Feasibility study on enhancing connectivity conservation in the PONT Focus Region: Albania

"Description of the 7th Connectivity Conservation Area (7thCCA) in South-Eastern Albania: a PONT study"

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Cover photo: View from Upper Vjosa Catchment with Nermerçke Mount in focus, @ M. Meco

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Abbreviations

AMBU	Water Resources Management Agency
APPEAR	Austrian Partnership Programme in Higher Education and Research for Development
BioNNA	Biodiversity National Network of Albania
CCA	Connectivity Conservation Area
CCI	Conservation Connectivity index
CSO	Civil society organizations
DCI	Dendritic Connectivity index
CII	Connectivity Intactness Index
CM	Council of Ministers
CR	Critically Endangered
DCM/VKM	Decision of the Council of Ministers/Vendim i Keshillit te Ministrave
EEA	European Environment Agency
ECSO	Environmental Civil Society Organizations
EN	Endangered
EU	European Union
IUCN	International Union for Conservation of Nature
IUCN WCPA	World Commission on Protected Areas
LSG	Local Self-Government
MCM	Million cubic meters
MoC	Ministry of Culture
MTE	Ministry of Tourism and Environment
MARD	Ministry of Agriculture and Rural Development
NAPA	National Agency of the Protected Areas
NEA	National Environmental Agency
NGO	Non-Governmental Organization
NP	National Park
MES	Macedonian Ecological Society
PA	Protected Area
PONT	Prespa Ohrid Nature Trust
PP	Prespa-Pindos
PPNEA	Protection and Preservation of Natural Environment in Albania
RAPA	Regional Administration of the Protected Areas
ToR	Terms of Reference
UNFCCC	United Nations Framework Convention on Climate Changes
UNEP	United Nations Environment Program
Vjosa NP	Vjosa National Park
WDPA	World Database of Protected Areas
WFD	Water Framework Directive
WWF	Worldwide Fund

1. INTRODUCTION

The main aim of this assessment is to define the boundaries of the seventh Connectivity Conservation Area (CCA) in the upper catchment of the Vjosa in Albania taking the previous CCA studies in the PONT Focus Region into account and assess the options and opportunities for PONT's contribution to enhancing aquatic and catchment connectivity conservation in the newly defined CCA.

In the introduction section of this report it is firstly described the study area in focus, arguing about the importance of the conservation connectivity in the Upper Vjosa catchment, covering both terrestrial and freshwater components with regards to ecological connectivity. Section 2 presents the methodological approach including modeling for definition of the boundaries of seventh CCA. Section 3 of the report represents the description of the upper Vjosa connectivity area, the most important ecological values, starting with its general physical description, biodiversity values and habitats. After this description and following methodological approach including modeling, the section 4 provides detailed analyses of the threats, challenges and opportunities to the connectivity within the upper Vjosa region and PONT Focus area. Throughout this section potentials for establishing a CCA, as well as the most important barriers that hinder connectivity are considered. The report concludes in section 5 with conclusions and strategic recommendations concerning the new CCA within the upper part of River Vjosa and PONT Focus area.

More specifically, the study assesses the options and opportunities for enhancing connectivity conservation in Southern Albania. This study is a follow-up of Polis-Sopot-Valamare-Gramoz Connectivity Conservation Area in Southeast Albania (Melovski D. et al. 2022) and the Prespa-Pindus Connectivity Conservation Area in North Western Greece (Papaioannou et al. 2023). It specifically aims to understand how the Polis-Sopot-Valamare-Gramoz Connectivity conservation Area in SE Albania and the Prespa-Pindus Connectivity conservation Area in NW Greece relate to the intended 7th PONT CCA**.** The CCA is expected to benefit biodiversity and ecosystem function, with a special focus on enhancing the connectivity of large mammals, birds and aquatic habitats.

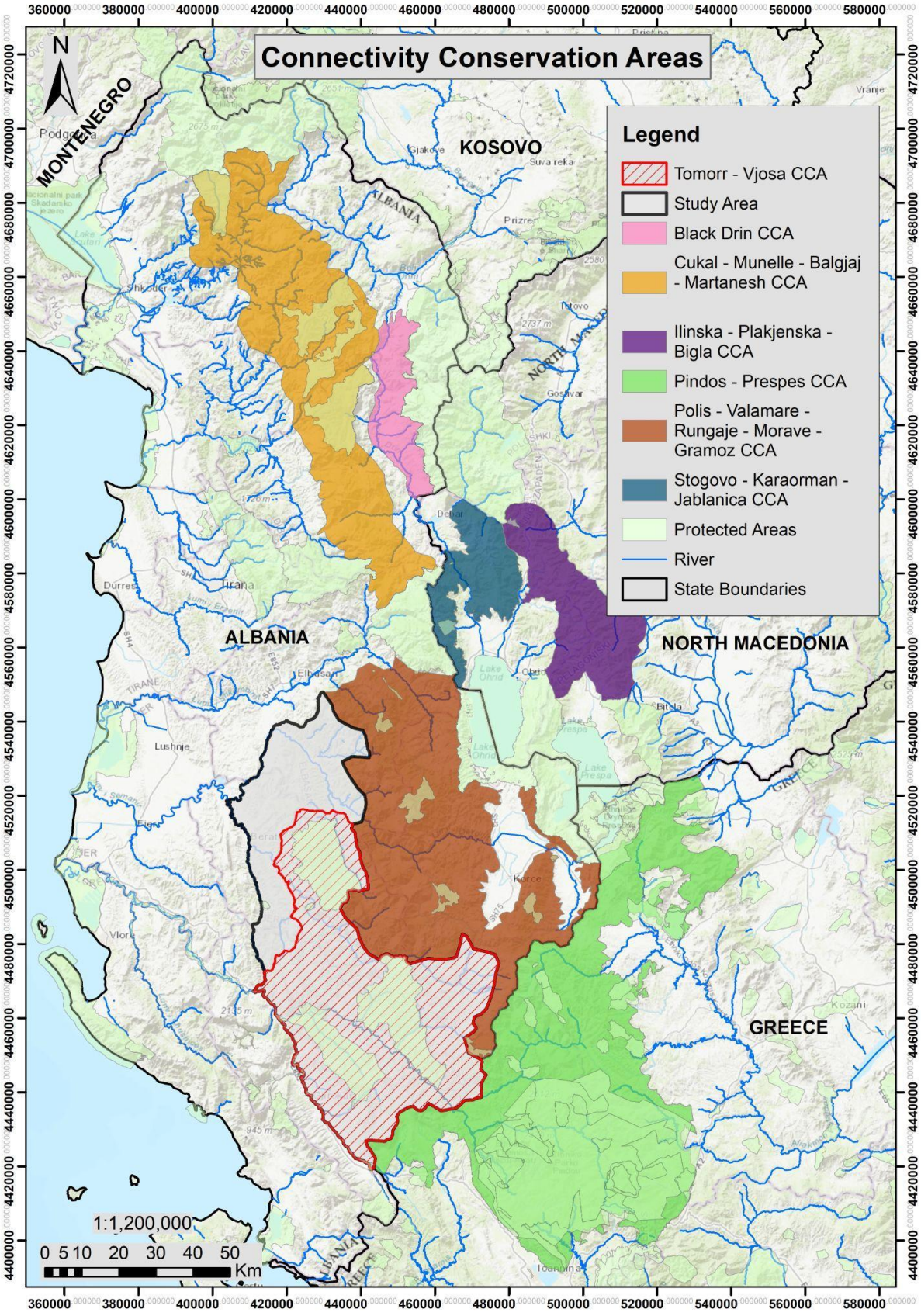


Figure 1. Map of the Upper Vjosa Catchment study area in the PONT Focus region including all existing CCAs

Counting different reasons that will be considered comprehensively in the following part of this survey will illustrate issues connected to the connectivity concept and challenges that from one side reflect complexity within the landscape level (considering terrestrial and aquatic components of intended 7th CCA) and from the other side the difficulty involved in the quantification of connectivity in a simple and widely applicable way. Recognizing (revile& understanding) elements that limit and promote habitat connectivity is a key objective in the case of Vjosa's wider area. The possibility of connectedness between any two environments might vary depending on several factors. These comprise traits of the environment, the boundary itself, and the species that cross it.

Despite widespread support for biodiversity conservation, over a million species are currently in danger of going extinct due to human influences on the environment, with species abundance reductions seen in practically every known habitat (IPBES 2019). Powers and Jetz (2019), argue that changes in human land use that have transformed habitats are important causes of biodiversity loss and are expected to continue doing so for the next century.

This survey is fully in line with the EU goals at COP15 on global biodiversity conference (CBD, 2022) proposing ambitious actions by 2030 and 2050 as (i) Restore 30% degraded ecosystems globally (on land and sea) by 2030; (ii) Conserve and manage 30% areas (terrestrial, inland water, and coastal and marine) by 2030; (iii) Sustainably manage areas under agriculture, aquaculture, fisheries, and forestry and substantially increase agroecology and other biodiversity-friendly practices; (iv) Tackle climate change through nature-based solutions, etc. According to the EU Water Framework Directive (WFD), connectivity is only targeted indirectly and it is important to recognize the interconnected nature of water bodies, and efforts should be made to enhance connectivity within and between these habitats.

In the wider study area, today's landscape is broken up by roads, power lines, urban development, agriculture, and numerous other obstacles that make it difficult for species to move. In that context, ecological connectivity will need to act through both conservation and policy support. This survey appeals for both conservation and restoration of ecological connectivity within the 7th CCA as an important measure to mitigate the impacts of land use change and climate change on biodiversity and ecosystems.

1.1. Importance of connectivity conservation in the upper Vjosa area

Although knowledge and approaches from terrestrial assessments can also be transferred to aquatic ecosystems, rivers exhibit certain characteristics, which should grant them a special position in connectivity conservation. The upper Vjosa basin, an ecologically significant and relatively undisturbed area, exemplifies these unique characteristics vividly:

Habitat and Migration Corridor: The upper Vjosa basin serves as both a habitat and a migration corridor for numerous species. This dual role is critical, as highlighted by Ward (1989) and Wiens (2002). The river's uninterrupted flow in this region provides essential migratory pathways for aquatic species, such as the endangered Balkan trout, which rely on this corridor for their life cycles.

Multidimensional Connectivity: Connectivity in rivers like the upper Vjosa acts on four dimensions: longitudinal, lateral, vertical, and temporal. The importance of each dimension changes along the river course (Vannote et al., 1980; Ward and Stanford, 1995). In the upper Vjosa, longitudinal connectivity is crucial for species migrating upstream to spawn. Lateral connectivity is equally important, linking the river with its floodplains and riparian zones, which support diverse ecosystems and provide breeding grounds for many species.

Hydrologic Connectivity: The hydrologic connectivity in the upper Vjosa basin facilitates the passive downstream transport of matter and energy and enables a multidimensional dispersal of organisms.

This connectivity supports the river's high biodiversity, allowing nutrients and organisms to move freely and support various life stages of aquatic species.

Diverse Habitat Connections: While terrestrial analyses often focus on the connectivity of specific habitat types (e.g., grasslands or forests), the connection of different habitats is also very important in the freshwater realm. The upper Vjosa basin supports species and life stages that require diverse habitat patches to complete their life cycles, such as several fish species. The river's pristine condition and diverse habitats make it a crucial sanctuary for these species.

Ward (1989) defined freshwater ecosystem connectivity across four dimensions: longitudinal, lateral, vertical, and temporal. In the upper Vjosa basin:

- **Longitudinal Connectivity**: The upper Vjosa's uninterrupted flow is vital for migratory species, facilitating the connection between upstream and downstream regions and supporting species dispersal. This directional component is distinct from terrestrial connectivity, and efforts to maximize linear connectivity throughout the catchment are essential for maintaining its ecological integrity.
- **Lateral Connectivity**: The upper Vjosa's lateral connectivity to riparian areas plays a vital role in connecting aquatic and terrestrial habitats. This connectivity is crucial for maintaining the dynamic interactions between the river and its floodplains, which support a wide array of plant and animal life, contributing to the river's ecological richness and resilience.

