From biodiversity to ecological processes: learning from an exceptionally intact European wild river system





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Vjosa, as a “unique” river!

- Vjosa flows entirely unobstructed all the way through Albania to the Adriatic Sea (such conditions of unobstructed flow have been already lost in big rivers of Europe).

- Vjosa river is an asset to Albanian heritage and represents a precious natural laboratory of significance at European scale.

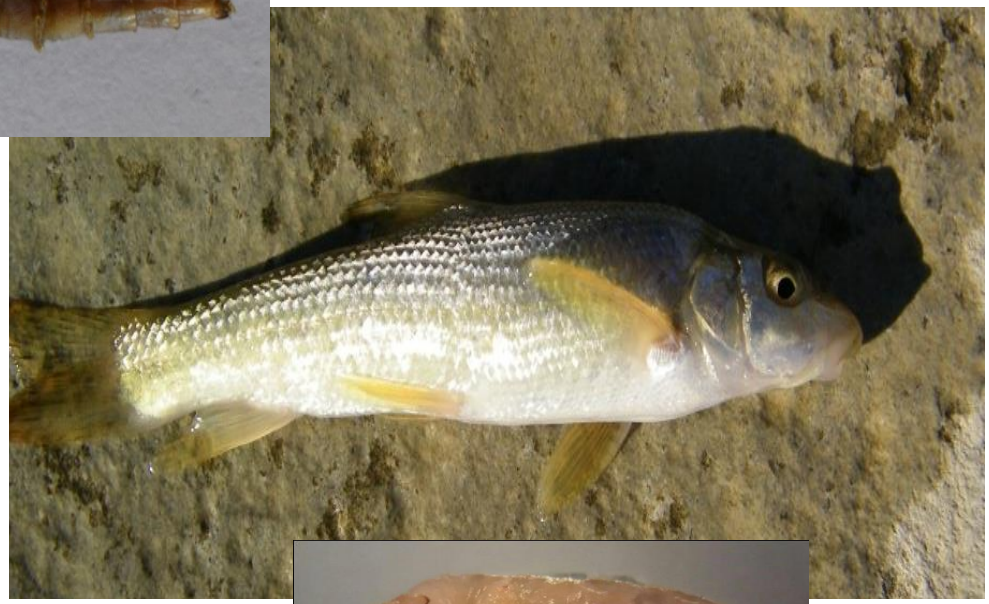
- In its near-natural state, the river is of high value for flood mitigation, water purification processes and the maintenance of a very rich biodiversity.

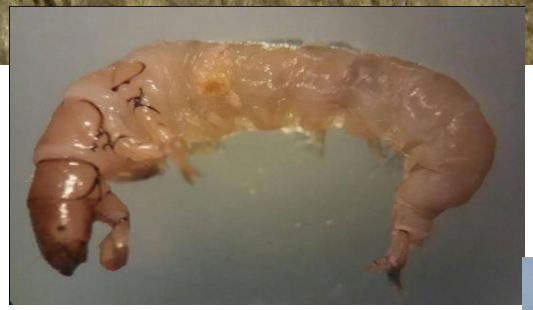
- From a social and economic point of view, it provides excellent opportunities for future developments, especially eco-tourism.

River's morphological diversity:
main river channel, side arms, oxbows, canyons, gravel bars, floodplain, islands, rocky parts, pools, swamps, thermal springs …

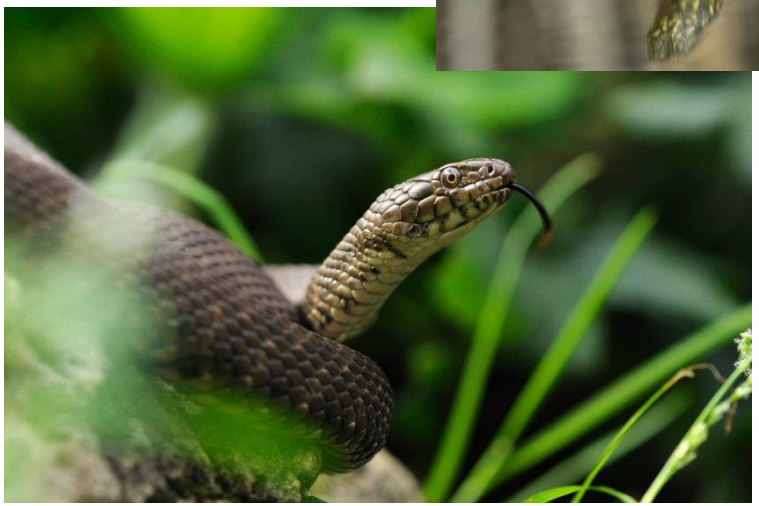
Important areas and habitats (according to EU directives).

High richness and biogeographic value for aquatic invertebrates and fish.





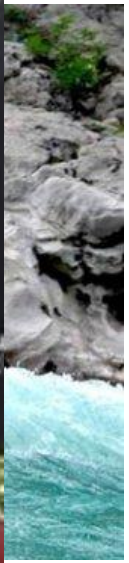
Rich terrestrial and wetland fauna



High potential for sustainable development

Organic agriculture, farming, wind energy, tourism, sports, research and educational activities …

High potential for sustainable development



Increased international interest on Vjosa research and conservation

Main international expeditions during 2016 – 2019:

October 2016
April 2017
May 2017
September 2017

March 2018
April 2018
October 2018.

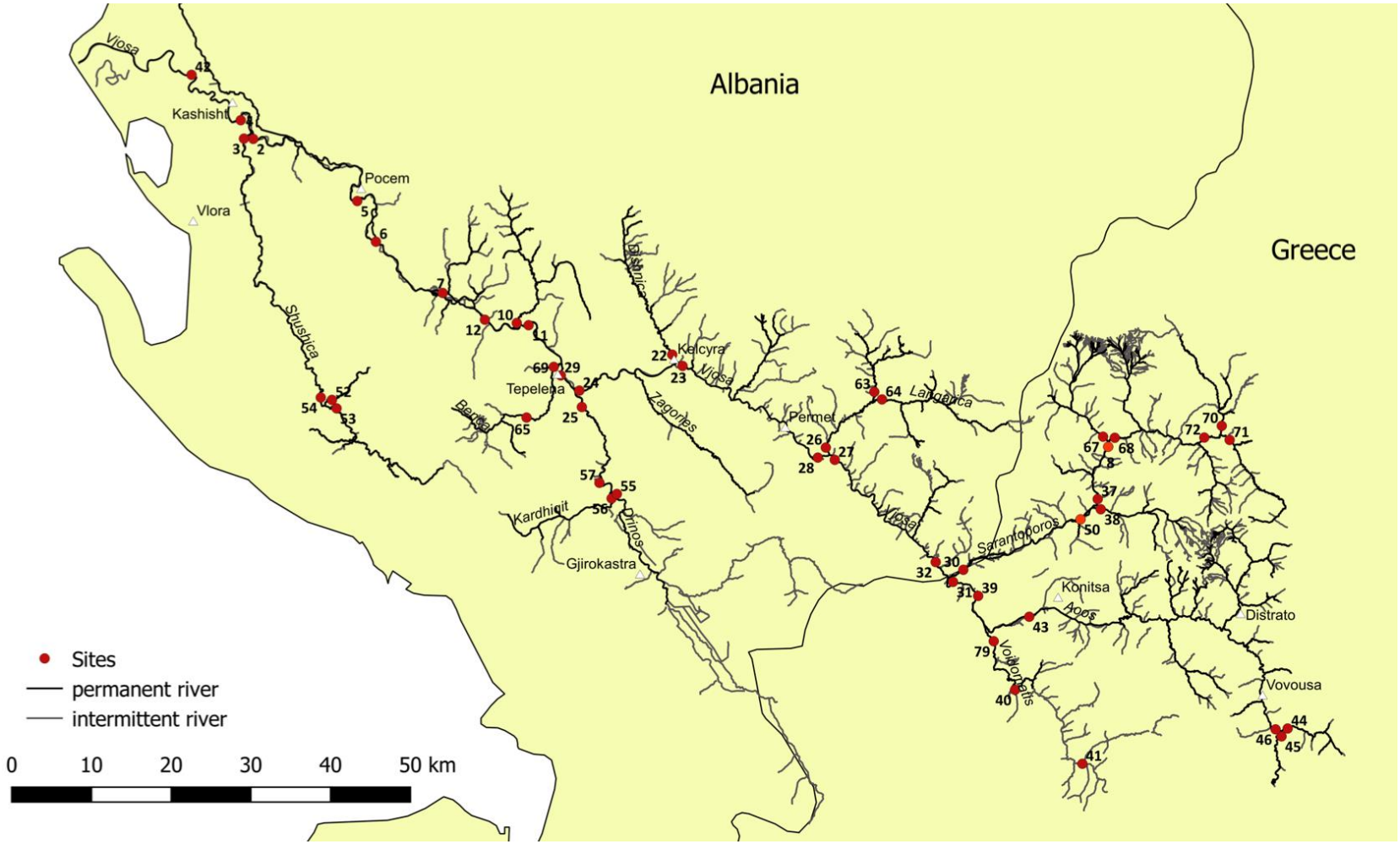
May 2019
June 2019
July 2019
October 2019

Main groups investigated:

- terrestrial vegetation,
- aquatic vegetation,
- periphyton,
- aquatic invertebrates (zoobenthos),
- fish,
- terrestrial invertebrates (insects & arachnids),
- terrestrial vertebrates (amphibians, reptiles, birds, mammals).

