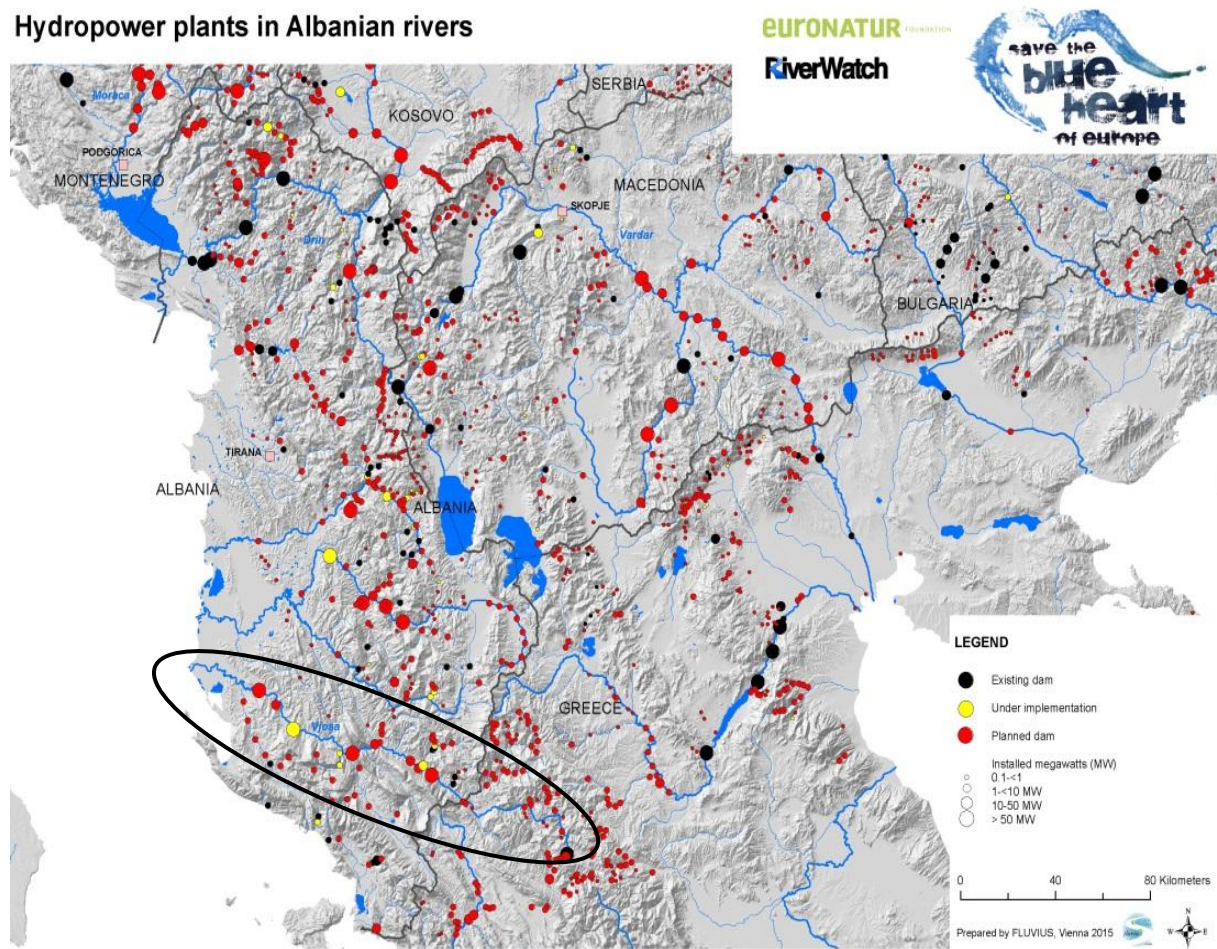


Figure 1. Existing, under construction and planned hydropower plants across Balkan region with highlighted Vjosa catchment, (September 2015, FLUVIUS, 2015)

Slika 1. Postojeće hidroelektrane, one u izgradnji i planirane za izgradnju u balkanskoj regije s istaknutim slivom rijeke Vjose (rujan 2015., FLUVIUS, 2015)

Despite to its important role as a renewable resource replacing fossil fuel dependent power generation, hydropower comes with its own significant social and environmental costs that seem to be largely unrecoverable. The challenges facing Albania are settling on the right balance and ethics of hydropower development so that natural resources and their uses by other sectors are maintained along with biodiversity and social and cultural inheritance. Potential losses in development, social and environmental values of

biodiversity need to be weighed against the economic and social benefits of hydropower.