In addition to protecting and restoring ecological connectivity, connectivity planning is now recognized as a way to help a region's flora and fauna adapt to the effects of land use and climate change. It will connect the new Vjosa NP with current and future challenges. Bringing the area to a specific CCA and connecting it with PONT existing ones, can also address several ecological and societal goals, including the preservation of species, terrestrial and aquatic ecosystems, geophysical diversity, and the ecological processes that support ecosystem services like climate regulation, the provision of natural resources, and significant cultural services in landscapes altered by human activity. So, connectivity conservation is actively framed as a people-centered approach to biodiversity conservation. Without social and institutional connectivity, the ecological goals of connectivity conservation are unlikely to be met. In the case of the 7th CCA and PONT vision the connectivity actions covers wide regions and crosses international or national political boundaries, it recognizes the diverse aspirations of communities living in a connectivity area considering socio-economic activities as cross border cultural and economic one, trans-boundary social resilience, peace building, cohesion, etc.

The particular location and geography of Vjosa connecting upland areas in Greece with the Adriatic Sea create a sizable natural corridor for animal movement, real movement and ground conservation of vital habitats. Therefore, when species extend their ranges northward, the connectedness of the River, tributaries and wider terrestrial components will be essential to their survival and ability to adapt. This is vital to large mammals and raptors. The PONT strategy recognizes the area's crucial role and its organic connection with the rest of the CCA beyond the borders. Numerous migratory and resident species, including eagles, vultures, fishes, etc., rely on different habitats at various times of their life cycles, making these areas vital to the regional biodiversity.

The area's geological settings, and its diverse geological, socio-cultural, and biological features have given rise to a dynamic society dedicated to the preservation of natural values. After Sovnik (2021) the distinguishing features of the upper Vjosa area comprise:

(i) Large and functioning ecosystem of sufficient size and ecological quality to maintain ecological functions and processes that allow the native species and communities to persist in the long-term, with no to minimal management intervention;

(ii) Contains typical examples of a major natural region, high density (series) of natural and cultural features and scenery, where native plant and animal species, habitats, morphology, geo-diversity and cultural sites are of special scientific, recreational, tourism and educational significance and the composition of the biodiversity remains in a natural state.

In summary, the area's efforts to preserve its terrestrial and aquatic connection must take into account the effects of climate change and expanding urbanization and tourism development in both urban and rural areas. Although there are many different and diverse human risks to habitat and connectivity throughout the area, connectivity science offers several tools and strategies for maintaining ecological integrity both now and in the future.

2. METHODS

The boundaries of the study area are defined following the ToR for this study and existing PONT focus area and existing CCAs. The study area is part of the PONT Focus Region that was expanded in December 2021, to include the Albanian Alps National Park and the Korab-Shara cluster in Albania and North Macedonia, as well as the ecological corridors between these clusters. Further on in 2022, the Connectivity Conservation Area in Greece was added. So, the study area boundaries are covering the upper part of River Vjosa that on its southeast is bordered with Prespa–Pindus CCA, on the northeast with Polis-Valamare-Rungaje-Morave-Gramoz CCA and on the west by the Vjosa basin and southern section of Osumi that is linked to Tomori NP.

The ‘’Tomorr-Vjosa’’ CCA area covers most of the PONT study area in the focus region, it overlays with study area borders from its southwestern, southeastern and eastern parts, while the CCA border from its northwestern part is shaped around Tomorri National Park area.

The methods employed during the preparation of this study (that is design stage) include a literature search that entails review and documentation of information about terrestrial and aquatic ecosystems, habitats and species, processes connected with status and conservation challenges. It deals with analyses of the current status of biodiversity research and conservation approaches in the larger Vjosa basin. The analyses and references consultations helped to assimilate up-to-date available information and as well as identify knowledge gaps in the understanding of the current state and driving forces for habitat and biodiversity conservation in the Vjosa basin. At this stage, this literature survey report does not take into consideration anecdotal wildlife (different fauna species) sightings provided through the communication process, unless the records were submitted and published in credible references. The main source of information was generated via Google Scholar and following our search which considered primary and secondary resources containing different information, where in total 106 publications (out of 310 results) were assessed.

a. Selection of species

In the case of the Vjosa region we followed two approaches: use of focal species and Ecological space, patch dynamics and permeability. The aquatic species have been selected because of their possible sensitivity to connectivity, such as in cases where populations rely on freshwater networks for hydrological or inter-basin connections (Experiences with dam construction in Albania and other river systems and also part of Vjosa as Lengarica). For any species, the quantity and kind of favorable habitat patches amidst unfavorable surroundings can be used to calculate network connectedness.

The most basic methods of measuring connectedness in the literature that are now accessible make use of functional network connectivity or geographical connectivity (calculated using a GIS as path distance or Euclidean distance). The flight paths and ranges of these species may be a useful model for the dispersal of many taxa, particularly fish species (considered in the case of the Vjosa basin during our analysis), but also for other macro-invertebrates and aquatic plants.

- Fish

European eel (*Anguilla anguilla*) and Pindus stone loach (*Oxynoemacheilus pindus*) were considered for measurements of freshwater connectivity in the Vjosa basin. This was based on species data distribution generated during the last decade. Further on it was connected with patch dynamics and permeability. The European eel (*Anguilla anguilla*) and Pindus stone loach (*Oxynoemachelius pindus*), assessed respectively as CR and VU species, were selected from the **fishes**. These species have been selected as connection models either because of their inherent value, data availability, and conservation status or because they may serve as representatives of other freshwater organisms.

- Mammals

Our selection of target mammal species for this study was guided by the need to understand the habitat requirements and connectivity needs of species with vast territorial demands and those that play significant ecological roles. The selected target **mammal species**, considering the needs and the conservation status are the Brown bear (*Ursus actors*), Euroasian otter (*Lutralutra*), and Balkan chamois (*Rupicapra rupicaprabalcanica*). Among the species considered, the brown bear (*Ursus actors*) stands out as particularly suitable for corridor analysis due to its diverse diet and varied habitat preferences. As an omnivorous species, the brown bear inhabits a wide range of environments, from mountain pastures to river valleys and lowland areas. This adaptability makes the brown bear an excellent subject for studying habitat connectivity and corridor analysis. The Balkan chamois and Eurasian otter further enriched our study by providing insights into the connectivity of mountainous/alpine habitats and aquatic ecosystems, respectively. Further to that these species are of national and international conservation concern, supporting the considerations of their choice in defining the connectivity corridors based on their needs and significance, as described in the following sections.

- Birds

Based on the biogeographical features of this area, regarding the **avifauna**, two bird species have been selected as key species: the Egyptian Vulture (*Neophron percnopterus*) and the Golden Eagle (*Aquila chrysaetos*). **The Egyptian Vulture** (*Neophron percnopterus*) is the smallest, the only migratory, and the most threatened vulture species in Europe. Albania marks the current westernmost edge of the species range in the Balkans and is, therefore, the most susceptible cluster to extinction compared to the rest of the Balkan countries (Velevski et al., 2015). Nowadays it is found in an area of around 5300 km2 situated in southern Albania and more specifically in the wide watershed of the Vjosa River (Dobrev, V., Topi, M. et al., 2023). The Egyptian Vulture (*Neophron percnopterus*) exhibits specific habitat preferences in the Balkans, where it is a notable species of conservation concern. Studies by Xirouchakis et al. (2016) and

Stara et al. (2019) highlight the importance of suitable nesting sites for Egyptian Vultures in the region, which typically include cliffs, rocky outcrops, and inaccessible areas with minimal human disturbance. These vultures also rely on open landscapes with sparse vegetation for foraging, as emphasized in research by Margalida et al. (2018) and Stara et al. (2020), where grasslands, pastures, and agricultural fields serve as crucial feeding grounds. Surveys conducted for similar areas (Šálek et al., 2021) the open scrubland hosted more bird species and individuals when they considered open habitat species and the area of open habitats, whereas farmland hedges had higher species diversity and individuals of woodland bird species when considered the area of woodland habitats. So, analyses of habitat affiliations of individual species corresponded to the whole-community patterns; and revealed that several woodland bird species were mainly associated with open landscapes (e.g., Chaffinch *Fringilla coelebs*, Common Nightingale *Luscinia megarhynchos* and Blackcap *Sylvia atricapilla*), whereas the open scrubland was preferred by open habitat bird species (e.g., Corn Bunting *Emberiza calandra*, Quail *Coturnix coturnix* and Skylark *Alauda arvensis*). These findings show that semi-natural habitats, such as open areas, have a great deal of potential for promoting and protecting bird communities and may have served as appropriate habitats for various species with varying ecological needs. Therefore, management strategies aimed at protection of these habitats, when combined with appropriate management (such as controlling the natural succession process in open scrubland and enhancing the structural diversity of already-existing areas), may significantly aid in the conservation of birds within open landscapes.

The Golden Eagle (*Aquila Chrysaetos*) is a large and iconic raptor species with specific habitat preferences. Research by Watson et al. (2018) has shown that Golden Eagles favour expansive mountainous areas with rugged terrain and cliffs for nesting. At the national level, the bird holds the status of Endangered. BirdLife International (2015) estimated a population of 50–150 pairs for the period 2002–2012. Short and long–term trends are unknown. Recent data (M. Topi unpublished data) give a number of less than 100 breeding pairs for the period 2012–2021, with a recent decline. Golden Eagle (*Aquila chrysaetos*) in the Balkan Peninsula is found from sea level to high mountains (up to a 2700masl), mainly in open, rocky habitats and less often in forested hilly-mountain habitats. It mainly nests on cliffs, much less often in forest habitats of ca 150 to 2100 masl.

a. Model development

During this study on species distribution modeling using Maxent, the comprehensive methodology followed aimed to predict suitable habitats for the target species. Several approaches exist, most of them based on machine-learning processes such as Random Forest or Boosted Regression Trees. The most commonly used software is MaxEnt ("maximum entropy"), that is based on the principle that "… subject to known constraints, the probability distribution that best represents the data is the one with the greatest entropy, i.e. the one which best reproduces the data" (Guisan et al., 2017, p. 217). The same authors state that "Maxent contrasts observed presence data … to the available environment in a given region" and that "…the best prediction is that the species occupies environmental conditions proportionally to their availability in the region". Technical details of MaxEnt concept and implementation in ecology by far exceed the context of this report, but overview is provided in Elith et al.(2011).

The process began by clearly defining the study objectives and delineating the geographical area of interest. Next, species occurrence records were collected from biodiversity databases, and relevant environmental variables, such as climate data and topographic information, were gathered from reputable sources. Ensuring data quality involved meticulously cleaning the species records by removing duplicates and applying spatial thinning to reduce autocorrelation. Environmental layers were prepared by

standardizing their spatial extent and resolution for consistency. The physical parameters of the environment such as: Digital Elevation Model, the 12 bioclimatic variables (available at: https://zenodo.org/records/5347837) that are typically used in the modeling processes and information on habitat coverage (Level 2 of the EUNIS classification of habitats) were used as environmental variables.

With the data prepared, the Maxent software was set up, and species occurrence records and environmental layers were inputted. The model was configured by selecting appropriate feature types and adjusting the regularization multiplier to control for model complexity and prevent overfitting. Using k-fold cross-validation, the model was run to ensure robustness and reliability of the predictions.

To evaluate the model's performance, the ROC curve was analyzed and the area under the curve (AUC) was calculated, aiming for values close to 1 for better performance. Response curves were also generated to illustrate the relationship between species presence and environmental variables. The contribution of each environmental variable was examined to understand their influence on species distribution. The results were visualized through species prediction maps, highlighting habitat areas of high, medium, and low suitability.

- A merger of 0.1x0.1 km squares assessed as 0.8 to 1 that is large enough to support viable populations of target species outline the “islands and strips” of habitat that have the highest probability to serve as corridors for species movement.
- A merger of 0.1x0.1 km squares assessed as 0.6-0.8 also have a high probability to serve as corridors; however, actions for improving habitat quality in these areas could further increase their capacity to facilitate species movement or even contribute to the formation of larger habitat patches that could serve as core areas.
- Merger of 0.1x0.1 km squares assessed as 0.4-0.6 are considered to be less favored for migration and movement of species; hence, a set of conservation and management actions are needed to improve their functionality as corridors.
- Those assessed as 0.1 to 0.4 have lowest probability to be used as corridors due to low habitat quality.

It was decided to merge the model of the five species into a single composite map (Figure 2). This way, a clear importance of the areas and corridors is shown from the perspective of the ecological needs of the brown bear, Balkan chamois, Otter, Egyptian Vulture and Golden Eagle. For the fish species, however, we were not able to apply the same approach, simply because of the defined flow of the rivers.

Finally, the findings were compiled into a comprehensive report, detailing the methodology, results, and interpretations. These insights were shared with biodiversity experts, providing actionable recommendations to guide conservation efforts. This systematic approach ensured that the predictions were reliable and could effectively contribute to biodiversity conservation and management strategies.