Univ. Tirana, IGB Berlin & BOKU Vienna expeditions 2018 – 2019 in Albania (Vjosa) and Greece (Aoös)

- benthic invertebrates (zoobenthos),
- biofilm on substrata,
- primary production,
- water chemistry,
- river metabolism
- sediment properties.



~ 50 sampled sites in Greece and Albania:

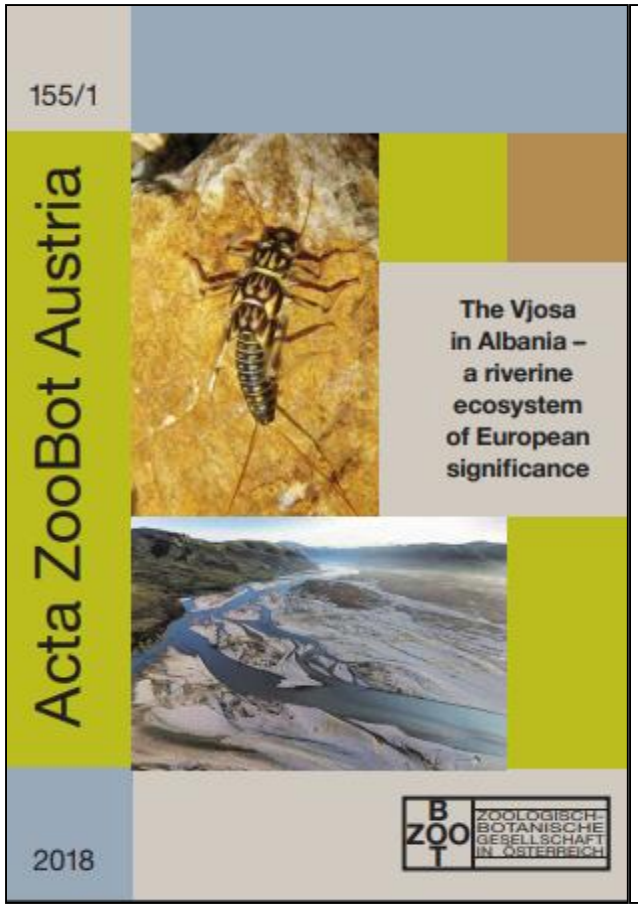
April – May 2018; October 2018;

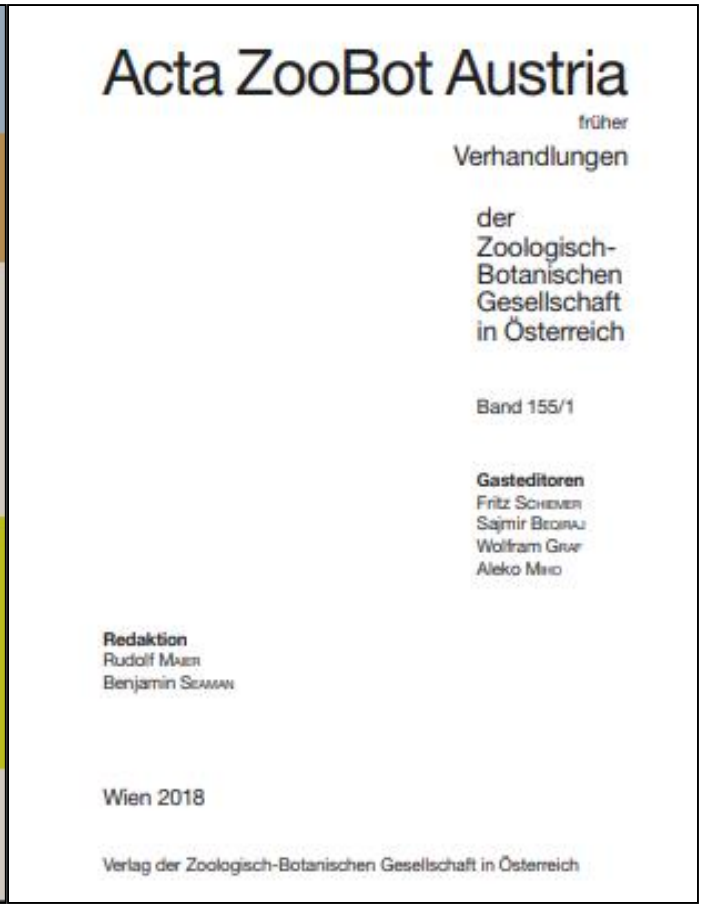
May 2019; July 2019;

September - October 2019

Involvement of young researchers and students, as a priority.
Student's thesis (master and PhD).
Mobilities between Austria, Germany and Albania.

A special publication on Vjosa, with the findings from 2016 & 2017 expeditions and existing data from previous investigations





25 papers in total, with the contribution of:

F. Schiemer, A. Miho, S. Beqiraj, W. Graf, S. Shumka, A. Drescher, U. Eichelmann, F. Bego, L. Kashta, L. Shuka, O. Nika, M. Grabowski, M. Hess, U. Heckes, W. Rabitsch, S. Vitecek, E. Bauernfeind, R. Šanda, P. Meulenbroek, T. Frank, M. Duda, E. Haring, H. Sattmann, M. Komnenov, T. Blick, C. Komposch, E. Shkëmbi, B. Gerken, B. Pepa, H. Kiçaj, K. Misja, A. Paparisto, D. Rabl, G. Kunz, W. Paill, J. Gunczy, S. Hristovski, H. Wagner, G. Degasperi, B. Seifert, R. Borovsky, J. Marka, F. Miri, E. Saçdanaku, M. Meço, K. Ngjela, B. Hoxha, I. Sejdo, E. Hysaj.

Riparian vegetation with *Platanus, Populus* and *Salix*

Riparian habitat with *Imperata cylindrica*

Sand dunes with *Amophila arenaria*

Important habitats and vegetation

The floodplains of the Vjosa River count as one of the most magnificent riparian ecosystems of the Balkan Peninsula, standing out due to their natural hydromorphodynamic fluvial processes.

More than **15 priority habitat types of European interest** have been identified (Habitat Directive 92/42/EEC – NATURA 2000, EUNIS, IPA).

NATURA 2000 habitat types of community interest

Annex I: Natural habitat types of community interest whose conservation requires the designation of special areas of conservation.

3130 Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or *Isoëto nanojuncetea*

3140 Hard oligo-mesotrophic waters with benthic vegetation of *Chara spp*.

3170 Mediterranean temporary ponds

3240 Alpine rivers and their ligneous vegetation with *Salix elaeagnos*

6420 Mediterranean tall humid herb grasslands of the *Molinio-Holoschoenion*

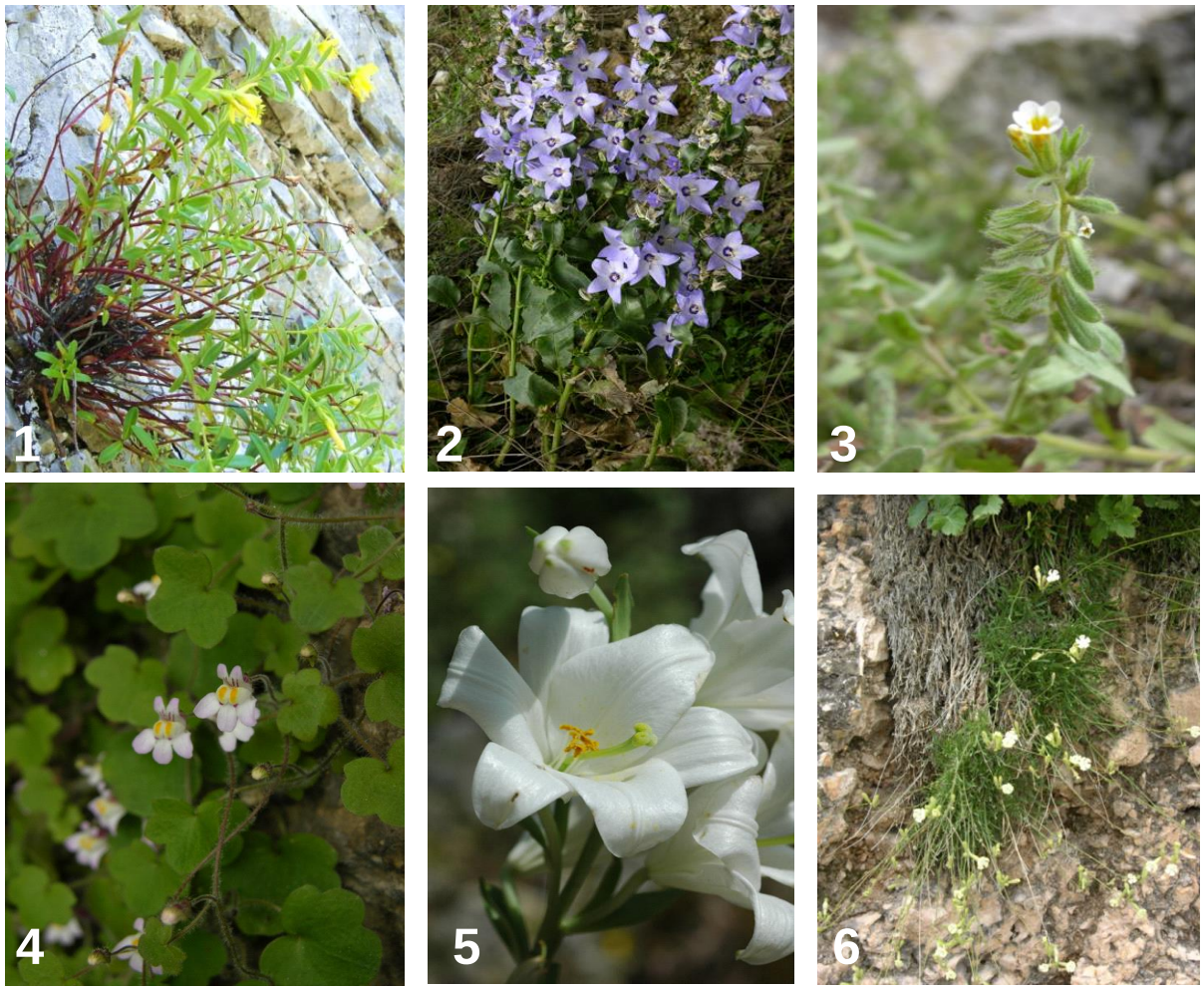
72A0 Reed beds

92A0 *Salix alba* and *Populus alba* galleries

92C0 Oriental plane woods

92D0 Southern riparian galleries and thickets (*Nerio-Tamaricetea* and *Securinegion tinctoriae*)