According to the recent literature sources [5, 6, 7, 8, 9, 10]. (, the major direct causes of human-induced biodiversity loss are: (i) the fragmentation, degradation or loss of habitats; (ii) the over-exploitation of natural resources; (iii) pollution of air and water (by several activities such as agriculture); (iv) the introduction of non-native (alien, non-native or exotic) species and (v) climate change-induced biodiversity loss. In case of Vjosa River basin all these

factors are clearly interrelated and well linked with some or all of the other, causing thus series of threatening sequences. Recently, with the rate of data we own for entire Vjosa watershed difficult to depict the long-term pattern of biodiversity loss, but based on assessments for similar wetlands [7], the current review with contexts of hydropower expansion clearly defines that there is no exception.

The rivers exhibit a torrential and erosive regime especially in the eastern,

mountainous part, forming large and meander beds in the western coastal lowland. More than 66 fish species were recorded in freshwater habitats (*new checklist under publication*).

Discharge of all Albanian rivers is seasonally highly variable, being sometimes more than ten times less in summer than in winter. The beds of the main rivers are usually very wide, as a great amount of gravel and pebbles is deposited next to the banks [11].

MATERIAL AND METHODS

The published results with this paper are based on the author's field surveys and long-term observations and monitoring data available at the Tirana University, Tirana Agricultural University and other sources. This review examines important data on the environmental and social negative impacts of HPPs into the environment's quality that confirms critical situation related to rare and endangered plants and animals (fish, amphibians and reptiles, birds and mammals), as well as rare and endangered habitats. Most of the threatened reported species belong to the Albanian Red List (2013), and/or IUCN endangered species [2].

The threat assessment carried out in this paper is based on the guidelines provided by both the International Union for Conservation of Nature (IUCN) and the Global International Waters Assessment

(GIWA) [12, 13]. The IUCN threat classification scheme was used to assess key threats to species. They involve past, ongoing and future threats, using a time frame of three generations or ten years, whichever is the longer (not exceeding 100 years in the future) as required by the Red List Criteria [13]. Environmental impacts were assessed using the scoring scheme provided by GIWA, which is more ecosystem oriented. Four impact scores ranging from 0 (impact unknown) through 1 (slight impact), 2 (moderate impact) to 3 (severe impact) were used to quantify the importance of each key issue (Tab. 2; Fig. 2). Details on determining impact scores can be found in the GIWA Methodology handbook for scaling and scoping [12]. Average scores were calculated for each threat class and maximum values are given.

Table 2. Summary chart of IUCN threat classification scheme, key threats, current impact and expected future (mid-term) importance in the Vjosa River basin. Global International Water Association (GIWA), (2001). Average scores were calculated for each threat class and maximum values are also given. The level of knowledge regarding these threats is subjectively estimated. For details and references see text.

Tablica 2. Sažetak klasifikacije ugroženosti prema IUCN, ključne prijetnje, trenutni utjecaj i očekivana buduća (srednjoročna) važnost u slivu rijeke Vjose. Globalna međunarodna udruga voda (GIWA), (2001). Prosječne ocjene izračunate su za svaku vrstu ugrožavanja kao i njihove maksimalne vrijednosti. Razina znanja o prijetnjama subjektivno su procjenjene. Pojednosti i reference potražite u tekstu.