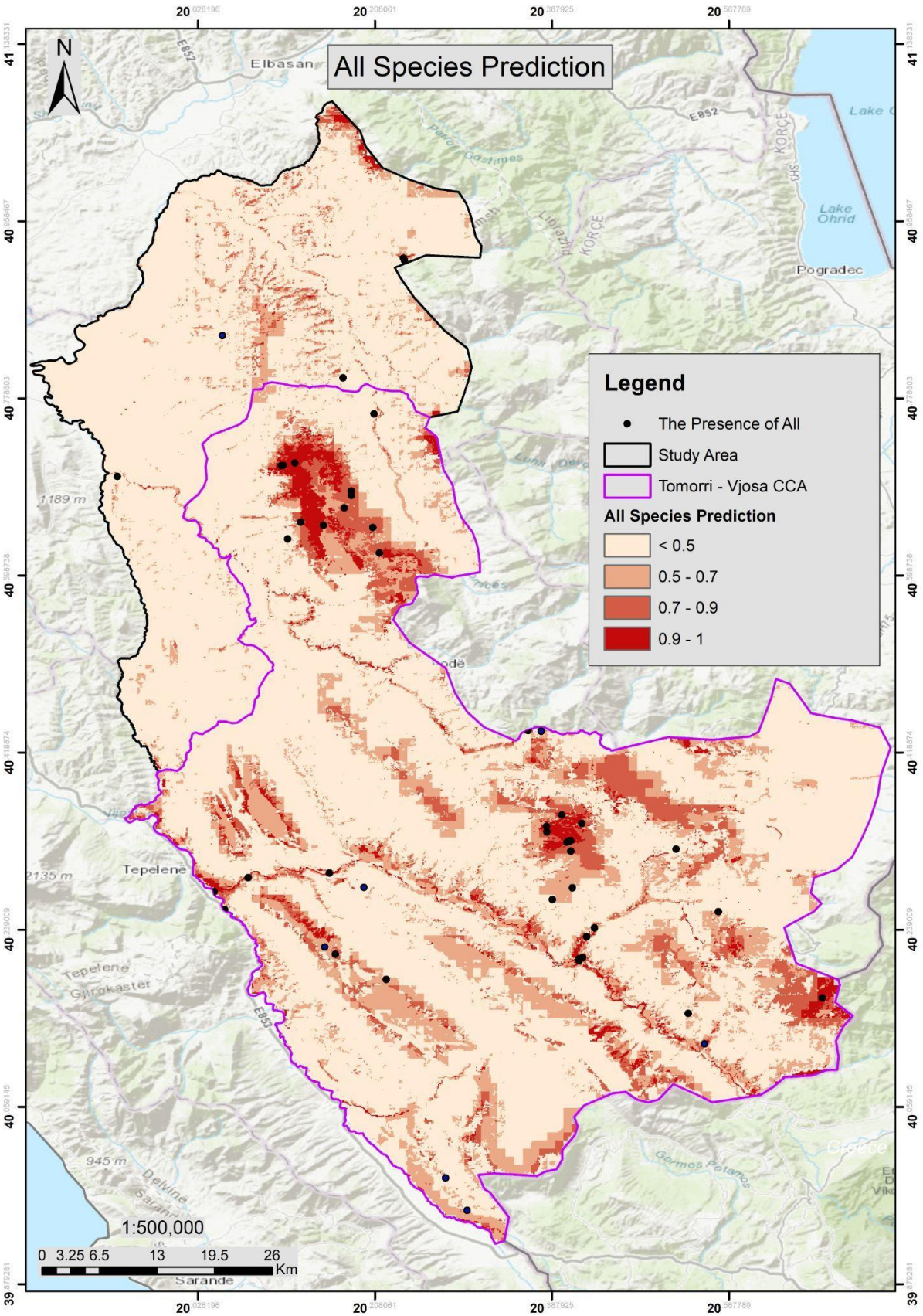


Figure 2. Composite map of all modeled species in the researched area.

3. Overview of Study Area of the Vjosa Upper Catchment

The Vjosa upper catchment lies at the core of Balkan Peninsula's exceptional biodiversity of plant and animal species that is a rare ecological and bio-geographical occurrence in Europe. The diversity and richness of plants, animals, and ecosystems in this area is incredibly high due to the region's complexity, intricate geological past, and interactions between populations, species, and ecosystems. The great diversity of endemic and relict species is highly notable in and of itself, but it also adds to the region's distinctiveness due to its disparate ecological traits, distribution patterns, and places of origin (Figure 3).

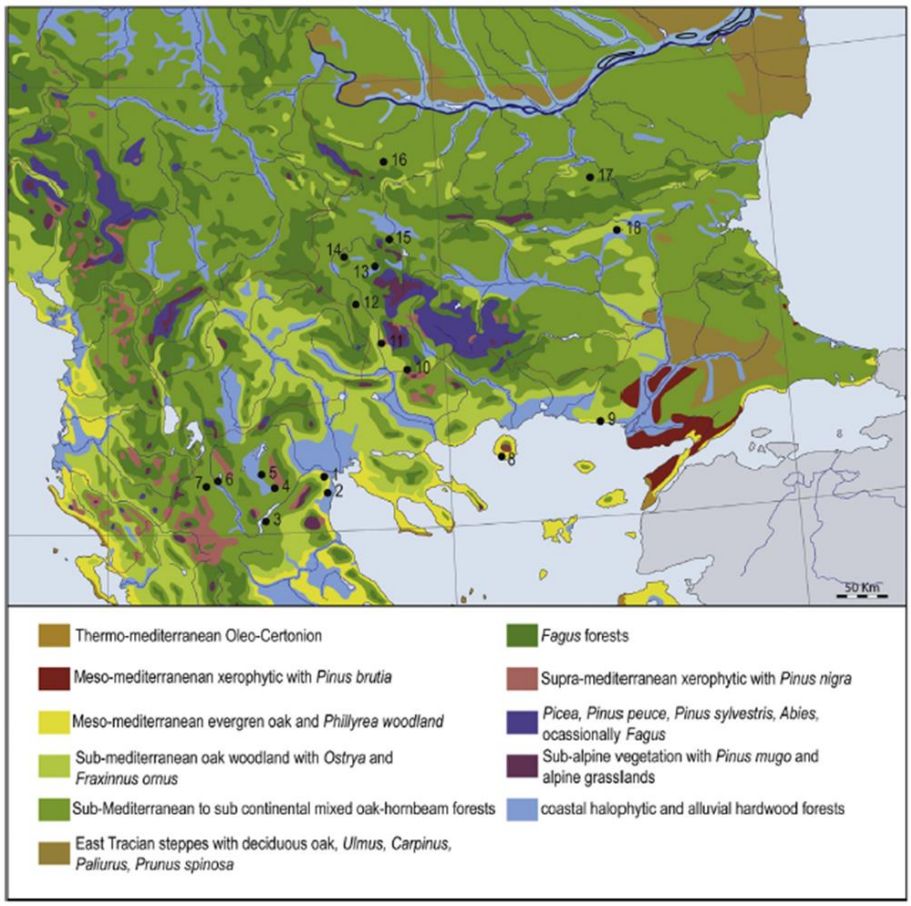


Figure 3 Map with potential vegetation (A summary conducted Marinova &Ntinou, 2017)

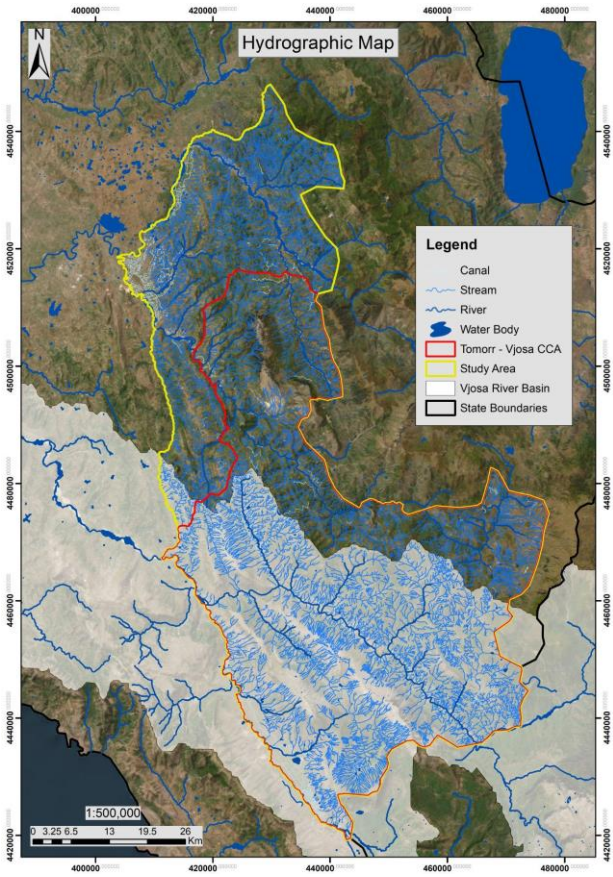
The 270 km long Vjosa, also known as Aoos in Greek, originates in the northern Pindos highlands near the city of Vouvousa. This system is free flowing and unrestricted by any longitudinal impediments, with the exception of the first 10 km. The river course's first 80 kilometers are in Greece, mostly through the Vikos-Aoos National Park. It is distinguished by a narrow riverbed and a sharp incline. The Vjosa River runs through a diversity of landscapes. The mean catchment slope is 28%, while the riverbed slope is about 4%. In Greece, the elevation of the Aoös ranges between 2636 to 400 m.a.s.l, while In Albania it ranges from 2500 m.a.s.l. to sea level (CNR-CEREG, 2015).

The river is referred to as Vjosa from the Albanian border downstream, where a significant tributary called Sarandoporos joins. At the border of Albania and Greece, Sarandoporos combines with the Aoos and forms Vjosa.

In the upper section the Vjosa follows a sequence of steep canyons between Përmet, Këlcyra and Dragot, entrenched in steep gorges intersected by areas with large alluvial fans and islands. After Dragot the

river valley widens except for the gorges of Kalivaçi and Poçemi. At the city of Tepelena, before and after the confluence with the Drino River, large gravel and sand bars formed by the braiding river dominate the fluvial landscape. Because sediment erosion outpaces sediment deposition in the Permet region, the river has an incised channel pattern and submerges in alluvial sediments. After this, the river's path is distinguished by broad, braided parts that alternate with narrow riverbeds and gorges at the locations where the river breaches significant geological barriers.

The river's middle course has hills composed of strongly fragmented terrigenous sedimentary rocks, eroded by Vjosa tributaries over time. These include areas with very high slopes around the highland of Kurveleshi, and at the mountains of Nemerçka, Lunxheri, Bureto, Postnan and Melesini. There are gorges and deep canyons in Bënçë, Këlcyrë, and Langaricë. The river's upper course is surrounded by large mountains, with abrupt crests and very steep slopes, the result of the water erosion and limestone terrain (karst). After Wickel and Galaitsi (2017), in Greece, the Aoös tributary Voidomatis flows through the Vikos Gorge, listed as the deepest canyon in the world by the Guinness Book.



The Vjosa Basin geology in Albania is dominated by sand and gravel alluvial deposits in the river valley. These alluvial deposits are formed by: Neocene's deposits composed of sandstone, siltstone, conglomerate and partly marlstone, Flysch deposits, Karstic calcareous deposits, and ultrabasic rock. The Vjosa River is characterized by a wide braided sandy gravel layer and a strong river dynamics. The course and the cross section of the river changes rapidly over the years (Wickel and Galaitsi, 2017). The deep karsts aquifers of the Aoös/Vjosa River sustain a constant base flow in the river generally throughout the dry season. On the Greek side, the Aoös River catchment comprises three hydrogeological units: Timfi, Amarantos, and Arenon Grammou, all karst. These three units provide a mean annual water volume (coming from several springs) of about 169 MCM (Seferlis et al. 2008).

Figure 4 Hydrographic Map of Vjosa Upper Catchment

3.1 Biodiversity, habitats and species measures in Upper Vjosa region/area

The Vjosa catchment is an essential area for conservation due to the myriad of habitat types it provides (Schiemer et al. 2018). Researchers have identified more than 15 priority habitat types of European

interest in the valley (EcoAlbania, 2021), of which four hold particular conservation interests. An additional seven habitat priority types in the area are endangered and possess significant floristic values (Meulenbroek et al., 2018).