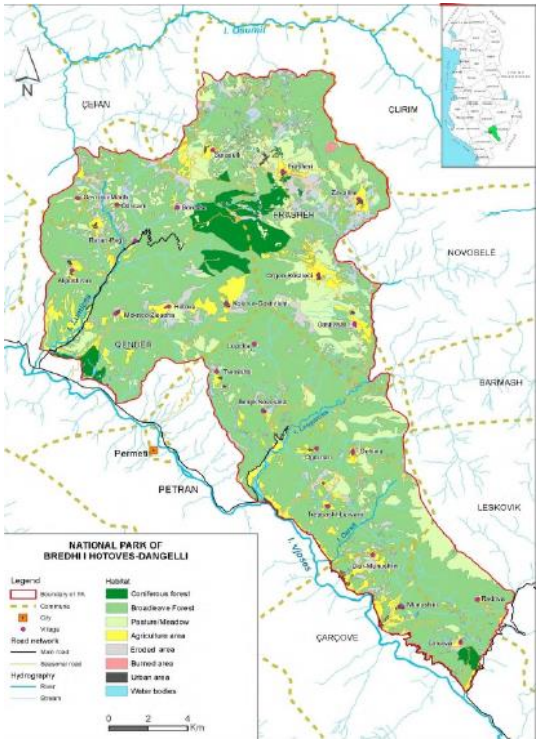
Calcareous rocky slopes with chsamophytic vegetation



1. *Hypericum haplophylloides*; 2. *Campanula versicolor*; 3. *Alkanna corcyrensis*; 4. *Cymbalaria microcalyx;* 5. *Lilium candidum*; 6. *Silene cephallenia*.

Protected Areas in the Vjosa catchment and its adjacent areas

- Strict Nature Reserve of Kardhiq (1,800 ha: IUCN Cat. I);
- National Park Hotovë-Dangëlli (34,361 ha; IUCN Cat. II);
- Gërmenj-Shelegur (430 ha; IUCN Cat. IV);
- Pishë Poro (1,500 ha; IUCN Cat. IV);
- Natural monuments: 110 total (IUCN Cat. III) (i.e. Zhei, Viroi, Sotira…)
- Coastal area between deltas of Seman and Vjosë (Pishë Poro) – CORINE Biotop, and proposed as a PA, IUCN Cat. IV.
- Vjosa Delta – Narta Lagoon (19,738 ha; IUCN Cat. IV) and IBA (Important Bird Area);
- Karaburun – Sazan Marine National Park (12,700 ha; IUCN II).



National Park Hotovë-Dangëlli

Records of new species

New species to science:
Isoperla vjosae (Graf, 2018)
(Plecoptera: Perlodidae)

New species to science:
Liocranoeca vjosensis n. sp.
(after Kamnenov, 2018)

New record to the Balkans:
Janetschekia monodon

~ 90 new species to Albania:

Ephemeroptera	**23**
Plecoptera	**2**
Heteroptera	**5**
Orthoptera	**1**
Coleoptera	**31**
Hymenoptera	**9**
Arachnida	**18**

Ephemeroptera species with dubious identification and / or very limited distribution range:

Baetis sp. nov. (near *Baetis nexus* Navás, 1918)
(probably new species to science, after Bauernfeind 2018)

Baetis (Baetis) beskidensis Sowa, 1972
Baetis (Baetis) ? lutheri Müller-Liebenau, 1967
Procloeon (Pseudocentroptilum) ? romanicum (Bog., 1951)
Ecdyonurus (Ecdyonurus) puma Jacob & Braasch, 1986
Rhithrogena neretvana Tanasijević, 1985
Rhithrogena bulgarica Braasch, Soldán & Sowa, 1985
Rhithrogena zernyi Bauernfeind, 1991
Brachycercus (?) harrisellus Curtis, 1834

252 taxa of diatoms, of which 110 in the Vjosa main stem.
Based on diatom indices, the ecological quality of waters in the Vjosa catchment appears to be of good quality.

133 taxa of aquatic Molluscsa, Ephemeroptera, Trichoptera, Plecoptera, Diptera, Megaloptera, Heteroptera, Coleoptera and Crustacea.

The fauna of the 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 of the natural hydromorphology.

Rare, critically endangered (CR) and highly sensitive taxa at European level

Prosopistoma pennigerum
(Ephemeroptera: Prosopistomatidae)

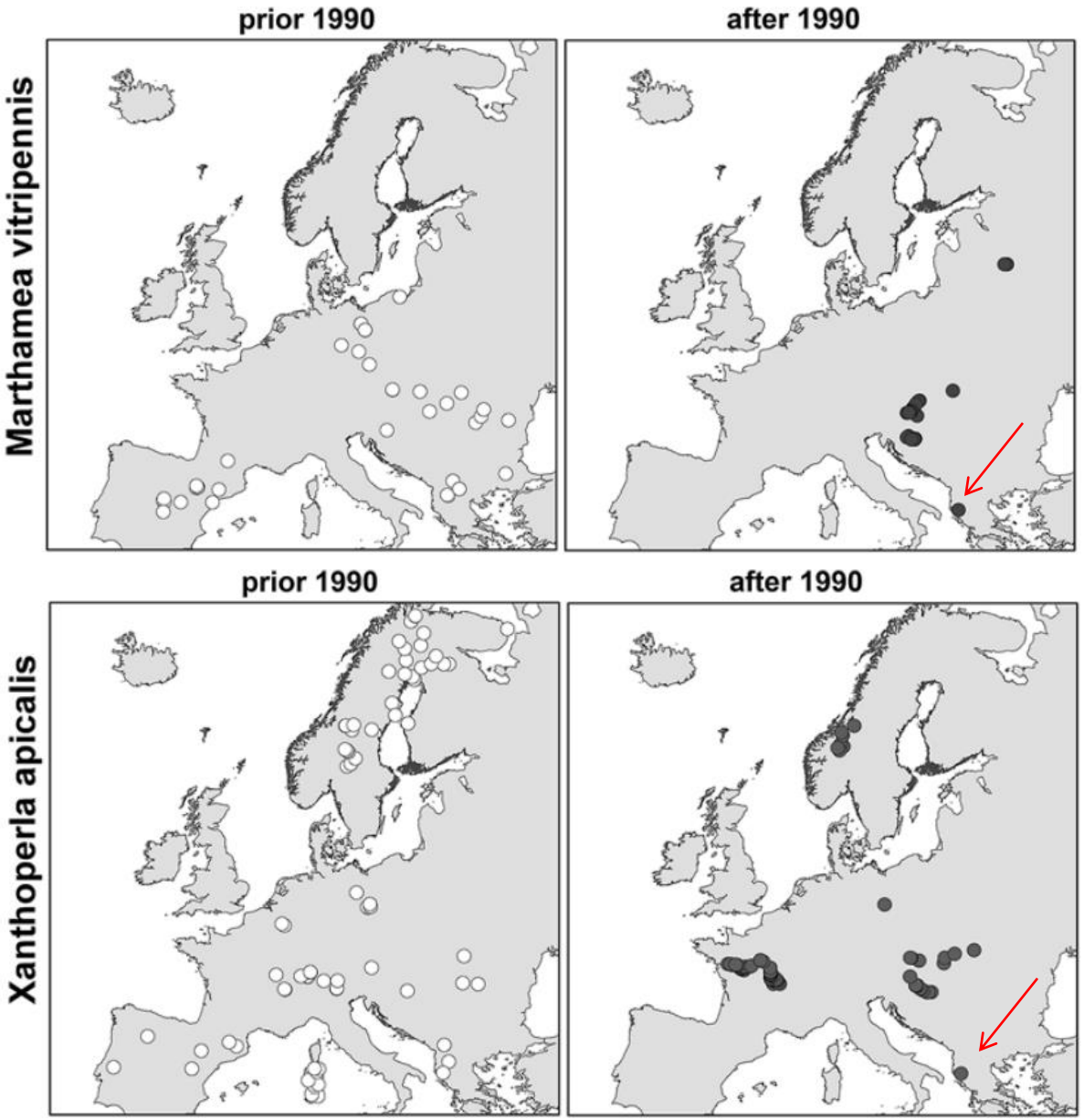
Potamophilus acuminatus
(Coleoptera: Elmidae)