Threat class	Major threat	Level of knowledge	Impact	Average impact	Maximum impact
1. Residential & commercial development	1.1. Housing&urban areas	well - known	3	2	3
	1.2. Commercial&industrial areas	moderately known	1		
	1.3. Tourism&recretaion areas	well - known	2		
2. Agriculture & aquaculture	2.1 Annual & perennial non-timber crops	less-known	2	2(2.33)	2
	2.2 Wood & pulp plantations	well - known	1		
	2.3 Livestock farming & ranching	well - known	2		
	2.4 Marine & freshwater aquaculture	less-known	2		
3. Energy production&mining	3.1. Oil&gas drilling	well - known	1	2	3
	3.2. Mining&Qurrying	well - known	2		
	3.3. River mining	well - known	3		
	3.4. Renewable energy	well - known	2		
4. Transportation&service corridors	4.1. Road&railroads	well - known	2	1(0.5)	2
	4.2. Utility&servic elines	–	0		
	4.3. Shippin lanes	–	0		
	4.4. Flight paths	–	0		
5. Biological resource use	5.1. Hunting&Trupping animals	moderately known	2	2(1.5)	3
	5.2. Gathering terrestrial plants	moderately known	1		
	5.3. Logging&wood harvesting	well - known	3		
	5.4. Fishing&harvesting aquatic resources	moderately known	1		
6. Human intrusion&disturbance	6.1. Recreational activities	less-known	1	1(0.66)	1
	6.2. War, civil unrest& military excersises	–	0		
	6.3. Work&other activities	less-known	1		
7. Natural system modifications	7.1. Fire&fire supression	less-known	2	2(2.33)	3
	7.2. Dams & water management/use	moderately known	2		
	7.3. Other ecosystem modifications	less-known	3		
8. Invasive spieces	8.1. Invasive non-native/alien species	moderately known	2	1(1.33)	2
	8.2. Problematic native species	less-known	0		
	8.3. Introduced genetic material	less-known	2		
9. Pollution	9.1. Domestic & urban waste water	well - known	3	2 (1.83)	3
	9.2. Industrial & military effluents	moderately known	2		
	9.3. Agricultural & forestry effluents	moderately known	2		
	9.4. Garbage & solid waste	well - known	3		
	9.5. Air-borne pollutants	less-known	1		
	9.6. Excess energy	–	0		
10. Geological events	10.1. Volcanoes	–	0	0	0
	10.2. Earthquakes/tsunamis	–	0		
	10.3. Avalanches/landslides	–	0		
11. Climate change&severe weather	11.1. Habitat shifting & alteration	well - known	3	2(2.2)	3
	11.2. Droughts	less-known	3		
	11.3. Temperature extremes	less-known	2		
	11.4. Storms&floodings	less-known	3		
	11.5. Other impacts	–	0		

Scores ranges: 0 (no know impact) through 1 (slight impact), 2 (moderate impact), 3 (severe impact)