The Vjosa River Basin is home to a vibrant and extensive diversity of fauna and includes many endemic species of great national and international importance in terms of conservation. Of these, 42 species originate from marine habitats, 12 from freshwater, and six from terrestrial sites; (iii) At least 31 species of fish inhabit the river system, 27 of which are native, including eight species endemic to the Balkan and four non-native species (Shumka et al., 2018). The Vjosa River provides ideal aquatic habitats for a variety of migratory fish species, as well as certain critically endangered species, such as the European eel; (iv) At least 32 of the 37 reptile species have been identified in Albania; (v) A total of 257 recorded bird species across the various ecosystems and habitats of the Vjosa River Basin(Sovnik, 2021); (vi) The area also harbors around 70 of the 86 registered terrestrial mammal species in Albania, including the European otter, which is significant for the entirety of the Vjosa River system, as well as some of the main large carnivores including the brown bear (*Ursus actors*), the chamois (*Rupicapra rupicapra balcanica*), the roe deer (*Capreolus capreolus*), and the wild boar (*Sus scrofa*). The study area is also a welcoming habitat for both cave-dwelling and forest bats; 29 out of 32 bat species recorded in Albania are present within the Vjosa watershed (Meulenbroek et al., 2018).

The fauna of Vjosa comprises typical elements of highly dynamic large rivers, all of which have lost large areas of their former distribution in Europe. These riverine faunal elements are highly sensitive to changes in the natural hydro-morphology. These points attest to the national (and international) importance of the Vjosa River Basin in terms of species conservation, and emphasize the necessity of its protection.

To date, a total of 1,175 species have been documented in the Vjosa River (Meulenbroek et al., 2021; Schiemer et al., 2018), including 516 arthropods, 157 birds, 37 fish, 24 mammals, 109 mollusks, 19 reptiles, 9 amphibians, 299 vascular plants, and 5 non-vascular plants. Of all the 1,175 species documented so far, 39 of them are on the IUCN Red List and 119 on the Red List of Albania. No less than 15 species of the IUCN Red List and 74 species of the National Red List are classified as "at risk" (CR - critically endangered, EN - endangered, VU - vulnerable). According to the IUCN Red List, globally threatened species in the Vjosa Valley include:

- One amphibian (*Pelophylax shqiperus*- EN),
- two birds (*Neophron percnopterus*- EN and *Streptopelia turtur*- VU),
- seven fish 4 CR (*Acipenser naccarii, Acipenser stellatus, Acipenser sturio, Aphanius iberus*), 2 EN (*Anguilla anguilla, Gobio scadarensis*) and one VU (*Oxynoemacheilus pindus*),
- one mammal (*Myotis capaccinii*- VU),
- two molluscs (*Unio crassus*- EN, *Vertigo moulinsiana*- VU), and
- two vascular plants (*Aesculus hippocastanum, Galanthus reginae-olgae*, both VU).

The presence of the above endangered and vulnerable species on the IUCN Red List indicates the international importance of the Vjosa River in terms of nature protection.

Many species that make the Vjosa River Basin their home are listed in *Appendix 1 – 3 of the Bern Convention*: 41 are found in the *Appendix of the Birds Directive*, and 78 in the *Habitats Directive*. Annex I of the Birds Directive lists 36 bird species, and Annex II of the Habitats Directive lists one amphibian, three arthropods, 12 fish, ten mammals, three mollusks, and five reptiles. Two species of fish and two mammals found in the Vjosa River Basin and listed in Annex II of the Habitats Directive are considered priority species and of very high conservation importance at the EU level.

Moreover, around 150 species of previously identified flora and fauna are listed in the Appendices of the Bern Convention, including three species of higher plants, nine insects, five amphibians and reptiles, 107 birds, and 17 mammals (Shumka et al., 2018). In the Gjirokastra region, according to Malo (2011), 700 higher plant taxa are reported, where 12 taxa are new for Albania, 40 taxa are sub-endemic, and 30 are rare or endangered species (Tan et al., 2011; Shumka et al., 2018).

3.2 General botanical and floristic values overview of Vjosa catchment

The complex geomorphology, hydrology and diverse microclimates have created conditions for a rich flora and different vegetation types in the Vjosa watershed. Along the Vjosa River banks riparian vegetation occurs, dominated by *Salix sp.,Populus sp., Alnus sp., Ulmus sp., Platanus sp.,* etc. The wide valley of the Vjosa River allows deep inland penetration of the Mediterranean climate into the continent, almost in the whole Vjosa catchment, which makes that vegetation up to the altitude about 600 m above the sea level to be dominated by evergreen Mediterranean maquis with dominance of *Arbus sp., Erica sp., Pistacia sp., Phillyrea sp*., etc. Above the maquis start the oak forests with dominance of *Quercus pubescens, Q. cerris, Q. frainetto*and *Q. trojana*, often mixed with *Oriental hornbeam* which is dominant especially in the area where the oak is degraded. The oak forests occur about up to the altitude 1000 m above the sea level. Above the oak vegetation belt, up to 1800 m above the sea level, the vegetation is dominated by coniferous forests dominated by *Abies borisiiregis* mixed with beech. These forests are dominant at the Bredh i Hotovës National Park and Zheji Nature Monument. The vegetation of highest areas of the catchment above the altitude of 1800 m are dominated by subalpine and alpine grasslands which cover the highest areas of Trebeshina-Dhëmbel-Nëmërçkë Mts.

Several habitat types are described in the Vjosa watershed. Starting from the Vjosa riverbed and riparian vegetation to the slopes of hills and mountains of the valley are identified 30 habitat types of European Directive Habitats 92/43/EEC.

The Vjosa catchment is characterized by a very rich flora. After a literature review and the personal unpublished data gathered during different expeditions done in the area are identified approximately more than 1000 species (Malo & Shuka, 2008; Barina et al., 2017; Drescher, 2018; Rössler et al., 2018; Peci, 2022; unpublished data). There are found 3 endemic and 26 sub endemic plant species. Most sub endemic, occur in Albania and Greece. Dozens of species are of conservation interest, 61 species, according to the Red List of Albania and/or IUCN. Among them 43 species are threatened, according to The Red List of Albania (2013) and/or IUCN (Tab.1) (Drescher, 2018; Mahmutaj et al. 2015; Rössler et al., 2018; Peci, 2022 unpublished data). The most threats and pressure to the floristic richness of the area are construction of the Hydro Power Plants, collection of medicinal plants, which the local community is well known for their use, under-grazing (that in current circumstances directly affects particularly upland areas where pioneering species rapidly expands), climate change, etc.

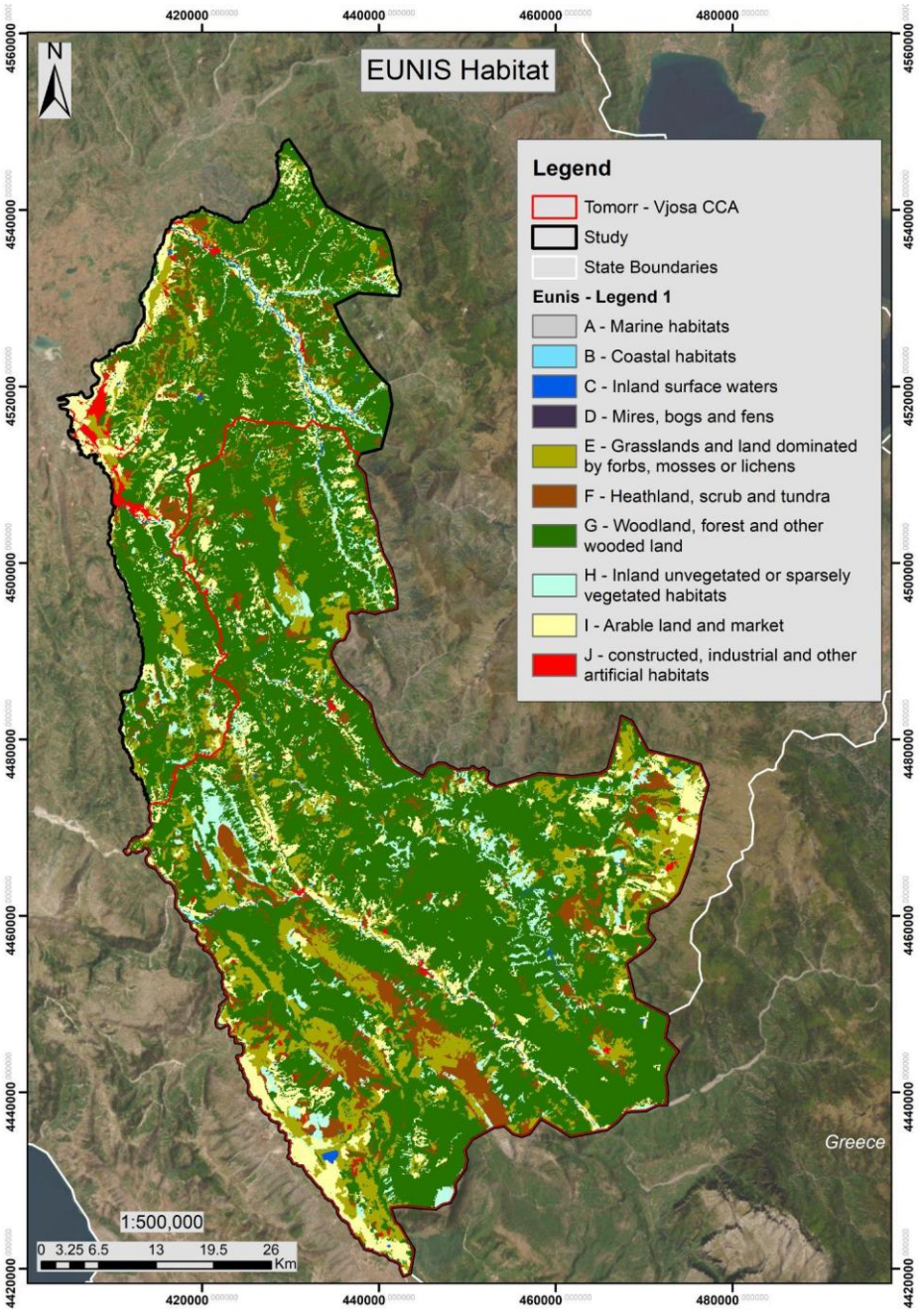


Fig 5 EUNIS Map of Tomorr - Vjosa CCA

3.3 Protected Areas in the Upper Vjosa Catchment

Protected areas in the Upper Vjosa catchment that are in the focus of PONT host several priority and other important species and habitats, while at the same time are disturbed by several human-induced threats affecting both natural values and connectivity potential. In Table 1, protected areas are presented not only for the study area, but also for the middle and lower area of the Vjosa river, categorizing them as priority area 1 - 3, for the purposes of this study.