Coenagrion ornatum
(Odonata: Coenagrionidae)

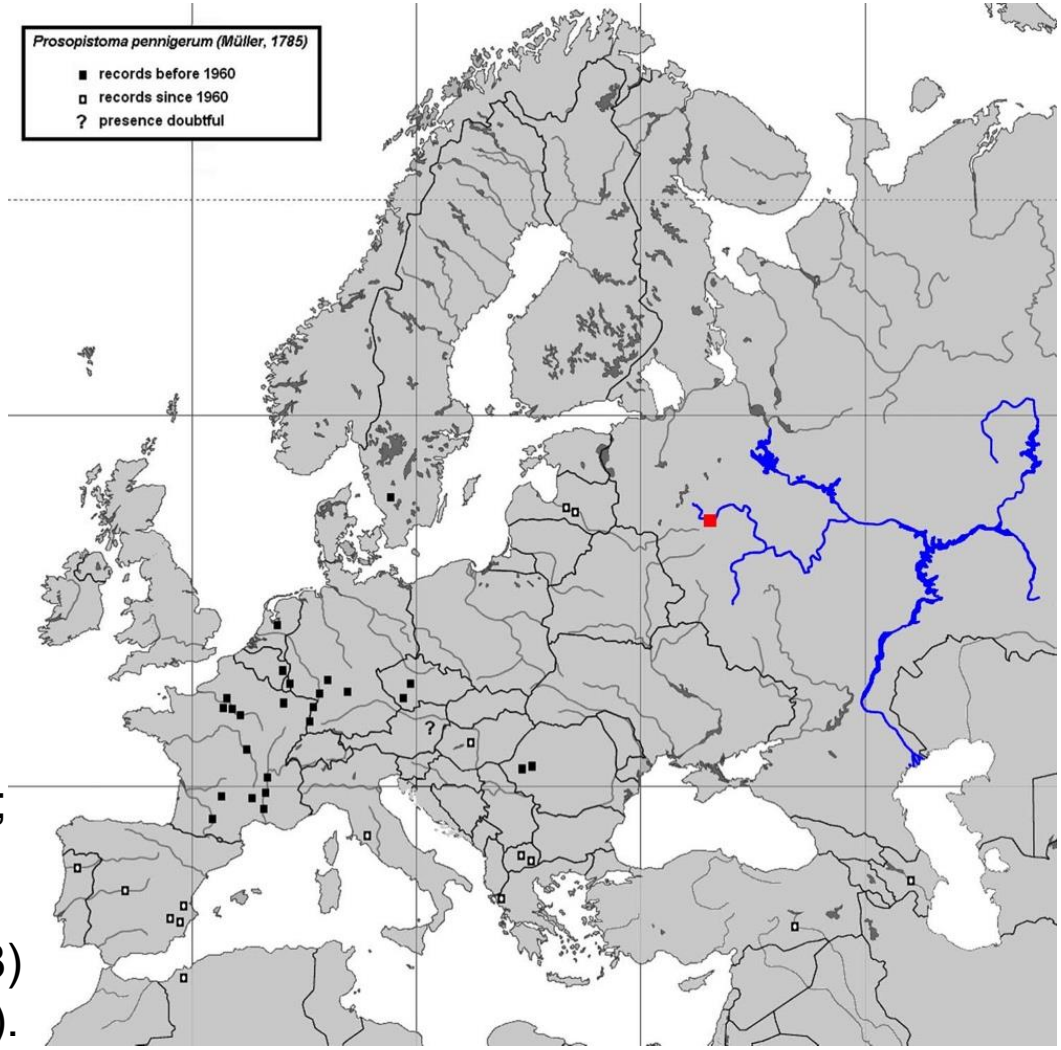
Species with very limited distribution in Europe (after 1990) that are present in Vjosa

Marthamea vitripennis
(Plecoptera: Perlidae)

Xanthoperla apicalis
(Plecoptera: Chloroperlidae)

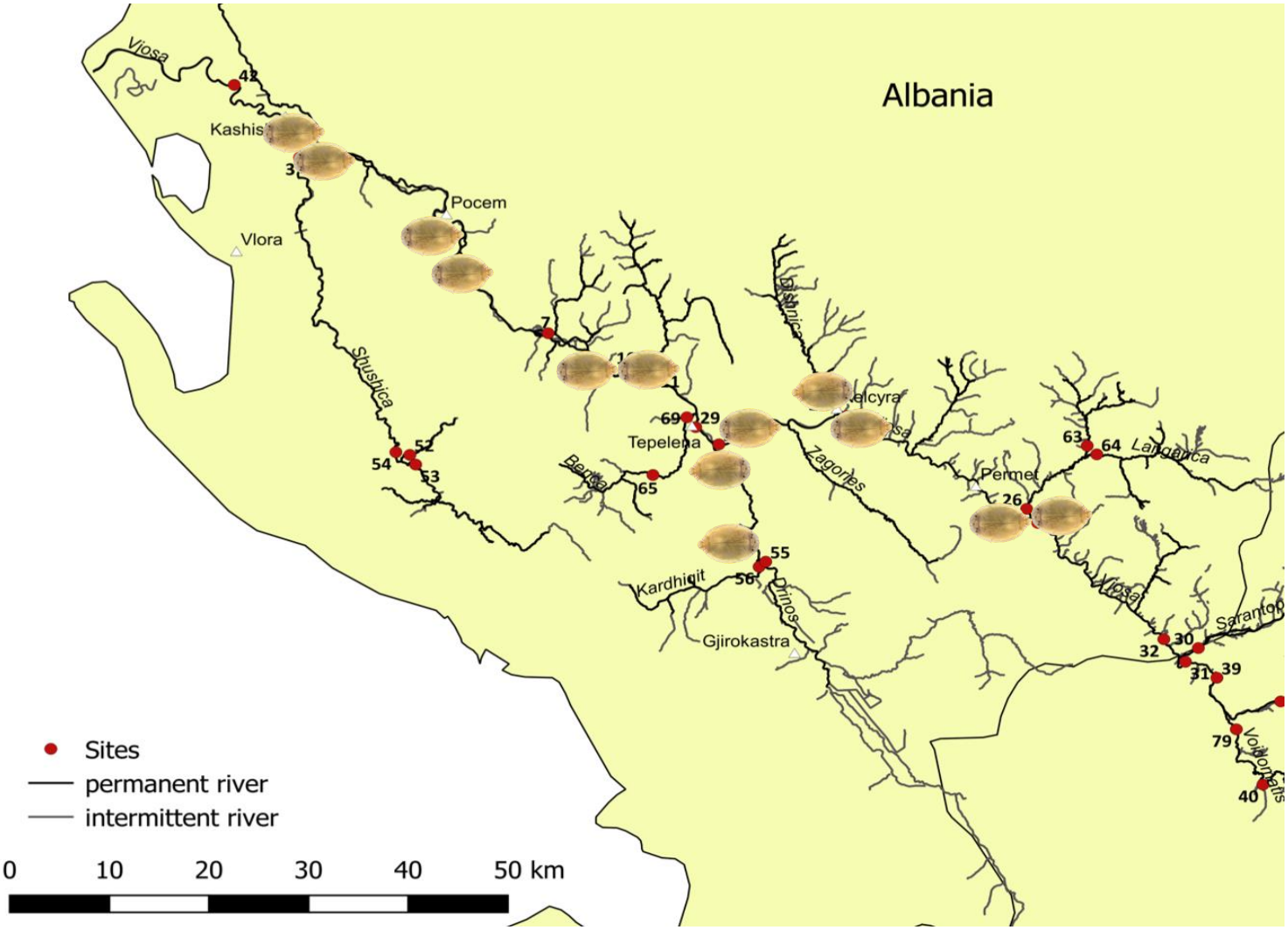


Prosopistoma pennigerum in Vjosa
(after Martini et al., 2019)



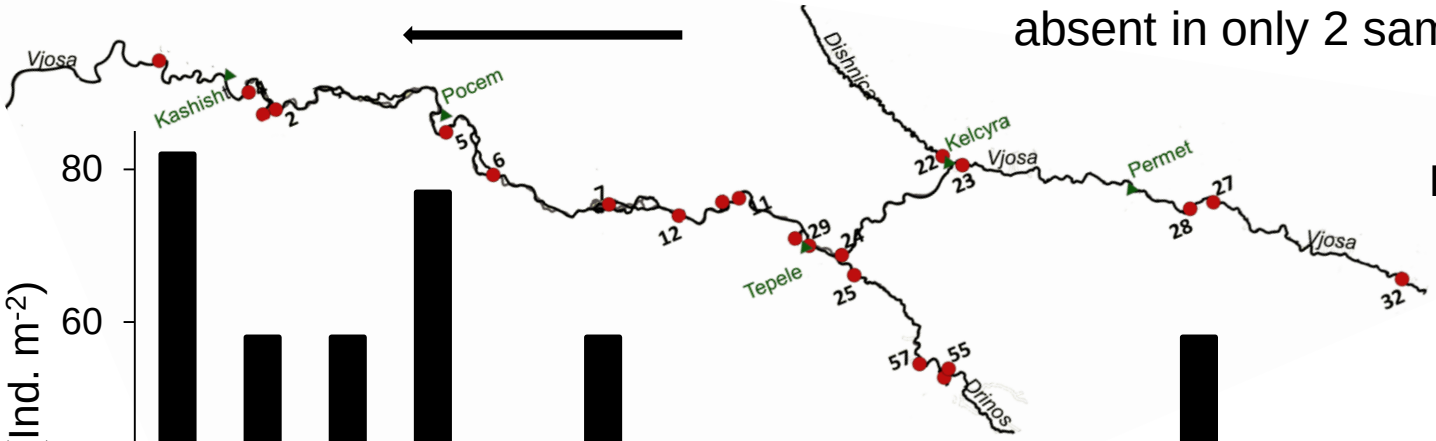
- A highly sensitive species;
- Considered extinct in most of Europe;
- Maximum abundances:
  11 larvae / m^2 (in Volga, Russia);
- **Rediscovered in Vjosa:**
  2006 – 2007 (Beqiraj et al., 2008)
  2014 - 2018 (Martini et al., 2019).