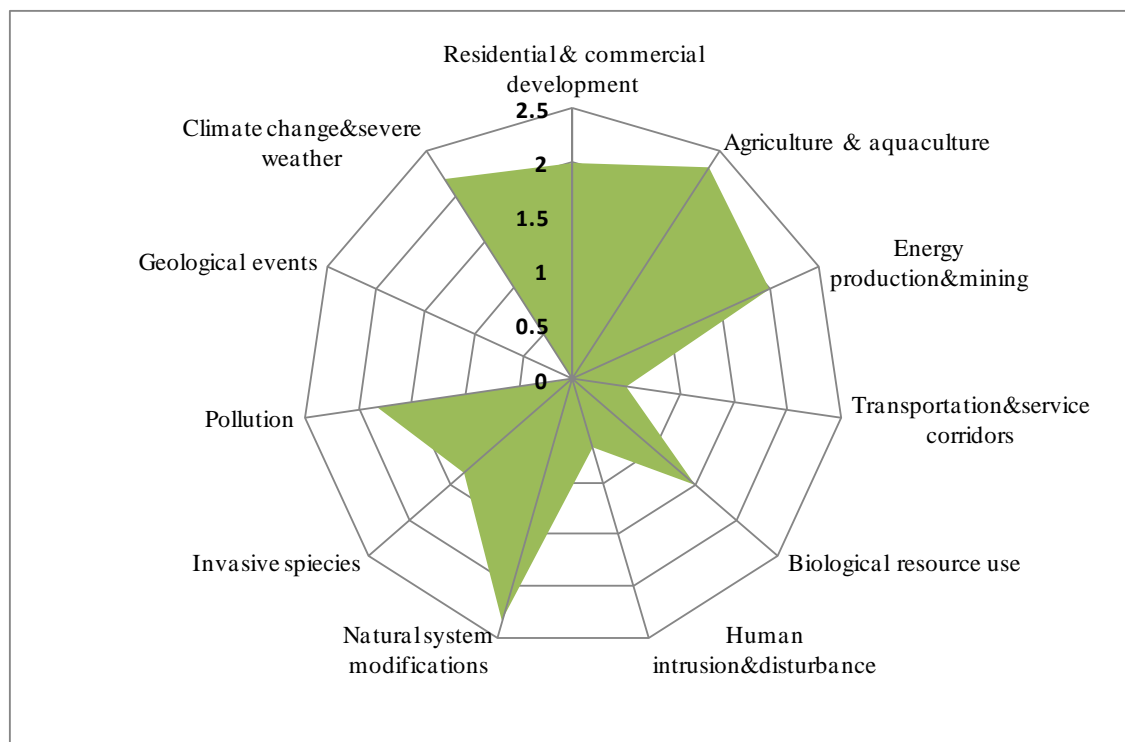


Figure 2. Major threat class and their average impact

Slika 2. Glavne razine opasnosti i njihov prosječni utjecaj

RESULTS AND DISCUSSION

The publications for Vjosa River remain very scarce. Under a search through Google scholar within last three decades there are ca. 60 publications where 70% of them belong to foreign authors [17]. Compared with several other sites in Albania this number is very low and that shows the great need for further surveys. Vjosa River has presented a stable and continuous freshwater ecosystem and hydrological regime for thousands of years. Considering the geographic, climatic and landscape characteristics and the existence of traditional ways of using the area, the river area posses high diversity of habitats and species from its delta in Adriatic to the most upper mountainous part in Albania and Greece. Vjosa delta, its closely related transitional wetlands (i.e. Narta lagoon) and

dunes belongs to the largest and the most important coastal wetlands of Albania, declared a Landscape Protected Area in the year 2004.

As it is described within second section of methodology the rate of knowledge regarding different threats (Table 1, Figure 2) was subjectively estimated. Threats to the Vjosa River ecosystem are complex, sometimes obvious in other cases rather invisible with the time frame for consequences ranging from current to long term prospective. So the references here are with compiled threats to both, specific taxa (and in cases to particular species) as well as to the river habitats. These threats act on different spatial scales with varying intensities with specific highlights to hydropower plants. The list of current and

particular potential threats assessed is incomplete and here we have restricted to anthropogenic threats. The amount of different and partly interacting threats results in a number of conservation concerns related to Vjosa River: (1) watershed impacts, (2) agriculture and forestry, (3) tourism and population growth, (4) non-indigenous species, (5) habitat alteration or loss, (6) unsustainable exploitation of fisheries, and (7) global climate change. These concerns

may include direct threats or may cause more indirect effects on both species and habitats. Different spatial scales are involved, ranging from local to ecosystem wide scales. Threats assumed as basis in these concerns may be present on either of the sides of the river (Greek part of the river) or be unclear. Moreover, many of the threats listed in Table 2 affect more than one of the above concerns.