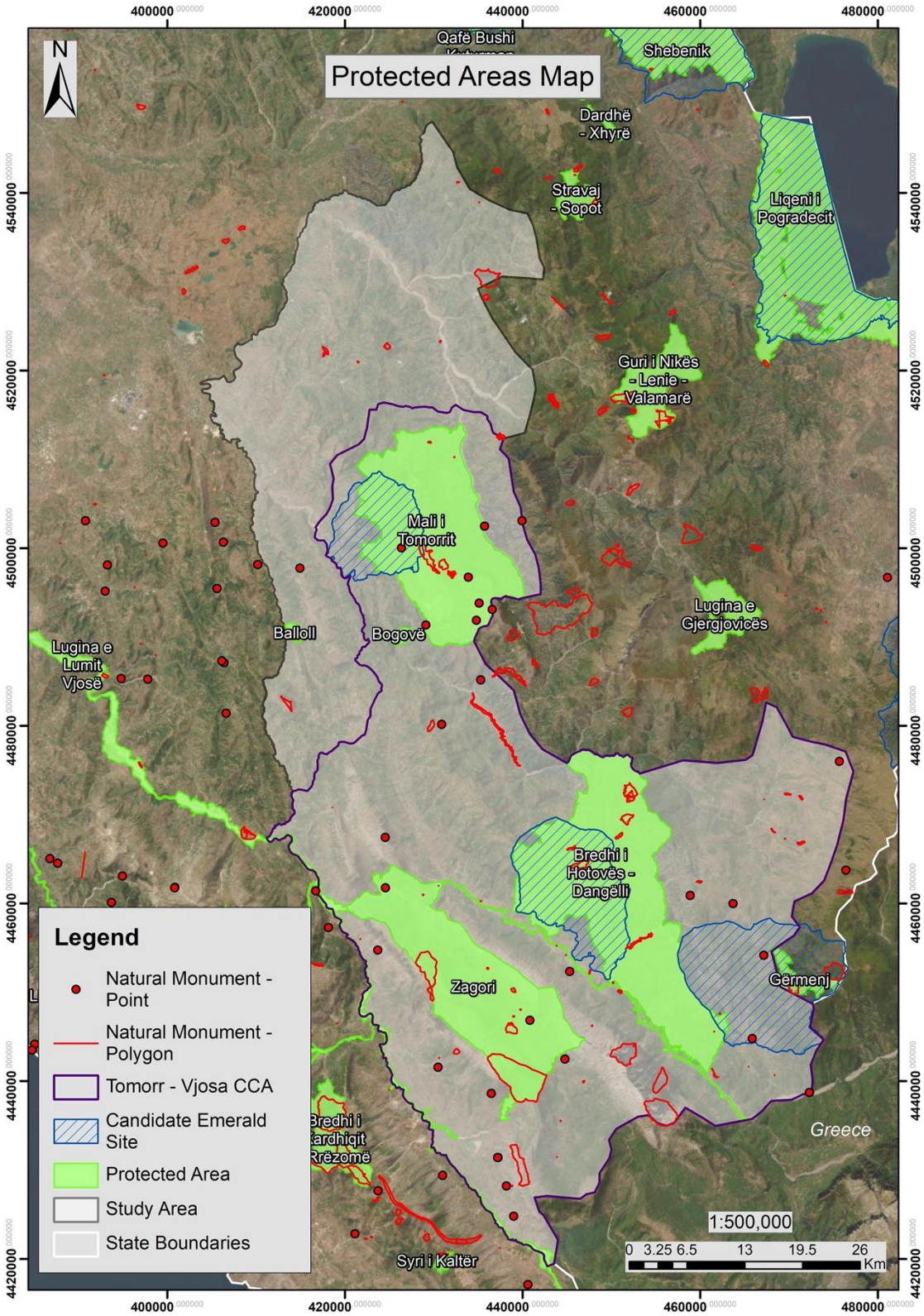


Fig 6 Map with Protected Areas in Tomorr - Vjosa CCA (*updated following the last revision of 2024*)

Name	IUCN Category	Legislation	Location	Area (Ha)
Upper Vjosa catchment/ 1st Priority Area				
Vjosa Wild River National Park	II National Park	Decision of the CM no. 125,date 13.03.2023	Memaliaj, Tepelenë, Gjirokastër, Libohovë, Dropull, Këlcyrë, Përmet	Total surface of VWRN 12,727; Ha within study area 627,48
Fir of Hotovë-Dangëlli	II National Park	Decision of the CM no. 1631,date 17.12.2008	Përmet, Këlcyrë, Skrapar, Kolonjë	36,003.76
Zagori	IV Nature Park	Decision of the CM no. 60, date 26.01.2022	Dropull, Këlcyrë, Tepelenë, Libohovë, Gjirokastër	24,607.63
Gërmenj	IV Managed Nature Reserve	Decision of the CMs no.102, date 26.01.2022	Kolonjë	1,410
Tomorri NP	IV National Park	Decision of the CMs no.59, date 26.01.2022	Berat, Polican, Skrapar, Gramsh	27,158.5
Bogovë	IV Managed Nature Reserve	Decision of the CMs no.60, date 26.01.2022	Skrapar	342.1
Upper & Middle Vjosa catchment / 2nd priority area				
Fir of Kardhiq - Rrëzomë	IV Managed Nature Reserve	Decision of the CMs no.nr. 60, datë 26.1.2022	Gjirokastër	4,303.4
Fir of Sotirë	IV Nature Park	Decision of the CMs no.nr. 60, datë 26.1.2022	Gjirokastër	4,927.67
Fir of Zhulat	IV Managed Nature Reserve	Decision of the CM no. 60, date 26.01.2022	Gjirokastër	936.2
Lower Vjosa river basin				
Pishë Poro – Nartë Protected Landscape	V Protected Landscape	Decision of the CM no. 694, date 26.10.2022	Fier, Vlorë	16,124.61

Table 1. Listing of Protected Areas in the Vjosa Catchment based on priority areas of PONT eligible region

4. Current Threats, Challenges/ Opportunities to Connectivity in the Study Area

We looked at threats to both biodiversity components (and in cases to particular species) as well as to the river ecosystems itself. Major conservation concerns identified for River Vjosa basin: (i) watershed impacts, (ii) Agriculture and forestry, (iii) tourism and population growth, (iv) non-indigenous species, (v) habitat alteration or loss, (vi) unsustainable exploitation of fisheries, and (vii) global climate change.

In more close and detailed analyses it seems that the fragmentation of habitat into small patches due to human activities such as mining (in case of Vjosa mining and river mining considered as well) is a major threat for terrestrial biodiversity and ecosystems integrity within this corridor. **The mining activity** seems to be very important in the Vjosa area. The Upper section of Vjosa River Basin is rich in resources, such as clay, inert, gypsum, limestone, dolomite and coal. One of the main activities in the industry with big pressure on the Vjosa basin is **gravel extraction.** Gravel extraction from riverbeds has been a major economic activity in the Vjosa watershed reaching its peak during the 2000s with more than 56 gravel extraction points during that time (Durmyshi et al. 2018), 16 gravel extraction points in the Shushica riverbed and about 14 gravel extraction points in the Drino riverbed. However, in recent years, the gravel extraction activity has been minimized and targeted only for public works, due to the construction/reconstruction of the roads in the region.

The fragmentation directly inhibits dispersal, reduces gene flow and decreases food availability, in both terrestrial and aquatic parts of the Vjosa wide basin. As the climate changes, many species will need to move to new habitats in the landscape and fragmentation will impede range shifts in those that have trouble crossing gaps between patches. So, **Landscape fragmentation** and **human-induced land-cover changes** are two of the main current threats.

Among the major (well-known) threats with high impact are **nutrient input** (particularly of phosphorus through point sources of pollution and untreated sewage and waste), **habitat conversion** and silt load (very present in wider areas such as Lengarica). Other threats are potentially of high impact but less well known. Such threats include **pollution with hazardous substances** (from sources such as mines in Memaliaj, former industries, agriculture) or climate change. **The sewage and solid waste** remains among the most serious environmental issues in the Vjosa basin. There is progress on the new sewage treatment system within Vjosa NP that is to be installed for parts of Vjosa basin. This has been promised by the Albanian government after the proclamation of Vjosa NP.

Some of the ***challenges include***: (i)Land tract management type usually is defined by different objectives and uses (e.g., resource extraction, fishing, mining, grazing, recreation, and conservation), mandates (e.g., preservation, multiple use), political hierarchy (e.g., central/NAPA, municipality), and intensity. (ii) An increase in the number of management types causes corridors to arise even faster or be more distinct than an increase in the number of management units alone. (iii)The human and financial capacities of PA management structures (at the national and regional levels) are limited, in both the numbers of staff and in their competencies. (iv) Lack of efficient monitoring of the use of resources in PAs; (v) Weak law enforcement in the field of nature conservation which has resulted in illegal logging and hunting in PAs and in other areas despite the Moratoriums; (vi) Activities such as education and knowledge sharing are not sufficiently developed or supported in PAs.

4.1 Threats and challenges with regard to Connectivity Conservation

We compiled threats to both biodiversity components (and in some cases to particular species) as well as to the river ecosystems themselves. Major conservation concerns identified for Upper River Vjosa are (i) watershed impacts.

According to “Albania’s First Biennial Update Report” issued by MTE (2023) in terms of temperature, all scenarios for the Vjosa River Basin suggest that the area is likely to become warmer. Similarly, increasing trends in annual and seasonal temperatures, both minimum and maximum values, are expected. Temperature extremes are also expected to increase. The analysis of the precipitation projections shows a negative slight trend for all seasons and time horizons. The analysis indicates a higher risk for intensification of heavy precipitation that causes flooding as well as a likely increase in drought frequency. Numerous species that shelter in terrestrial and aquatic ecosystems within Vjosa catchment, in order to keep pace with their habitat needs and climate preferences, species must shift their distribution. So, once the thresholds are affected the geographic range shifts will change the composition of ecological communities (Lovejoy and Hannah 2019) which will alter the structure and function of ecosystems from the smallest to the largest spatial scales (Gonzalez et al. 2020). Further on the spatial redistribution of species and ecosystems will also affect the supply of ecosystem services that human society relies upon (Diaz et al. 2020).

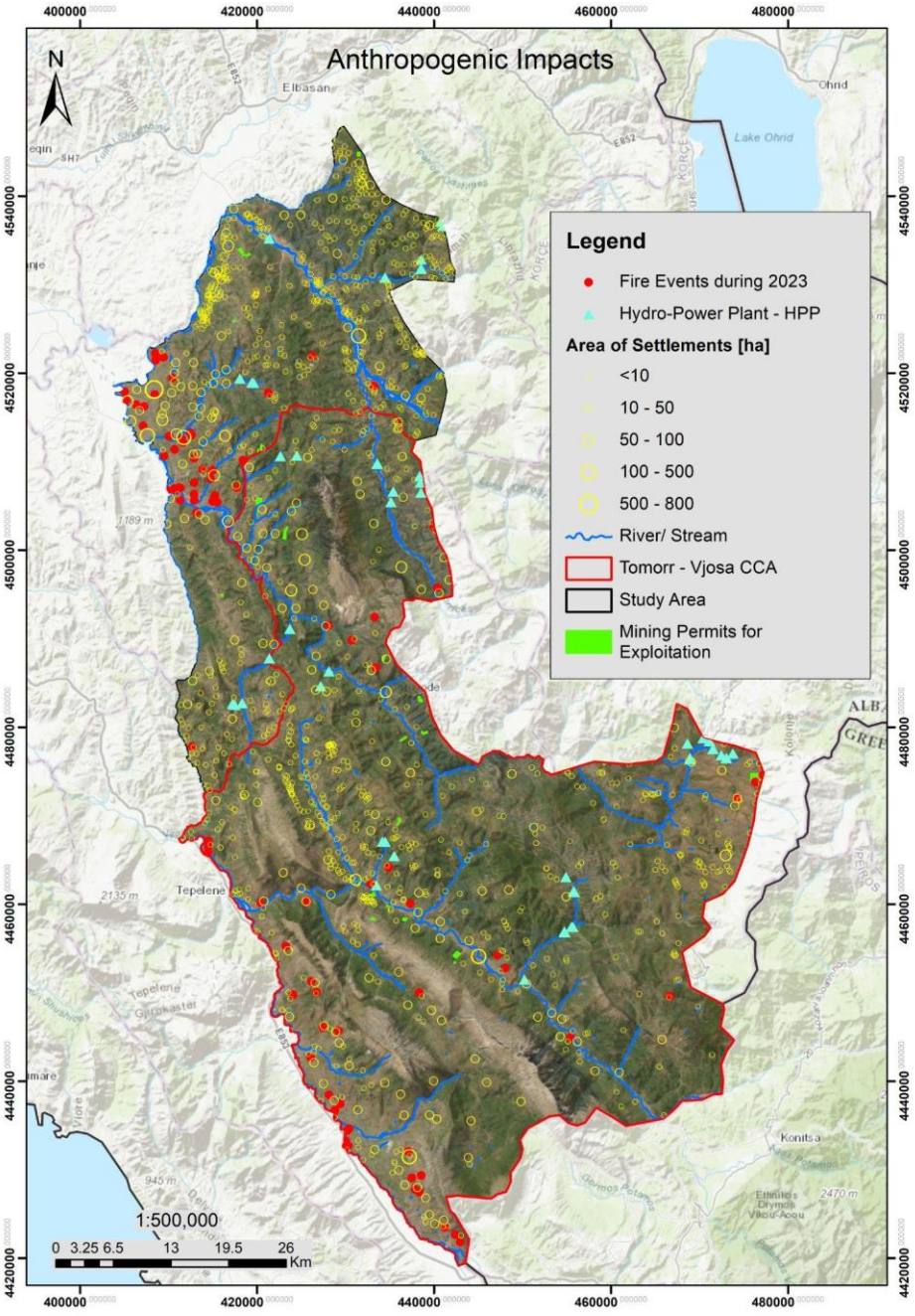


Figure 7 Land use and spatial distribution of selected major threats to Vjosa Basin

4.2 Stakeholders involvement

Given that a CCA should be a participatory and inclusive entity, managers must identify key actors, partners, and other stakeholders. They can come from public or private institutions, communities, NGOs, academia, among others. In these circumstances multiple actors increase the diversity of perspectives that comes to bear on decisions as well as heightens understanding of expectations and the role that local people could play within the CCA initiative. Additionally, their involvement may reveal other conservation efforts within the proposed zone.