Occurrences of *P. pennigerum* in October 2018

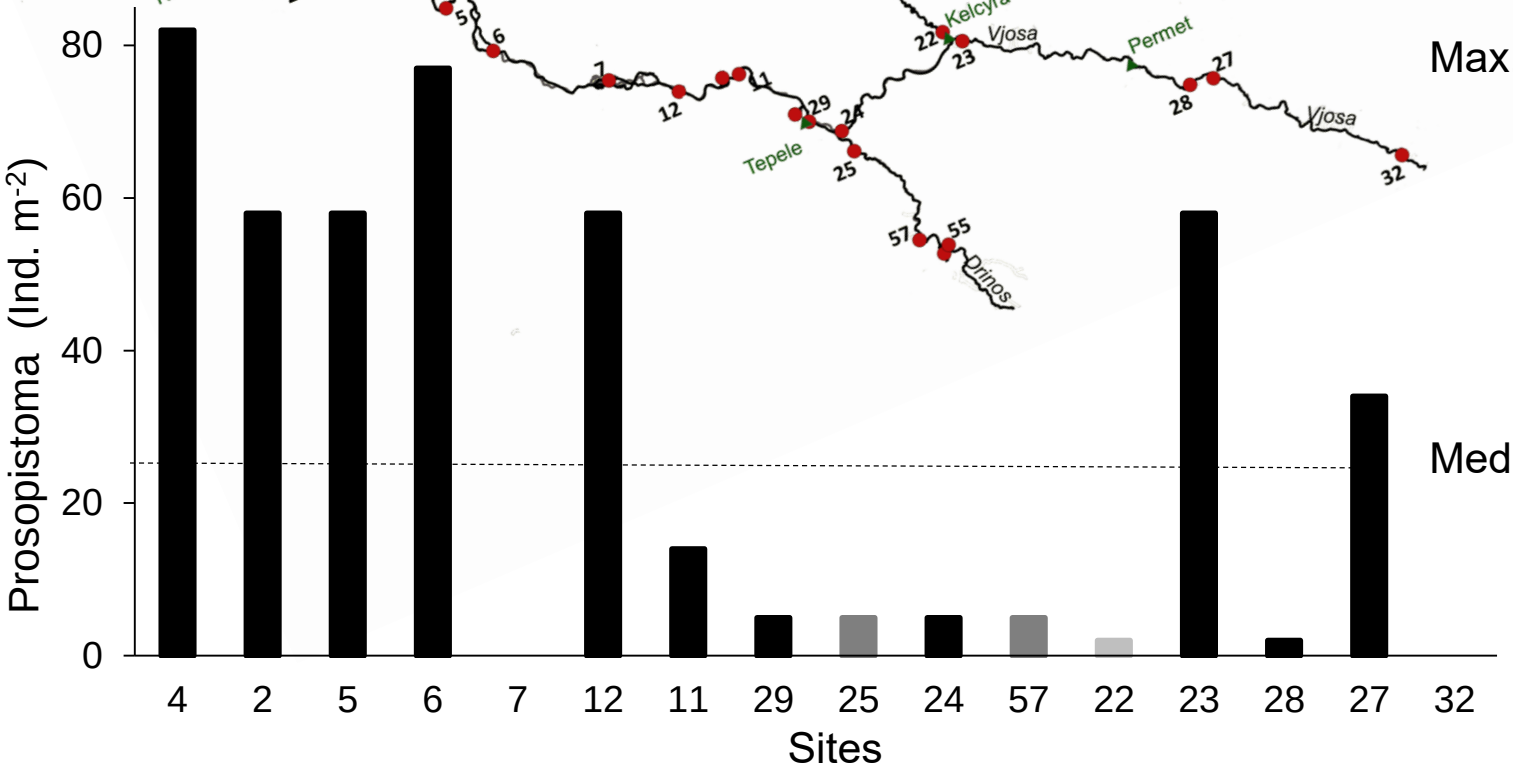


- Surprising abundances in 13 sites.

Surprising abundace of *P. pennigerum* in October 2018



absent in only 2 sampling sites!



Max. 82 (Ind m^{-2})

Median 24 (Ind m^{-2})

Carabid (Coleoptera) species from Vjosa that are very rare in European riverine habitats

1. Cicindela monticola albanica *2. Bembidion quadricolle*
3. Bembidion striatum *4. Stenolophus discophorus*
5. Poecilus striatopunctatus

***The species richness of ground beetles in the Vjosa valley is enormous, due to high flow rates and floods, which leads to a rich structural diversity of microhabitats.**

***Vjosa might prospectively act as a very important genetic pool in terms of maintaining source populations of international significance.**

Xya variegata (Orthoptera), an indicator species of highly dynamic river systems.

Stenus longipes (Staphylinidae), a characteristic species of natural gravel banks

61 terrestrial true bug (Heteroptera) species recorded in Vjosa. ***5 species are new to Albania****.*

22 taxa of Orthoptera; ***1 new to Albania****.* ***All included in the European Red List*** *with the LC status.*
The list contains ***indicator species of natural dynamic riverine systems****. The Vjosa floodplain and its vicinity offers a broad range of different habitats suitable for Orthoptera species and might be* ***a potential hot spot of Orthoptera diversity.***

74 staphylinid species; ***28 new to Albania****. Many species are sensitive indicators of natural riverbanks.*

112 carabid species; ***3 new to Albania****. 6 species are* ***very rare throughout of Europe.***

Demetrias imperialis (Carabidae), new species to Albania.

55 species of spiders recorded in Vjosa.
A new species to science: Liocranoeca vjosensis n. sp.
2 species are new to the Balkans.
17 species are new to Albania.

An updated spider check-list of Albania with 490 species.

3 Opiliones species from Vjosa; ***1 new species to Albania.***

Odonata from Vjosa: an updated list with 28 species; all of them endangered, including few vulnerable (VU) species at the Mediterranean scale.

19 ant species found in Vjosa; ***9 new to Albania.***

28 species of terrestrial gastropods.
The most preferred habitats for the gastropods were the well-structured calcareous rocks were, rather than the floodplain directly adjacent to the river.

Paranemastoma longipes, species with very limited Bosnia, Herzegovina, Albania

36 fish species, of which 4 are introduced. 11 species are endemic to the Balkans. Presence of 3 critically endangered species (CR).

The river provides potential habitat and spawning sites for migratory anadromous sturgeons Acipenser sturio and Acipenser nacarii that are critically endangered species (CR).

6 amphibians and 8 reptile species; all of them included in the list of Bern Convention.
8 species of herpetofauna are listed in the Appendix IV of the EU Habitats Directive.

The otter (L. lutra) population, one of the most endangered species worldwide, is in good conditions in the Vjosa River.

Vjosa catchment, an important area for birds and mammals

257 birds species, out 323 species recorded in national scale

70 mammal species, out 86 species recorded in national scale

2500+ species (plants and animals) have been recorded in Vjosa area.

150 species are listed in the Appendices of the **Bern Convention**.

Emys orbicularis

Pelophylax spp.