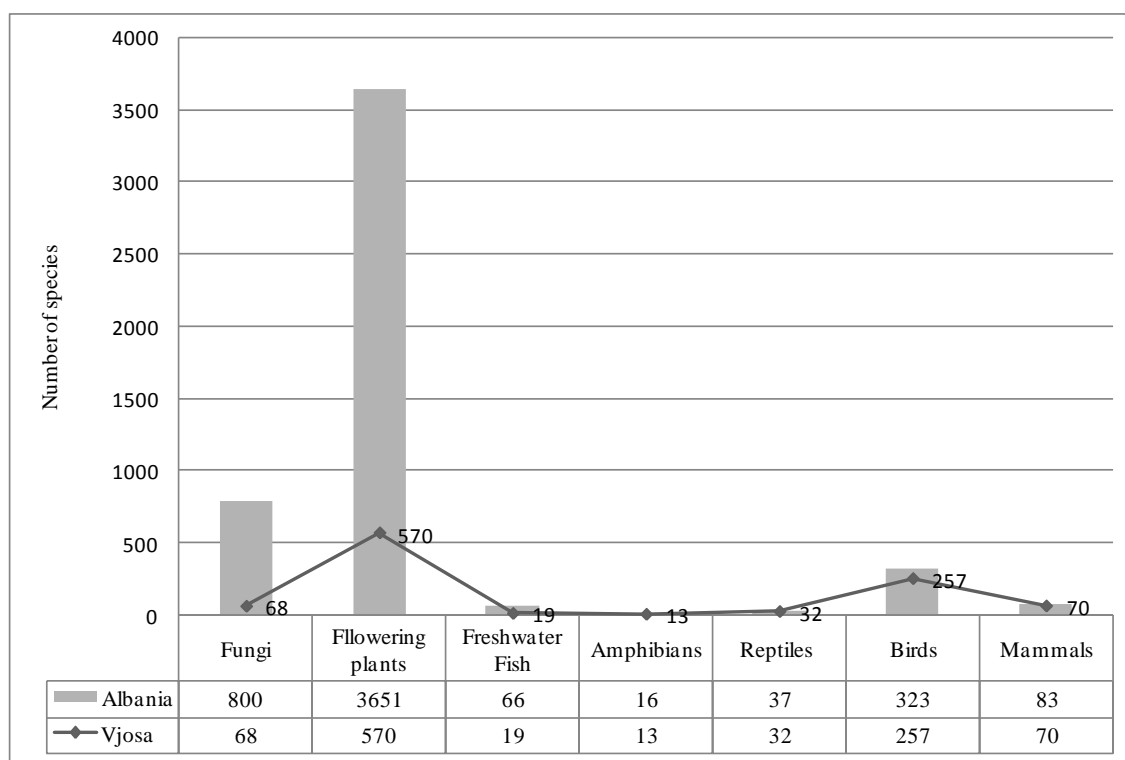


Figure 3. Number of recorded species per different group of flora and fauna in Vjosa River and in Albania

Slika 3. Broj zabilježenih vrsta različitih skupina flore i faune u rijeci Vjosa i Albaniji

Amongst 11 different threats analyzed within this paper (Tab. 2), habitat modifications remain one of the most serious. With several constructed small Hydropower's, one big size under construction (Kalivaçi), one already given through concession (Poçemi), and dozen other planed it seems the habitat

modification will seriously threaten the ecosystem functioning. The alteration or even loss of habitats as one of the best understood conservation concerns is an ongoing problem in wider Vjosa River system, along with expansion of construction around the major towns Kelcyra, Memaliaj, Gjirokastra (average impact 2.33).

THE BIODIVERSITY WITHIN VJOSA RIVER SYSTEM

The Vjosa River in Albania is of pan-European or even global importance. It represents one of the last intact large river systems in Europe, hosting all different types of ecosystems: from the narrow gorges in the upper part to the wide braided river sections in the middle part to the near natural delta at the Adriatic Sea. Scientific knowledge about the Vjosa and its biodiversity or crucial physical processes such as sediment transport or groundwater systems is very limited [14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24]. (s. It is one of the least explored rivers in Europe: we might know more about the biodiversity of river systems in South America or Asia than we do about the Vjosa [25]. Very few studies are conducted before many decades [17].