PPNEA was undertaking a consultation process with NAPA, RAPA and local municipalities. Further on the close communication and exchange of views was done with other locally engaged actors from the NGO sector as MedINA (Greece) and EcoAlbania (Albania). The meeting with NGO MedIna was organised online at the end of May, aiming not only to introduce the proposed CCA from Albania, but also to discuss on priorities in transboundary level. While the meeting with NGO EcoAlbania was organised at the beginning of June, at the premises of EcoAlbania offices. Several reports on species presence, threats to biodiversity and stakeholder perceptions were shared and made available.

A focused meeting with the main stakeholders from the Tepelene, Permet and Gjirokaster areas was organised in the city of Tepelene on 3rd June 2024, which served to introduce the study aim, study area and the proposed corridor for Upper Vjosa. A group of diverse stakeholders participated including Vice Head of Gjirokaster County, Vice Mayor of Tepelene municipality, RAPA Gjirokaster and Berat, representative from Local Action Group ''Pro Permet'', different local NGOs, University of Gjirokaster, tourist association ''Vjosa Explorer''. The participants expressed support to the connectivity conservation initiative for Upper Vjosa. At the same time, they actively discussed about threats in the area, such as projects for photovoltaic and wind farms, potential infrastructure development projects such the construction railways, airport in Gjirokaster, to more nature related conservation problems such as erosion along Vjosa river. It was also mentioned the need for information of the communities in and around protected areas about natural values and its potential. Additionally, reforestation efforts have been initiated though establishment of local nurseries in the municipality, such as in Tepelene and Dropull, all these by producing local native seedlings for reforestation in Vjosa NP.

Photo taken during stakeholder meeting in Tepelene

Numerous international funded projects have attempted to design, study, analyze, monitor, stabilize and even improve the situation of Vjosa basin. Whereas these efforts are, without doubt, necessary to protect one of the remaining European values as free flow Vjosa River with its unique non-biotic and biotic components. There are international activities concerned with conservation issues, the most outstanding and influential of which has been initiated by the River Watch, while the outcome of this is the result of a pursued unique collaboration between the Albanian Government, local and international experts, environmental NGOs from the Save the Blue Heart of Europe campaign, IUCN and outdoor clothing company Patagonia. There is currently a steadily increasing research devoted to conservation at Vjosa basin. There is a need for further conservation and research on understanding of the ecology and distribution as well as current population states for basically all plant and animal groups or species. Research into protection strategies for particular habitat types and vulnerable species is required. Far

more research should be conducted regarding the impact of climate change on the ecosystem, species communities and single species. Research in sustainable agriculture, forestry, and tourism is currently either underrepresented or poorly-existent. However, the need for ecotourism in the Vjosa basin has been proposed several times (EcoAlbania, 2021; Sovnik, 2021).

The project "**Environmental assessment of the Vjosa riverscape as the basis for an integrated water management and sustainable catchment development**" that is supported by APPEAR Academic Partnership and is implemented by a Consortium composed by University of Tirana, Agricultural University of Tirana, Polytechnic University of Tirana, University of Natural Resources and Life Sciences (BOKU), University of Vienna and University of Innsbruck Austria. The project seeks to establish a long-term continued research cooperation of Albanian and Austrian scientists in the field of water governance. The specific topic is a cooperative and interdisciplinary study of the Vjosa river system in Southern Albania – as the basis for its sustainable development. Together with its tributaries, the Vjosa represents a dynamic river ecosystem characterized by a near-natural flow regime and largely undisturbed hydromorphic dynamics.

The other APPEAR project: "**Enhancing a science-policy interface development for the Vjosa**" has an overall objective to strengthen the sustainable development of the Vjosa River catchment by bridging the science-society interface, enhancing science support for responsible governmental institutions and fostering the communication between decision-makers, scientists, public, stakeholders and civil society organizations (CSOs).

5. Connectivity Conservation Area ''Tomorri– Vjosa''

Name of CCA	Tomorri - Vjosa
Surface	3072.76 km^2
Location/central nearest point	North, near Tomorrica river, Gramsh (40.793333°/20.199166°); South, Drinos river, border with Greece (39.921944°/20.335556°); West, Luftinja stream, near Memaliaj(40.399722°/19.987778°); East, Border with "Polis-Rungaje-Gramoz-Morave" CCA, near Gramoz mountain and border with (40.424167°/ 20.731389°).
Core areas connected	Tomorri National Park - CCA ''Polis - Rungaje - Gramoz-Morave'' - Fir of Hotove - Dangelli National Park - Prespa-Pindos CCA
Protected Areas in the CCA	Vjosa Wild River NP, Fir of Hotovë- Dangëlli, Zagori, Gërmenj, Tomorri NP, Bogovë

Bio-geographic region	Mediterranean region 100%
Important habitat types	**Riparian habitats**, 3140 *Hard oligo-mesotrophic waters with benthic vegetation of Chara spp., 3240 Alpine rivers and their ligneous vegetation with Salix elaeagnos, 92C0 Platanus orientalis and Liquidambar orientalis woods (Platanion orientalis), 92D0 Southern riparian galleries and thickets (Nerio-Tamaricetea and Securinegiontinctoriae.* **Terrestrial habitats** in the slopes of hills and mountains of the Vjosa valley such as 6220 * *Pseudo-steppe with grasses and annuals of the Thero-Brachypodietea, 9530* Mediterranean pine forests with endemic Mesogean pines, 6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (*important orchid sites),* 8140 *Eastern Mediterranean screes,8210 Calcareous rocky slopes with chasmophytic vegetation, 91K0 Illyrian Fagus sylvatica forests (Aremonio-Fagion), 91M0 Pannonian-Balkanic turkey oak-sessile oak forests, 9250 Hellenic beech forests with Abies borisii-regis, 9340 Quercus ilex and Quercus rotundifolia forests, 6170 Alpine and subalpine calcareous grasslands, 91L0 Illyrian oak-hornbeam forests (Erythronio-carpinion)*
Important wildlife species	Brown bear (*Ursus actors),* Balkan chamois (*Rupicapra rupicapra balcanica*), Euroasian otter (*Lutra lutra*)
Land use	1916.75 km^2 Woodland, forest and other wooded land; 447.058 km^2 Grasslands and land dominated by forbs, mosses or lichens; 299.021 km^2 Arable land and market gardens; 217.373 km^2 Heathland, scrub and tundra; 165.73 km^2 Inland unvegetated or sparsely vegetated habitats; 13.91 km^2 Constructed, industrial and other artificial habitats and 12.92 km^2 Inland surface waters.
Current governance and management of natural resources	**Municipalities:** Berat, Polican, Skrapar, Këlcyrë, Përmet, Libohovë, Kolonjë, Dropull, Memaliaj, Tepelenë, Gjirokastër
Current threats/challenges/opportunities to connectivity	Hydropower development, gravel extraction, (future) oil extraction, intensification of agriculture, illegal hunting, illegal logging, tourism development

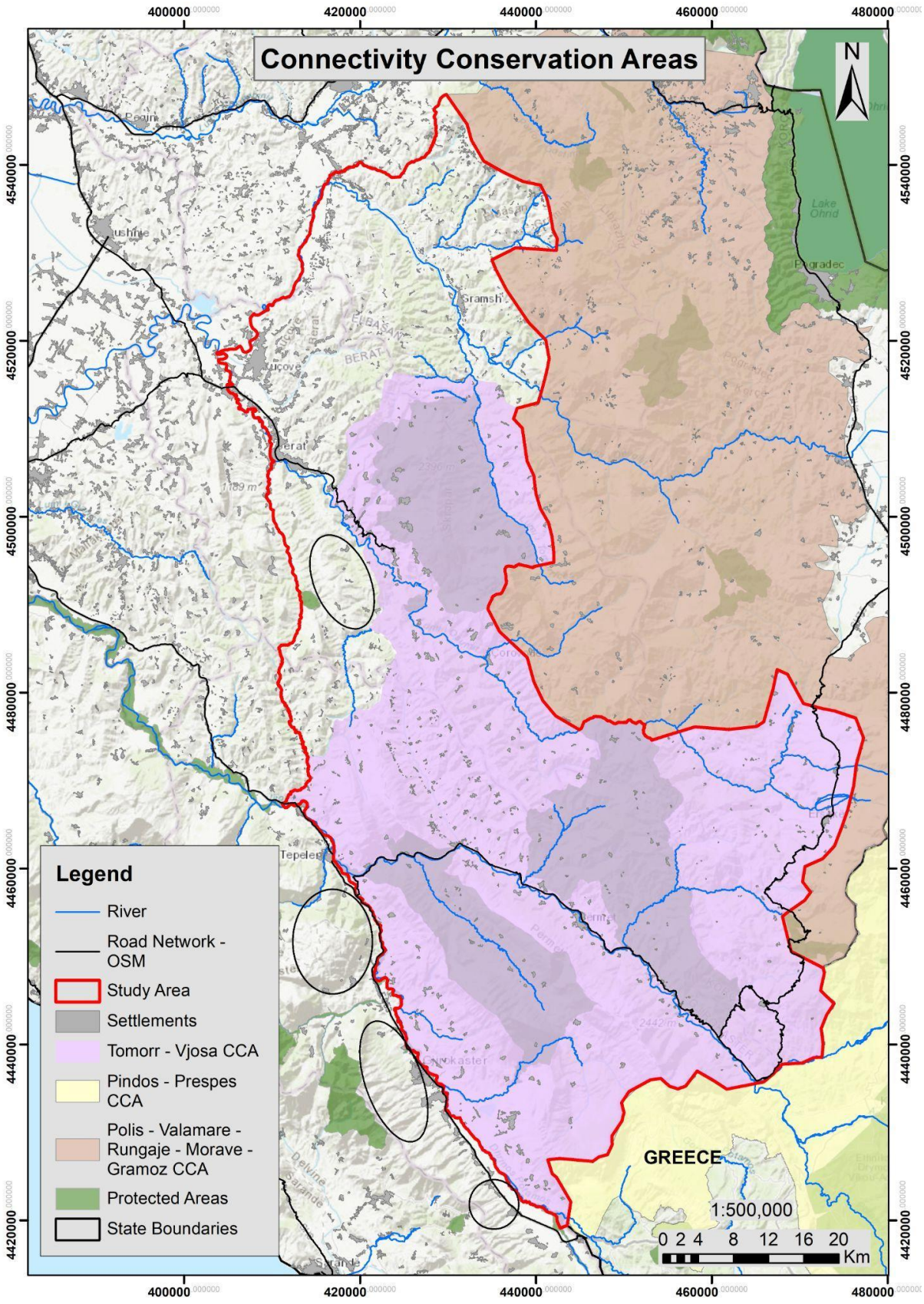


Figure 8. Tomorri - Vjosa Connectivity Conservation Area indicating neighboring protected areas, populated places, major roads, and artificial lakes suggesting possible fragmentation.

Main features contributing to landscape connectivity and species movement

Tomorri Mountain National Park and the Fir of Hotova-Dangëlli National Park represent key habitats for mammals, especially brown bear and chamois. The high-altitude, rocky environments of Tomorri National Park, provide ideal conditions for chamois, supporting its habitat preferences.

An interesting highlight from the prediction map is the role of Qarrishta Mountain, positioned between the Osumi and Vjosa rivers. This mountain appears to be a vital corridor, potentially facilitating connectivity between the Fir of Hotova National Park and Tomorri National Park. This connectivity is essential for maintaining genetic diversity and allowing for natural movements of bear populations between these core areas. The mountains of Qarrishta, Kokojka (within the Fir of Hotova National Park), Qelqi, Postenan, and Shelegur, while of secondary importance, are still significant for maintaining regional and transboundary connectivity. These areas facilitate movement and genetic flow with other core conservation areas (CCAs) and support transboundary connectivity, crucial for the species' long-term viability.

Additionally, the beech forests of Qelqi Mountain and Qinam-Orgocka, located to the east of Hotova, as well as the forests of Shelegur near the Greek border, are identified as significant habitats for bears in this region. Furthermore, the steep mountain ranges of Shëndelli-Lunxhëri-Burrito and Trebeshinë-Dhëmbel-Nemërçkë are identified as essential habitats, reinforcing the model's predictions about the importance of these rugged landscapes. The valleys of the Drinos and Vjosa rivers to the west are noted as potential barriers to bear movement, a finding that is strongly supported by the prediction model.