Natrix tessellata

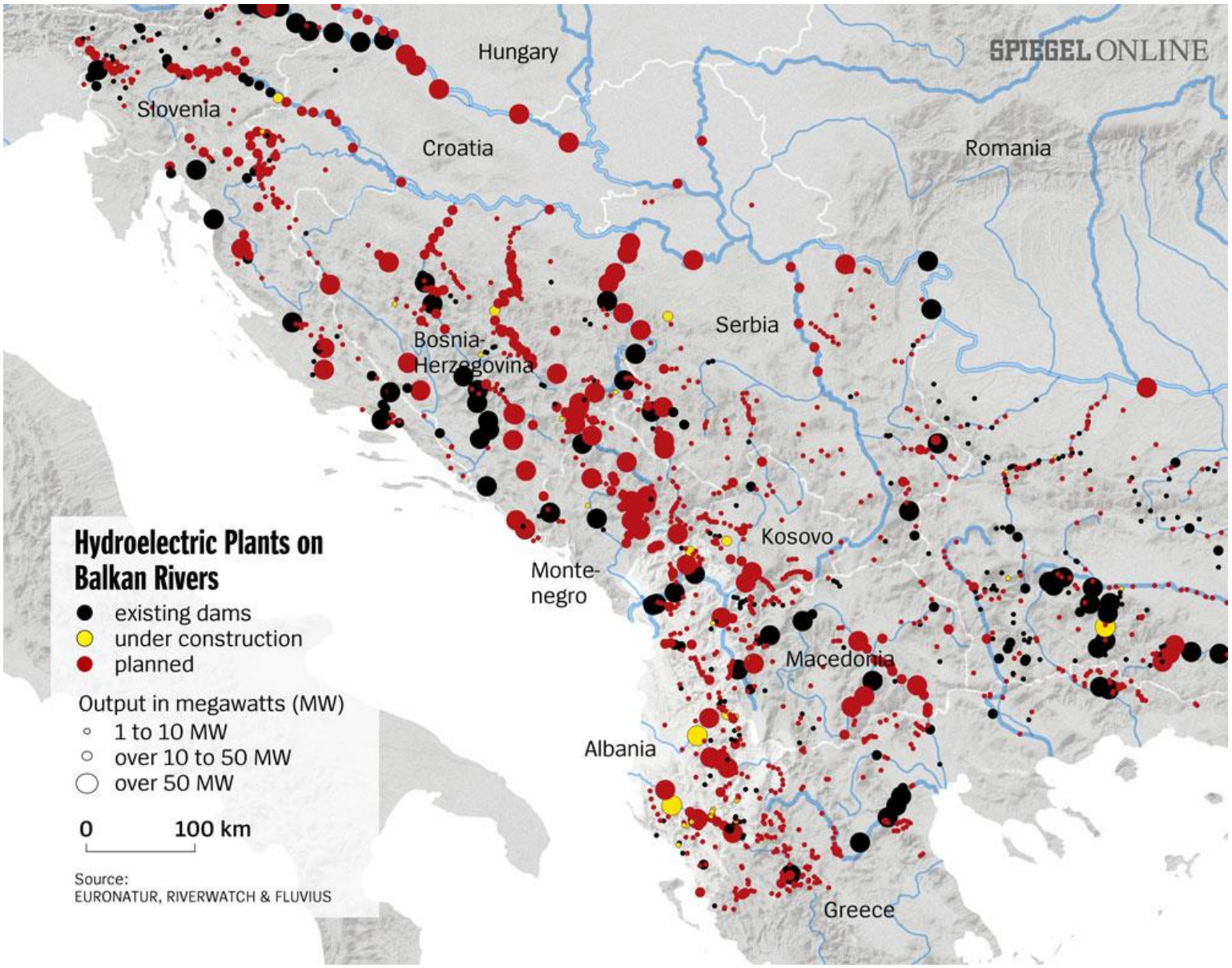
Lutra lutra

Rana graeca

Historical impacts sources to biodiversity in Vjosa

- Agriculture
- Cattle grazing
- Deforestation
- Urban pollution
- Industrial pollution (especially from coal mining in Memaliaj)
- Tourism activities
- Illegal fishing and hunting
- Gravel and sand mining

The main risk to Vjosa currently: planned HPPs and dams



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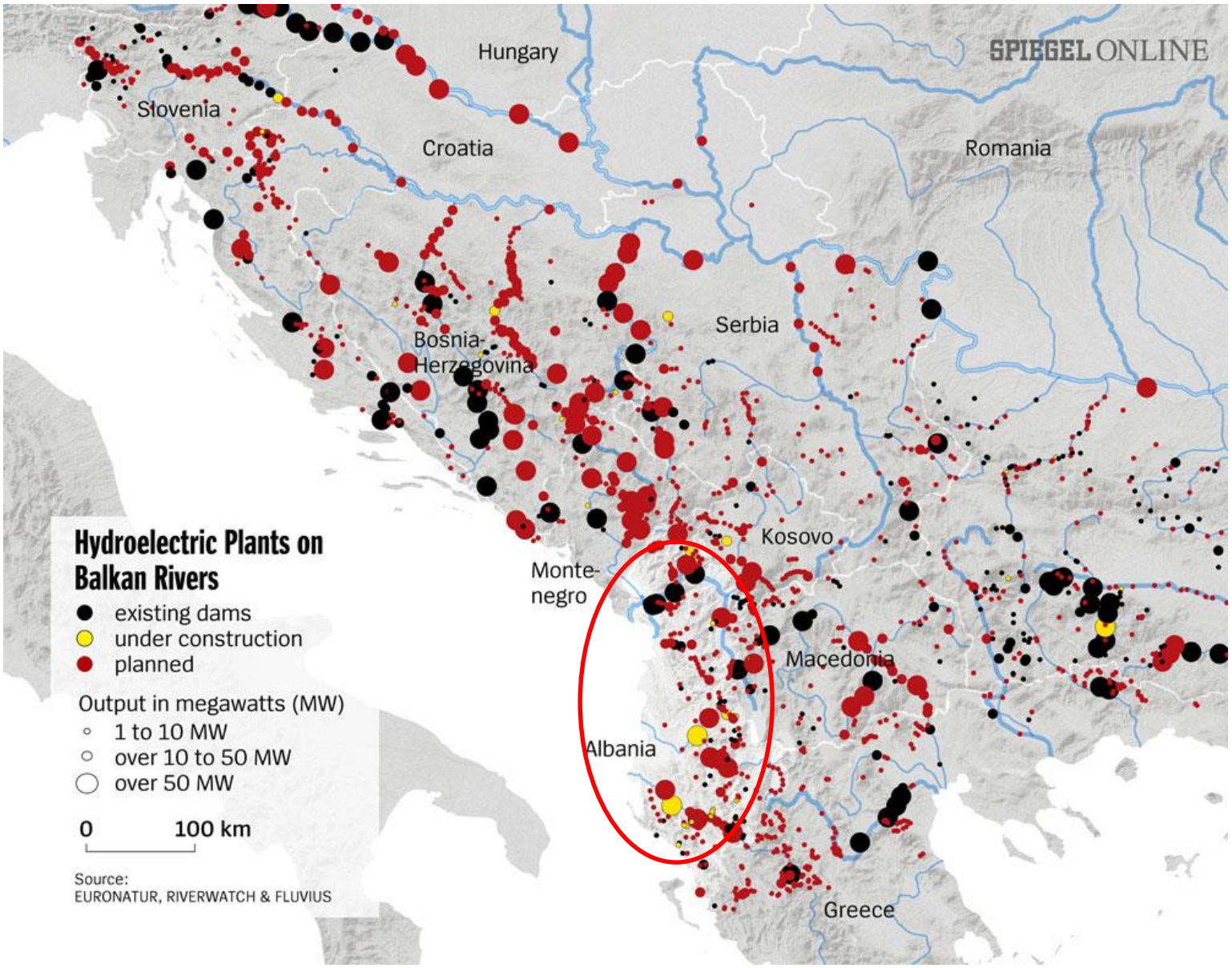
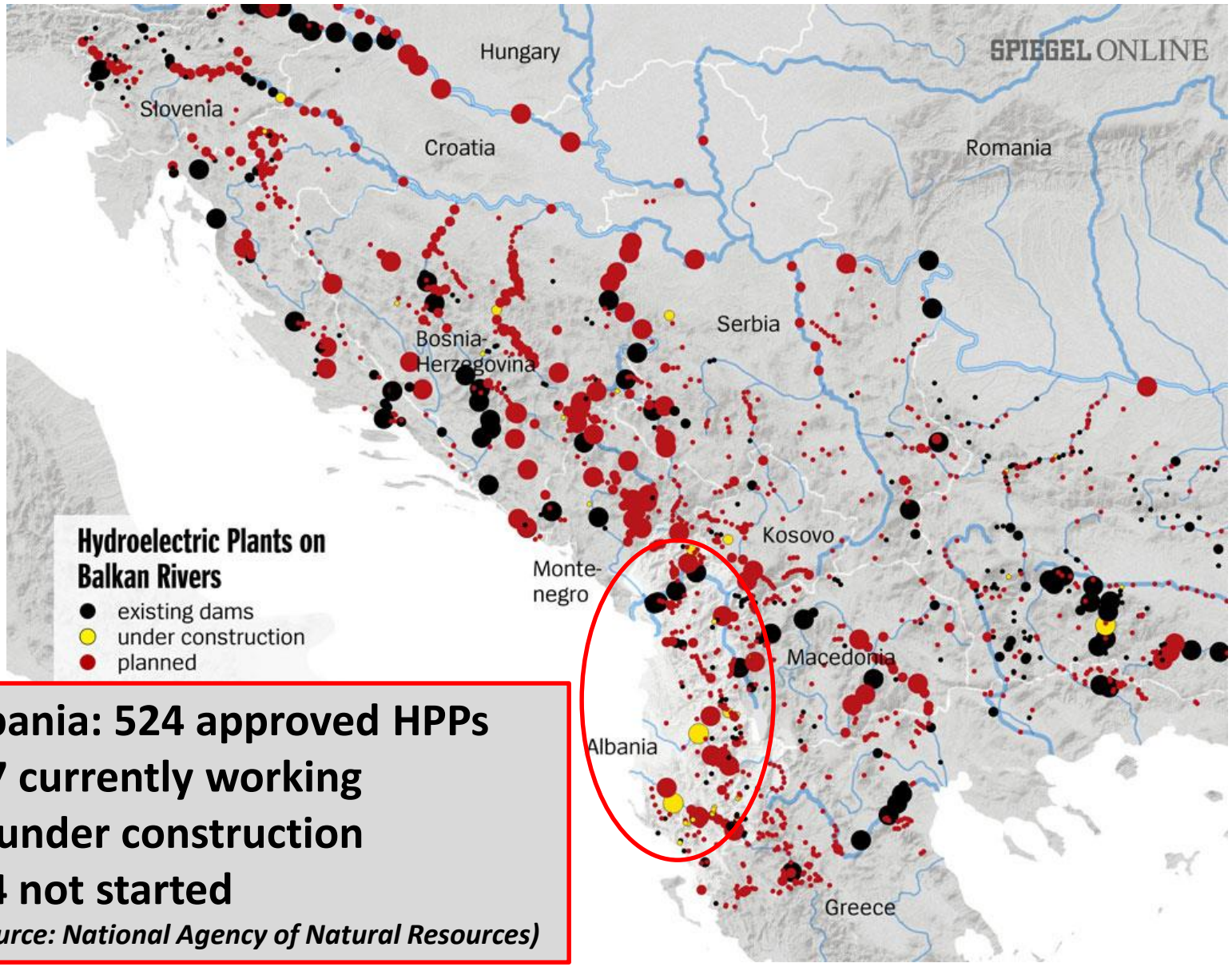


The main risk to Vjosa currently: planned HPPs and dams



In Albania: 524 approved HPPs

- **117 currently working**
- **43 under construction**
- **364 not started**

(data source: National Agency of Natural Resources)

Poçem planned dam

Kalivaç dam under construction

The expected threats in Vjosa:

- Deterioration of groundwater resources;
- Development of toxic algal blooms due to the flooding of fertile agricultural areas;
- Endangering of characteristic habitat types and species listed in the EU Habitats Directive;
- Coastal erosion due to the drastic reduction of sediment transport by the river;
- Loss of livelihood of the residents in the affected area, as their agricultural fields are to be drowned in the projected dam reservoir;
- Considerable reduction of energy production within a period of about 30 years, as the dam reservoir fills up with the high sediment load of the river.