The free flowing Vjosa river is of outstanding importance for various migratory fish species, i.e. the critically endangered European eel *A. anguilla* as well as sub-endemic fish species like the Ohrid loach (*Cobitis ohridana* Karaman 1928) and the Pindus stone loach (*Oxynoemacheilus pindus* Economidis, 2005). In terms of bird populations, the area provides breeding ground for Stone curlew (*Burhinus oedicephalus* Linnaeus, 1758), Little ringed plover (*Charadrius dubius Scopoli*, 1786) and others, foraging ground for the Little tern (*Sterna albifrons* Pallas, 1764), Egyptian vultures (*Neophron percnopterus*

Linnaeus, 1758), and the Lesser Kestrel (*Falco naumanni* Fleischer, 1818), as well as an important habitat for the near threatened otter (*Lutra lutra* Linnaeus, 1758). Due to the lack of knowledge, the status of some species is unclear, for example the Little tern (*Sterna albifrons* Pallas, 1764), which is regularly seen in the upstream and downstream area, but nesting sites have not been recorded yet. The undisturbed morphodynamic processes with its enormous sediment shift lead to a constant natural regeneration of these habitats, as well as to a lateral erosion, producing large-scale, steep riverbanks. These provide breeding grounds for thousands of Sand martins (*Riparia riparia* Linnaeus, 1758), for Kingfishers (*Alcedo atthis* Linnaeus, 1758), and Bee-eaters (*Merops apiaster* Linnaeus, 1758). The flora of the Vjosa ecosystem is also impressive. The uppermost river section hosts a variety of endangered endemic plant species, such as the endangered *Solenanthes albanicus* (Degen & Bald. 1936). The lower valley is characterized by mixed Oak forests and Strawberry trees (*Arbutus andrachne* L.); for the latter the Vjosa valley represents the only habitat in the country. This complex river system is characterized by large gravel banks with pioneer vegetation, islands, side arms, oxbows, ponds, and alluvial forests with *Platanus orientalis* L. and willows (*Salix* spp.).

CONCLUSION

Protecting river and stream life in entire Vjosa catchment area seems to be a complex challenge. Due to a large watershed the, freshwater species are affected by activities taking place anywhere upstream or uphill in the watershed, even many kilometers away. Conservation actions must

therefore address threats to water quantity and quality over the wider areas that are upstream from risked species and habitats. Further to that it is wise to consider that all type of human activities in watersheds can pose a host of threats to freshwater species. Yet, it is often difficult to address the

stresses on stream species, and habitats. Even when these impacts are correctly

recorded, the sources of water quality and quantity problems can be difficult to control.

REFERENCES

- [1] National Agency of Natural Resources, October 2009. <http://www.akbn.gov.al/>
- [2] Diku A., Paparisto A., Miho A., Shumka S., 2016: HPPs development in Albanian Alps vs. biodiversity and habitat integrity – Valbona valley case. Conference on Environment and Biotechnology. AUT Tirana, Albania
- [3] Lorela Lazaj and Rineldi Xhelilaj 2017: Mapping of hydropower plant in Albania, using Geographic Information System. Save Blue heart of Europe. p. 50
- [4] Schwartz, U., 2012. *Hydromorphological Status and Dam Projects*. Vienna, Report, p. 151
- [5] Allan, J., Alexander, F., 1993. *Biodiversity Conservation in Running Waters*. Bioscience 43 (1): 32-42.
- [6] Turner, R.K., van den Bergh, M., Söderqvist, T., Barendregt, A., van der Straaten, J., Maltby, E., van Ierland, E.C., 2000. *Ecological-economic analysis of wetlands: scientific integration for management and policy*. Ecological Economics 35:7-23.
- [7] Brooks, T.M., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B., Rylands, A.B., Konstant, W.R., Pilgrim, J., Oldfield, S., Magin, G., Hilton-Taylor, C., 2002. *Habitat loss and extinction in the hotspots of biodiversity*. Conservation Biology. Vol. 16. No. 4: 909-923.
- [8] Braat, L.P., ten Brink (eds.), 2008. *The Cost of Policy In action: the case of not meeting the 2010 biodiversity target*. Alterra report 1718, Wageningen.
- [9] Lysen, I., 2008. *Global Biomass Assessment*. Dutch Planbureau au voor de Leefomgeving (PBL).
- [10] Slingenbergh, A., Braat, L., van der Vindt, H., Eichler, L., Turner, K., 2009. *Study on understanding the causes of biodiversity loss and the policy assessment framework*. EC DGE
- [11] Dill, W.A., 1993. *Inland fisheries of Europe*. EIFAC Technical Paper, No. 52 Suppl. Rome, FAO.
- [12] GIWA, 2001. *Methodology Handbook. Source in: Scaling and coping*, http://www.unep.org/dewa/giwa/methodology/RevScalScop_Meth10July2001.PDF, last access: 5 May 2010, 2001.
- [13] IUCN, 2001. *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission, IUCN, Gland, Switzerland and Cambridge, UK.
- [14] Jablonski, D., 2011. *Reptiles and amphibians of Albania with new records and notes on occurrence and*