The Vjosa River, along with the Drinos, emerges as a primary habitat for otters. These rivers provide essential resources and suitable environments crucial for the species' life cycle. Additionally, smaller tributaries of the Vjosa river, including the Sarandaporos, Langarica, Dishnica, Zagori, Luftinja, and Suha streams, play significant roles in ensuring connectivity with the main river systems. These tributaries contribute to the continuity of suitable habitats, allowing otters to move freely and maintain genetic diversity across their range. The Osumi River, located further north, is also identified as a vital habitat for otters. Its main body, along with several smaller tributaries, notably the Vokopola and Çorovoda streams, provides important resources and refuge areas for the species. These watercourses support the otters' feeding, breeding, and sheltering needs, thereby enhancing their survival prospects in this part of the region.

Moving further north, the Devolli River course retains some importance for otters, although it does not match the significance of the Vjosa and Osumi rivers. The recent damming of the Devolli has likely had a substantial impact on the river's ecology, affecting otters and other aquatic species dramatically. This alteration has likely led to habitat fragmentation and reduced the availability of suitable environments for otters, highlighting the challenges posed by human activities on their natural habitats. Conservation efforts should focus on maintaining and restoring these critical aquatic ecosystems, considering the interconnected nature of rivers and streams that support otter populations.

The watersheds of Drino, Zagori Valley, Osumi, Tomorrica and Devolli, as well as the Upper part of Vjosa Watershed represent all important habitats for the bird species in focus, Egyptian Vulture and Golden

Eagle. Even though the study area does not extend further, the conservation efforts should be expanded to include the wide watershed of Drino Valley from Sotira, to Mali i Gjere, to Fir of Kardhiq, Zhulat, Golëm, Gryka e Këndrevicës, and the whole area of Salari Stream Watershed that discharges in Vjosa River and from the Salari Stream discharge to continue straight north to include the part of the Mediterranean evergreen vegetation hills of Mallakastra, further to the part of Berat District area and Elbasan District area up to reaching Devolli stream in the north.

Current governance and management of natural resources

''Tomorri - Vjosa '' CCA expands in several municipalities covering different spatial areas, populations and of different importance for the connectivity potential of the CCA in focus. The biggest municipalities in the CCA are Berati, Gjirokastra and Tepelene and Permet, while Polican, Skrapar, Gramsh, Memaliaj, Kelcyre, Dropull, Libohove, Kolonje, differ on their spatial coverage, with some of the municipalities located almost entirely within the CCA area. Based on the Law 139/2015 "On Local Self-Government", the municipalities have an important mandate, especially in areas of the CCA the municipalities approve different categories of planning (as local urban plans, territorial plans, regulatory plans, etc.), they are also responsible for approving energy and nature resources utilization plans, waste management, regional nature parks, etc.

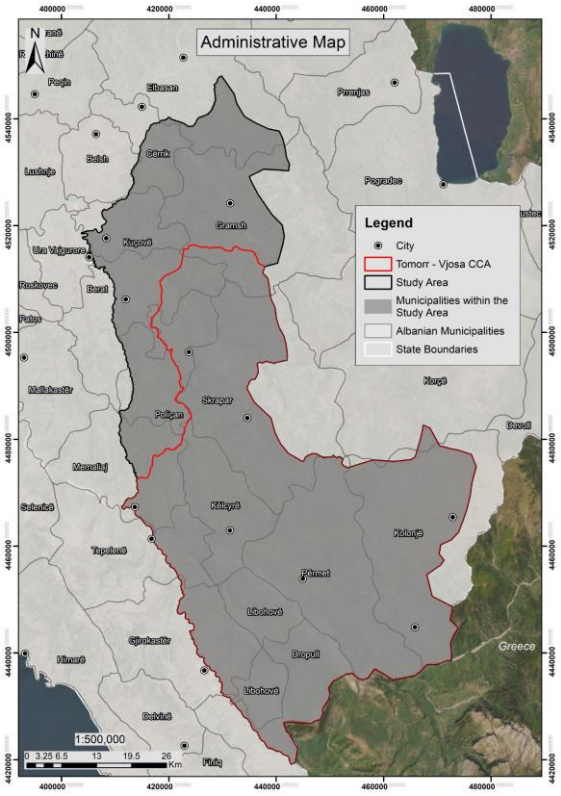


Fig. 9 **Administrative map of the Tomorr - Vjosa CCA**

In Albania, the Ministry of Tourism and Environment, is responsible for environmental protection measures and acts through various directorates. The National Agency of the Protected Areas (NAPA) and the structures at the local level i.e. Regional Agency of the Protected Areas Gjirokastra, Korca, and Vlora have a responsibility of administration and challenge to face the current situation and the

perspective related to protected areas and their management within ecological corridor Vjosa basin. The Water Resources Management Agency (AMBU) of Albania is tasked with ensuring good governance of water resources to meet vital needs while considering ecosystem sustainability. In recent years, AMBU has developed and approved several Integrated River Basin Management Plans (IRBMPs) for various river basins in Albania, with plans underway for the Vjosa IRBMP.

Recently, a process was initiated for preparation of proposal for declaration of Vjosa as UNESCO "Man and Biosphere", led by the Ministry of Tourism and Environment and the National Agency of Protected Areas. Also, an Integrated Management Plan for the conservation and development of the Vjosa NP for a 10-year period has been established.

5.1 Recommendations for connectivity actions in the 7th CCA to be supported by PONT

Long-term goal, Vision

7th CCA aims to protect the ecological integrity of the connectivity conservation area while maintaining a favorable conservation status for the local habitat types, rare and protected species' habitats, and populations of fauna. This is particularly important for target species, such as otter, large carnivores, birds of prey and endangered aquatic species which are found in the Vjosa basin and other connectivity conservation areas in the PONT Focus Region, which includes Greece, Albania, and Northern Macedonia.

- Indicative recommended actions

Biodiversity conservation

- Detailed and advanced mapping of CCA sections with specific threats, issues, obstacles and incorporate in an assessment, analyzing land-use patterns and threats for each section (This assessment identified the top threats along the length of the corridor and provided conservation organizations within information needed to direct scarce funds to sites where they are most needed, such as specific bottlenecks, mining activities, HPPs, road crossings or unprotected sections of private land.)

- Initiating a comprehensive biodiversity monitoring in CCA, gathering of new data in cooperation with researchers, scientific institutions, PA management bodies, local authorities and community groups.

- Assess the rate of genetic exchange to understand the movement of target species between population segments of CCAs that have been separated by the highway & impoundments etc.

- Expand understanding of the biodiversity of target species that are native for Vjosa basin and classified as threatened (vulnerable, endangered, or critically endangered) based on the IUCN red list, national, European, or global; or are protected by the Habitats and Birds' Directive; and are protected by Albanian legislation.

- Map the different types of habitat in the Vjosa basin-CCA's Special Protection Areas (SPAs) in the same way that was done for the Sites of Community Importance (SCIs).

- Identify the current and potential core areas for large carnivores (bear, wolf) and formulate scenarios for defining conservation corridors through the generation of suitable spatial models (gathering of field data on the species' distribution, data processing, scenario and model configuration).

- Identify the current state of aquatic species (with focus to those of conservation priority) and formulate scenarios for defining conservation options through the generation of suitable spatial models (gathering of field data on the species' distribution, data processing, scenario and model configuration).

- Evaluate the available suitable habitat for the Eurasian Lynx within the Vjosa basin CCA through cooperation with PP-CCA. Locate optimal areas for the species as well as potential wildlife corridors both within the CCAs and across neighboring countries. Conducting a pilot study to monitor for potential signs of lynx presence (i.e., through camera traps, tracks surveys, etc.) within those optimal areas.

- The secure ability of animals to move at a variety of scales is important for the health and persistence of their populations.

- The conservation and/or enhancement of the status of rare and protected wild fauna populations and their habitats within the boundaries of the 7thCCA,;

- The identification of ecologically significant zones for rare and protected wild fauna, particularly in relation to target species (e.g., Balkan chamois, large carnivorous, otter, birds of prey, fish) and preservation of appropriate ecological corridors that would permit them to freely move between their various distribution centers, both inside and outside the7th CCA boundaries.

Protection of aquatic environment

- Focus should be given to Vjosa River and tributaries on key spawning grounds of fish species in the riverine ecosystems of all Vjosa basin-CCA catchments are identified.

- Evaluate the local trout population (and potentially other sympatric species) and the ecosystems in the rivers of the larger Vjosa river basin.

- Detailed study on Otter population state, distribution and threats.

- Construction of a number of otter holts in selected sections of the Drinos. One factor limiting the otter population in the area is thought to be the scarcity of potential nesting locations along the lake's shoreline.

- Identification, mapping and restoration of the riparian forest. The riparian vegetation has been severely reduced and the erosion of the riverbed and banks has accelerated due to the decades-long unlawful exploitation of river sediment deposits, which has major repercussions for aquatic life. Selected riparian zones must be appropriately fenced to reduce grazing pressure and discourage more aggregate extraction, thereby promoting the habitat's natural repair processes.

It is anticipated that the river stretch's suitability for many species, including otters, would significantly improve as the ecosystem of the river gradually recovers.

- Removal of river mining facilities.

- Promote small scale water treatment facilities for small settlements, restaurants and other facilities that directly discharge waste water.

- Introducing new technologies that reduce energy consumption at the local level

- Analyses of current benefits and challenges from operating hydropower plants to assess economic feasibility of hydropower plant construction vs other nature friendly sources and alternative income generation activities;

- Assess effects of disturbance from operating mining activities, queries; river mining units (noise levels, people presence, and machinery) over species presence/movement.

- Arrange and host events with agencies and environmental specialists to discuss the methodological ways to record protected species (mostly the target species) inside the Vjosa basin-CCA.

Initiatives centered on the livestock, forest and agriculture industries

- Evaluating the effects of the abandonment of agriculture and livestock raising (and the ensuing natural scrub/forest regrowth) on biodiversity and previously offered ecosystem services in sizable portions of the mid-elevation zone (500–1000 meters) in the Vjosa basin–CCA.

- Conducting research to ascertain potential effects on upland areas of the documented shift from traditional transhumance livestock farming of sheep and goats to the current large-scale cow rearing.

- Support the National Forest Agency, Municipalities and communities to adapt forest management plans to include specific management objectives to decrease the area of scrubland and coppice wood that is most susceptible to fire.

- Conduct research of forest state and recovery needs

- Undertake forestation measures, strictly use of native trees during ground actions.

- Raise awareness on the importance of maintenance of hedges and promoting re-establishment of traditional management of abandoned agricultural land that borderlines forests

- Raise awareness of local communities/shepherds for fighting intonation fires

Key sector-related measures

- To reduce the likelihood of catastrophic fires, techniques to improve goat-sheep livestock production should be investigated. This is especially important for reforested and/or abandoned former agricultural areas surrounding the communities.

Climate Change actions

Establish a mechanism for collecting data

- Management plans of the protected areas (new ones and updated) are reflecting the climate change concerns.
- Initiate a climate mitigation plan.
- Link PA administration with relevant climate responsible institutions.
- Promote data collection on climate change trajectories inside the Vjosa basin-CCA, compare contemporary and older climate data.
- Developing and improving research initiatives to gain a deeper comprehension of the paths taken by climate change.
- Monitoring and assessing changes in the physicochemical properties (hydrology) of fragile micro-ecosystems in connection to changes in meteorological data (atmosphere) in the Tomorri-Vjosa-CCA.

Nature-based tourism as a means of poverty reduction and economic development while enhancing connectivity conservation

- Develop an ecotourism action plan for environmentally friendly forms of tourism, highlighting and promoting the importance for local communities and cultural values, of mild and environmentally friendly forms of tourism instead of mass tourism.
- Develop communications and marketing materials that highlight experiences, adventure, and educational possibilities to cater to the requirements and interests of different tourist categories.
- Develop a Quality Assurance Program – Vjosa products of origin, including a Training program for interested businesses to become certified by the Vjosa Quality Mark
- Support the creation of interpretive-thematic routes presenting the ecology and threats of Vjosa CCA target species for use by the local population and visitors with educational and recreational applications (recording documentation, interpretation, signs, mobile applications, etc.).
- Support the development of hiking and biking trails, as part of building the infrastructure for low-impact eco-tourism activities.