None of these threats have been properly addressed by the Environmental Impact Assessment (EIA) presented in the Poçem project plan!!!


Anguilla


Bence


Prosopistoma


Vjosa at Qesarat

What is all this biodiversity doing in fact?

Anguilla

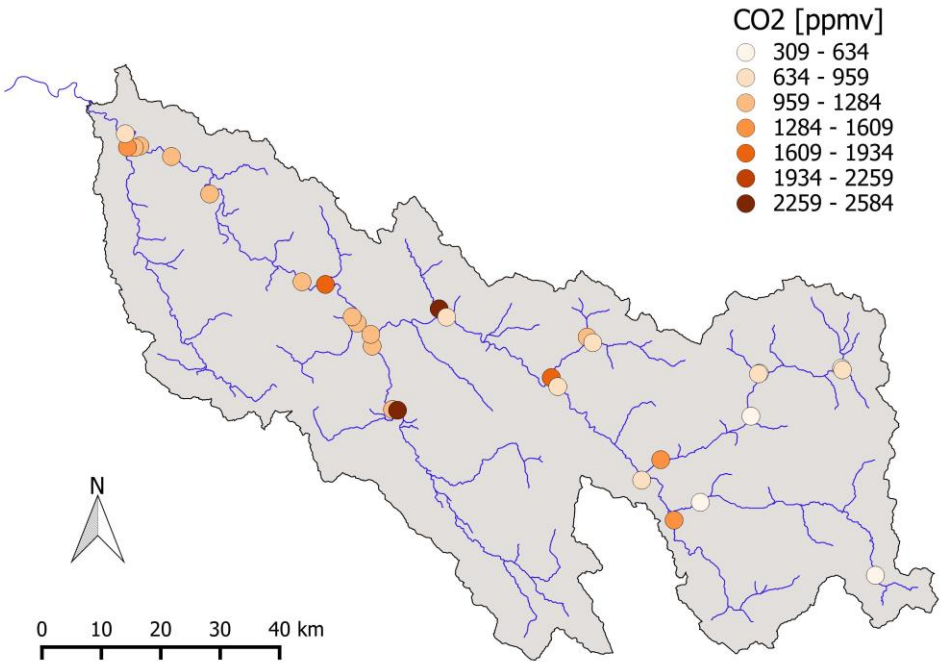
Bence

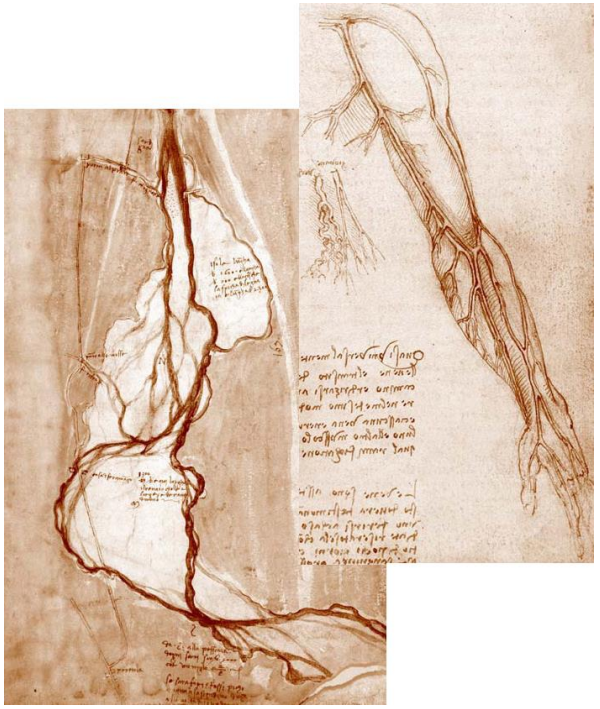
Prosopistoma

Vjosa at Qesarat

The “river network” as a fluvial meta-ecosystem – “fluvial (meta-)ecosystem ecology”
E.g. spatially resolving bulk fluxes at the regional scale

CO_2 concentration in the Vjosa river network in spring 2018

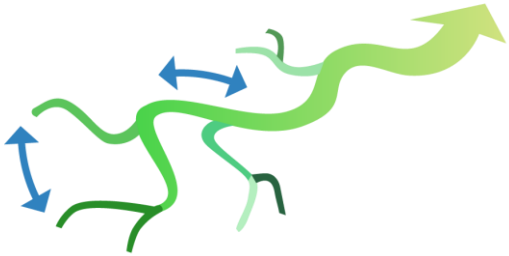


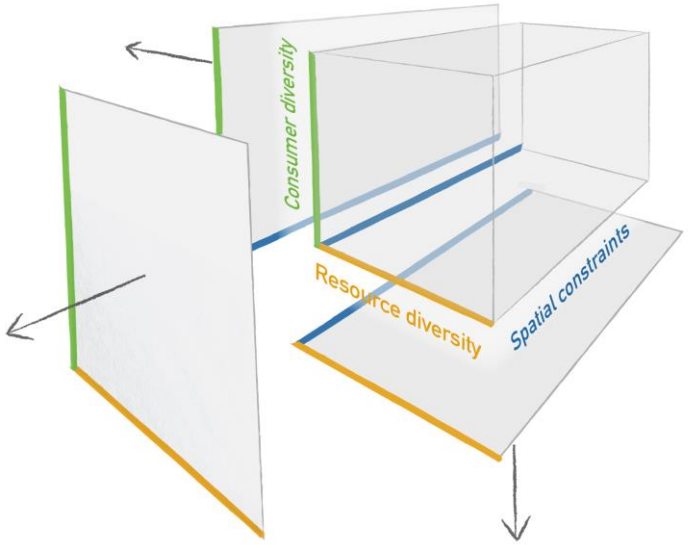


River Arno
(Leonardo da Vinci 1500)

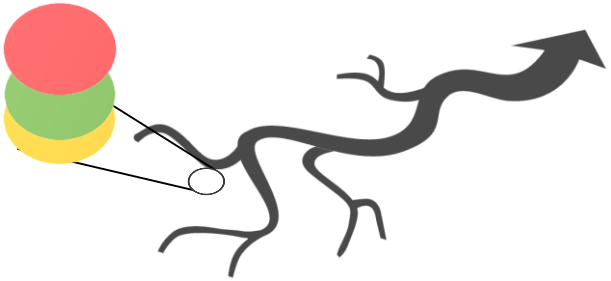
Metaecosystem function =
Resource diversity × Biodiversity × Spatial constraints