- distribution*. Acta Soc. Zool. Bohem. 75: 223–238.
- [15] Kostoski, G., Albrecht, C., Trajanovski, S., Wilke, T., 2010. *A freshwater biodiversity hotspot under pressure – assessing threats and identifying conservation needs for ancient Lake Ohrid*. Biogeosciences, 7, 3999–4015, 2010
- [16] Korsós, Z., Barina, Z., Pifkó, D., 2008. *First record of Vipera ursinii graeca in Albania (Reptilia: Serpentes, Viperidae)*. Acta Herpetologica 3(2): 167-173.
- [17]. Shumka, S., 2014. *Fish Survey in Vjosa River basin. Report for VERBUND*. Vienna. 1-45.
- [18] Shumka, S., Cake, A., Nikleka, E., 2010. *The fish composition and importance in Drinos river ecosystems*. Natura Montenegrina, Podgorica, 9(3):489-493.
- [19] Hysaj, E., Bego, F., Prigioni, C., Balestrieri, A., 2013. *Distribution and marking intensity of the Euroasian Otter, Lutra lutra, on the river Drinos (Southern Albania)*. FOLIA ZOOLOGICA. Journal. 62: 33-38.
- [20] Marková, S., Šanda, R., Crivelli, A., Shumka, S., Wilson, I.F., Vukić, J., Berrebi, P., Kotlík, P., 2010. *Nuclear and mitochondrial DNA sequence data reveal the evolutionary history of Barbus (Cyprinidae) in the ancient lake systems of the Balkans*. Molecular Phylogenetics and Evolution 55, 488–500. doi:10.1016/j.ympev.2010.01.030.
- [21] Miho, A., Kashta, L., Beqiraj, S., 2013. *Between the Land and the Sea - Ecoguide to discover the transitional waters of Albania*. Julvin 2, Tiranë. 1-462. ISBN 978-9928-137-27-2. <http://www.fshn.edu.al/home/publikime-shkencore>.
- [22] Paspali, G., Bego, F., 2008. *On the small mammals (Mammalia: Rodentia and Insectivora) of the Drinos valley (Gjirokaster) and Vurgu field (Delvine)*. Proceedings of the international conference on Biological and Environmental Sciences. UT, FSHN: 265-270.
- [23] Snoj, A., Marić, S., Berrebi, P., Crivelli, A.J., Shumka, S., Sušnik, S., 2009. *Genetic architecture of trout from Albania as revealed by mtDNA control region variation*. Genetics Selection Evolution 41, 22: 1–11. doi:10.1186/1297-9686-41-22.
- [24] Théou, Ph., Loçe, E., Đurović, M., 2015. *Results of the pioneer survey of potential bat hibernacula in Albania (2012–2015)*. Natura Sloveniae 17(1): 25-39.
- [25] wel
- beautiful, unknown and threatened.
Vienna p. 7
- [26] Feher, Z., Eross, Z.P., 2009. *Contribution to the Mollusca fauna of Albania. Results of the field trips of the Hungarian Natural History Museum between 1992 and 2007*. Schr. Malakozool. 25: 3-21.