Agro- and eco-tourism and climate change adaptations

- Enhance and promote local products and traditional gastronomy.
- Collecting data on traditional practices of land use (livestock farming, cultivation, processing, etc.) and presenting them to visitors.
- Promote slow food initiatives and agro-biodiversity protection.
- Raising awareness of local communities about sustainable management of resources and nature conservation, and building nature resilience;

- Promote of use/revitalize the local races and varieties, as means of conservation and development.
- Assess the ecosystem services/alternatives to non-friendly manners of natural value utilization

Information and awareness

- Raising awareness and providing information on the value of traditional livestock grazing techniques, particularly transhumance livestock systems, among local communities and authorities.
- Provide a brief handbook on poaching incidents that explains how to identify the genetic makeup of animal remains (for both citizens and conservation workers).
- The creation and release of a useful manual for the protection, study, and research of the iconic species, intended for use by relevant organizations and services such as RAPA, NAPA, Municipalities, and other relevant parties (like environmental NGOs).
- Development of educational environmental packages on the environment, focusing on the target species and the significance of the Vjosa basin-CCA.
- Close work with schools and educational institutions - application in educational institutions.

Governance

- Encourage cooperation between relevant organizations (such as protected area management units, local agencies, etc.), municipalities, regional authorities, NGOs, and local communities, as well as other stakeholders.

- Inform the appropriate authorities in charge of creating and approving spatial, development, environmental, and forestry plans—all of which may have an impact on the Vjosa basin-CCA and its conservation corridors—about the biological significance of the area.

- Inform local authorities, municipalities, and communities about the ecosystem services that the Vjosa-CCA offers.

- Streamline the outcomes of National Communication UNFCCC for improvement of institutional capacity for effective climate change-related planning and management in the CCA

- Form partnerships (i.e., with recreational fishermen) to conserve and promote the uninterrupted and sufficient flow in surface water bodies, emphasizing its importance for fish stocks, with the goal of restoring (or at least preventing further degradation of) the aquatic ecosystems/corridors

- Understand the role of current human presence, socio-economic components in different changes caused to the environment.

Streamline the governance structures capacity at the local and national level, PAs and other actors towards CCA objectives:

- Including corridors into Municipality territorial planning.

- Advancing the role and capacities of the LSG unites, local environmental NGOs, organized stakeholders, end users, etc.
- Promote cooperation with NEA and Inspectorates; advance their capacity for addressing ecological water requirements, following the relevant EIA law and regulation for operational procedures, water management. Campaign for well function and building for fish waterways.
- Undertake analyses of social, economic and demographic changes within the last three decades. Assess the role of land abandonment on biodiversity and ecosystem services.
- Promote resilient rural development program and integrate ground conservation measures/actions into development endeavors.

Transboundary Cooperation

Agree on a common transboundary vision

- Develop and agree on a common transboundary vision. We consider engagement in a transboundary process because either opportunity awaits the concerned protected areas, surrounding communities and countries, or an ecological crisis and/or a threat will be mitigated by the process. While designing the transboundary conservation process, coordinators and key stakeholders will be identified and engaged in the process from its beginning.
- Development of a Transboundary Diagnostic Analysis and Strategic Action Planning Process for Vjosa/Aoos Basin
- Joint communication and education activities and Public Awareness Strategy
- Establish a core group with experts and representatives from local authorities, management units, the municipalities, and the regional governments, in order to share knowledge and good practices in matters regarding the implementation of research and management measures in the 7th CCA and PP CCA (for each country with a shared border).
- Engage team of experts and management bodies (i.e., forestry sector, national parks, border police, etc.) in order to enforce good practices and management measures to limit (or eliminate) cases of transboundary environmental crimes, such as poaching of the Balkan chamois.

Development of a transboundary monitoring system that addresses issues of climate change, wildfires, etc.

- Joint efforts by PA authorities and other responsible agencies for implementing initially the monitoring system of the basic monitoring of land use, water quality and quantity, forests and other terrestrial habitats, birds and vegetation.

Conservation and Research

- Research on habitats, states across countries. Identify gaps between habitats, fragmentations, threats and challenges that exist in these both countries and elsewhere.
- Joint protocols or methodological framework to monitor different species sub-populations (both terrestrial and aquatic).
- Joint field work for understanding the distribution patterns of selected species. Identify the distribution of the species and the habitat use on the transboundary zones.

5.2. Conclusions and Strategic Recommendations concerning the new CCA

The ToR, the current PONT focus region, and the CCAs are used to establish the borders of the study area. The study area is a portion of the PONT Focus Region, which was extended in December 2021 to encompass the Korab-Shara cluster in Albania and North Macedonia, the Albanian Alps National Park, and the ecological corridors that connect these clusters. Greece's Connectivity Conservation Area was added later in 2022. Therefore, the boundaries of the research area include the upper portion of the River Vjosa, which borders the Prespa–Pindus CCA to the southeast, Polis–Valamare–Rungaje–Morave–Gramoz CCA to the north, the Vjosa basin, and the southern portion of Osumi that is connected to Tomori NP to the west.

The importance of the middle and lower section of the River Vjosa and important corridors for species movement, migration and reproduction is noted but fell outside the scope of this study.

Surrounded by mountainous, hilly, and agricultural ecosystems, the middle section of Vjosa River has different habitats compared to the lower part. Along this section are found several important protected areas such as Fir of Kardhiq – Rrezome, and Fir of Zhulat, which host important bird' species, such as the Egyptian vulture (globally EN species), of which almost 90% of the EV breeding pairs left in Albania are found in the Upper / Middle part of the Vjosa River. In addition, these important ecological corridors are of high interest by the presence of mammals which are present in the river and the surrounding ecosystems. The valley is wide, and the floodplains of Vjosa River are recognized as one of the most important riparian ecosystems.

The lower part of the Vjosa River opens up and forms one of the most outstanding landscapes and diverse habitats through its delta. These diverse habitats formed by this river, the so-called Pishe–Poro–Narte, at the national level, are proclaimed as Protected Landscape (IUCN Category V). Meanwhile, at the international level, its is recognized by such as (i) an Important Bird and Biodiversity Area; (ii) a global Key Biodiversity Area, (iii) a Candidate Emerald site, and (iv) a candidate for a proposed Site of Community Importance. Based on the latest studies done by PPNEA on birds, Topi et al (2023), the area shows to have more than 200 bird species and regularly sustains important portions of over 1% of the European populations for several species, such as the case for Pied Avocet (Recurvirostra avosetta), Dalmatian Pelican (Pelecanus crispus) and Greater Flamingo (Phoenicopterus roseus). This area is an important hotspot for breeding, wintering, and stopover for many birds nationally and internationally. In addition, besides birds presence and importance, the lower Vjosa River is important on fish migration and water connectivity sea-river.

Connectivity is widely accepted as a key important component to all organisms in spatially structured environments, and critical to understanding how global change affects their habitats and ranges (Ormerod et al. 2011). However, in the case of Albania connections among terrestrial and freshwaters have been under-represented in the recent connectivity debate. In fact "interchangeably" lies in land and water interface (Talley et al. 2011). This is vital for the ecosystem functioning within Vjosa National Park and other protected and non-protected areas considered in this survey. The reason of its importance lies in the current gap:

- Delivering a conceptual framework for habitat connectivity within potential PONT 7th Conservation Connectivity Area, PPNEA (2024) was underlining the lack of specific approach for evaluating habitat connectivity that among other lies in primary effects and dynamical features. Therefore, only when that movement modifies one of the systems in some way does there exist a functional relationship. These changes can manifest as nearly any kind of physical or biological

interaction, but they can be broadly classified as falling into one or more of the following five primary effect classes: trophic, demographic, environmental, behavioral, and genetic. These classes have strong overlapping and far-reaching indirect effects on communities and ecosystems.

- Connectivity affects not only the movement of species within and between terrestrial unites and water bodies (in case of Vjosa NP mostly between running ecosystems), but also the hydrological transport of energy, solutes, pollutants and sediments;

- Ecosystem function in freshwaters depends critically on lateral connectivity with floodplains, catchments and riparian zones, as well as on longitudinal connectivity upstream and downstream;

- Freshwater catchments are pivotal landscape units that are highly connected internally, but fragmented naturally across their boundaries. Luckily in case of Vjosa the fragmentation visually is limited, but the following analyses considering pressures confirms that there are numerous;

- Internal fluxes and external connections in freshwater ecosystems and their catchments have been extensively modified by human activities;

- Within protected and non-protected area, the freshwaters have disproportionately large conservation importance reflected among different species groups and habitats;

- The freshwater ecosystems (in light of water resources as an environmental factor) are highly sensitive and most vulnerable to global climate changes. Expected changes in precipitation and temperatures will affect not only the hydrology of the watershed but demand for water as well (MTE, 2021). Industrial and domestic water demand show similar changes across all climatic scenarios. Only water demand from irrigation is exerting additional pressure on a changing climate.

Regarding the pressures, stressors, and management issues that the concept might be used to address within this ecological study that follows the general management principles of Vjosa National Park, aquatic connectivity (both freshwater and terrestrial) should be best taken into account in the Vjosa basin. Remember that applications can be made to matter, energy, and water fluxes in addition to organisms. Examples of such applications in contexts of study area are as follows:

- Climate change impacts and adaptation (relevant to lateral, inter-basin, longitudinal and hydrological connectivity); this is very relevant with regard to abundant type of water ecosystems within entire landscape (running: Vjosa main channel, Shushica, Langarica, Drinos, Benca; standing: reservoirs or standing & transitional: Narta).

- Rural land use change (historical and current one, mostly with regard to lowland flow and not only), including agricultural policy, protected areas policy, forestry policy, bias policy of agriculture-protected areas-tourism-forest), tourism, habitats recovery (!? Narta case) and other landscape-scale initiatives (lateral, inter-basin and hydrological connectivity).

- Recovery from large-scale salinization at the lowland areas (inter-basin connectivity, hydrological connectivity), mostly linked with rise of the sea water level.

- Urbanization and urban drainage (lateral, inter-basin and hydrological connectivity), housing expansion (case of villages spread along the river and new planned touristic residences) and direct link with water ecosystem and receptor.

- Point-source pollutants from consented and non-consented discharges, notably combined sewer overflows, sewage treatment (not treatment discharges), stone and river mining and small scale industry including food production units as dairies (hydrological connectivity).

- Microbiological problems from sewage mainly in Vjosa, Drinos and Shushica(and not only) and livestock (lateral, longitudinal and hydrological connectivity). This is directly connected to food safety, tourist and visitor's safety, etc.

- Hydromorphological modification, mostly historical reflected via Cannel of Irrigation in Peshkepia (Shushica) (lateral, longitudinal and hydrological connectivity).

- Water resource development including storage water establishment, mainly in Drinos and Shushica (longitudinal, inter-basin and hydrological connectivity).

- Water abstraction that leads to extreme reduction of water in River Shushica, particularly during summer season (longitudinal, lateral and hydrological connectivity).

- Invasive non-native species that includes all types of ecosystems, mostly aquatic ones (longitudinal, inter-basin and hydrological connectivity).

- Developments in energy policy and energy generation approaches, notably in-river structures such as Langarica (longitudinal and hydrological connectivity).

- Recent change of attention, focus and emphasis towards ecosystem services driven by tourism (lateral, inter-basin, longitudinal and hydrological connectivity).

- Management for priority issues including freshwater species and priority freshwater habitat management (lateral, inter-basin, longitudinal and hydrological connectivity).

- All aspects of coastal, freshwater and catchment restoration.

Counting the above list illustrates issues connected to connectivity concept and challenges from one side reflects complexity within landscape level (considering terrestrial and aquatic components of intended 7th CCA) and from the other side the difficulty involved in quantification of connectivity in a simple and widely applicable way. Recognizing (revile & understand) elements that limit and promote habitat connectivity is a key objective in case of Vjosa wider area. The possibility of connectedness between any two environments might vary depending on a number of factors. These comprise traits of the environment, the boundary itself, and the species that cross it. There is a possibility that a number of biological characteristics may make terrestrial and aquatic habitats more connected. Ontogenetic habitat changes, which permit or mandate an organism to use aquatic and terrestrial habitats at different periods of its life, are one important characteristic. The extent to which the connection reaches the recipient environment should depend on a number of other variables, including the size of the home range, the ability to disperse, and the trophic status of the species displaying these habitat shifts. Longer time scales should

see a close relationship between life-history patterns and the biological characteristics that make up our next category, environmental traits (Roff 2002).

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