1. Metacommunity Ecology:
Environment and dispersal shape regional biodiversity patterns

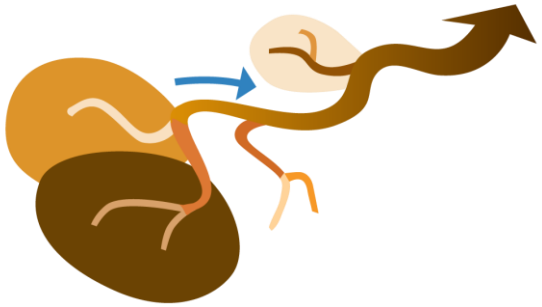




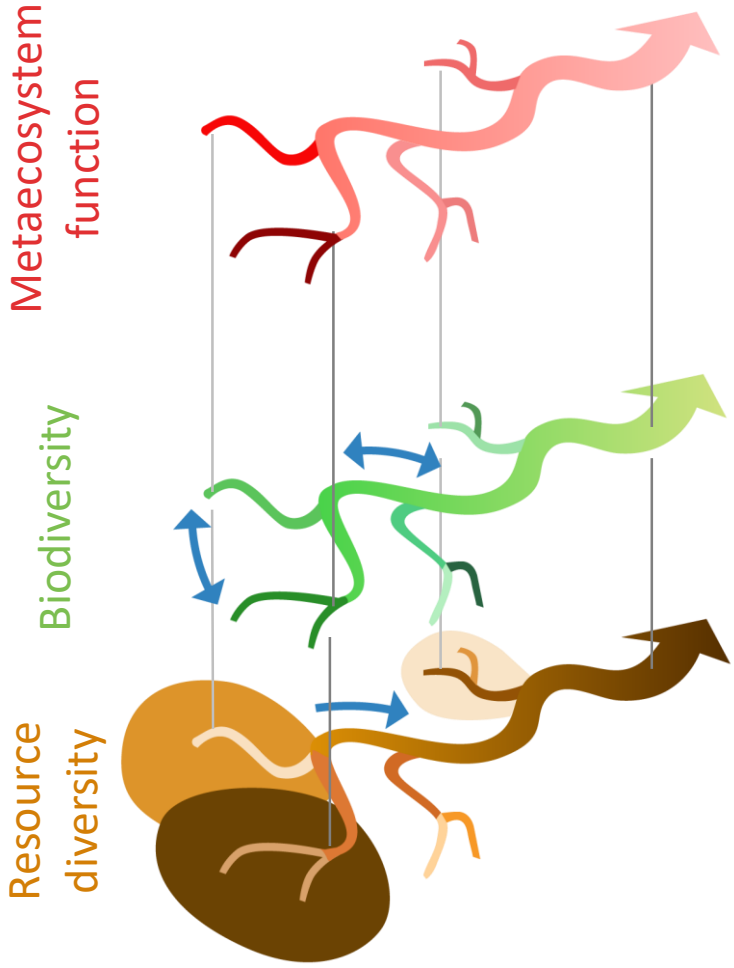
3. Functional Ecology:
Complementarity: Diverse resources need diverse consumers for efficient respiration

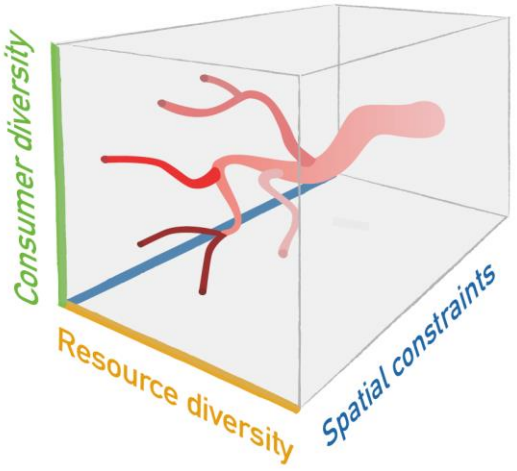


2. Carbon/Nutrient Biogeochemistry:
Spatial controls on organic matter diversity and nutrient stoichiometry: land cover, mixing, downstream transport and transformation



Metaecosystem function =
Resource diversity × Biodiversity × Spatial constraints



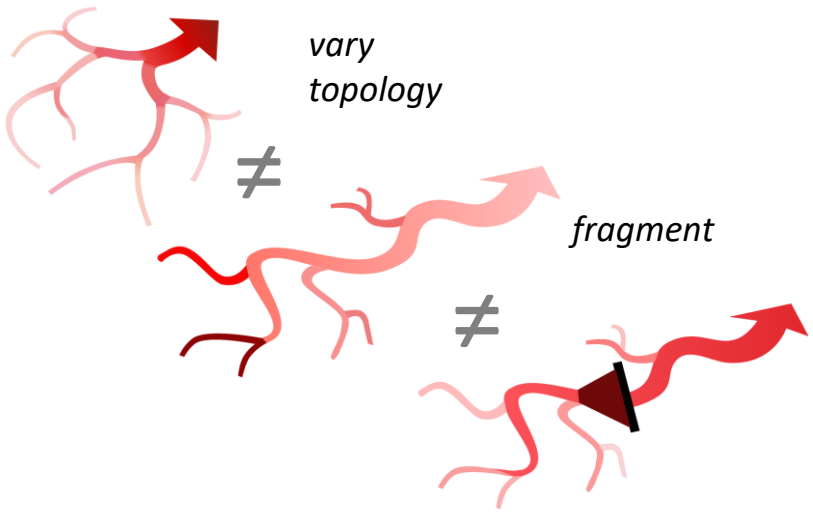


How does a river network unfold in this coordinate system?

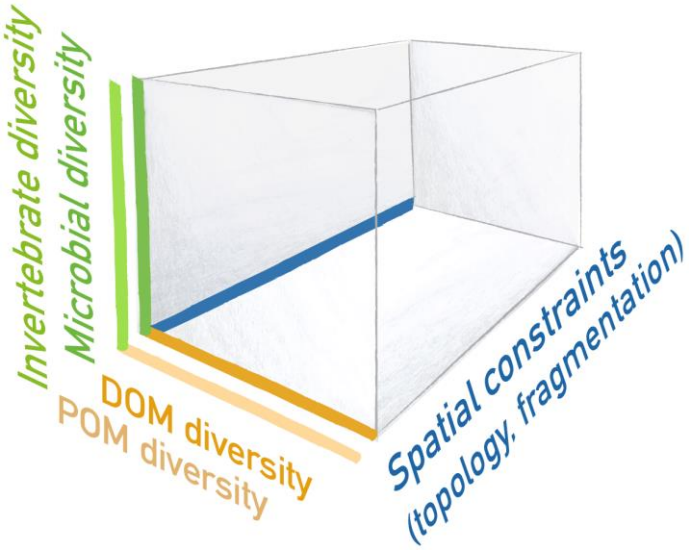
How does this control function?

Metaecosystem function =
Resource diversity × Biodiversity × Spatial constraints

Using a network as one sampling unit



Varying the controls



A wild river is needed!

→ Vjosa/Aoos: A large (the last in Europe?) alpine non-interrupted, hydromorphologically intact river network with a healthy flow and sediment regime, naturally high geological “background” diversity and high (unknown?) biodiversity.

Finding degraded systems with impacted connectivity is not a problem!


Arkoudorema


Shushica


Voidomatis


Vourkopotamos


Sarantaporos


Langarica

Sarantaporos upstream of Tre Urat

Aoos below Konitsa

Vjosa at Kanikol/Dracove

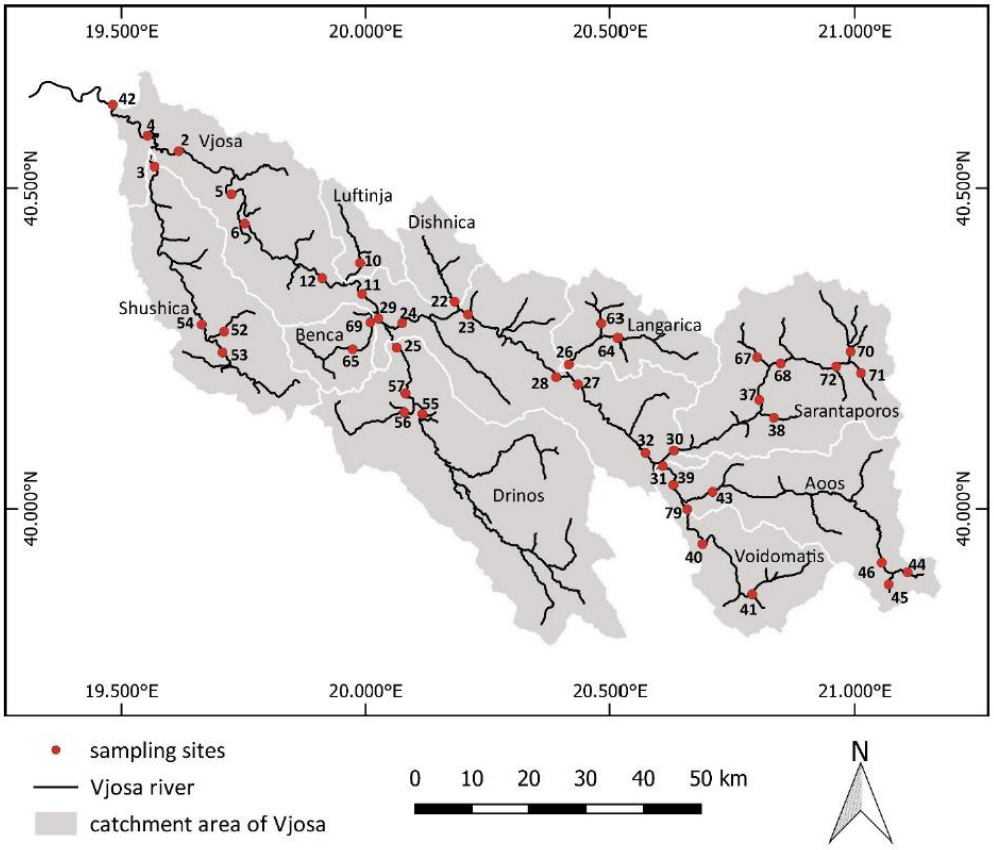
Vjosa upstream of Kalivac

Confluence in upper Shushica

Confluence of Sarantaporos and Aoos

Confluence of Drinos and Vjosa

Aspects of our work in the Vjosa river network in 2018 + 2019



Aspects of our work in the Vjosa river network in 2018 + 2019

Many people: Sajmir Beqiraj, Simon Vitecek, Thomas Fuss, Lukas Thuile Bistarelli, Matt Talluto, Dea Zyruku, Emil Birnstiel, Remo Wüthrich, Olivia Wilfling, Franziska Walther, Sonia Herreror Ortega, Beatriz Noriega Ortega, Jonas Sandrock, Jan Martini, Jess Droujko, Frank Masese, Kliti Lofca, Ledi Hyseni, Stephanie Shousha, many more not in the field (Wolfram Graf, Florian Altermatt, Florian Leese).

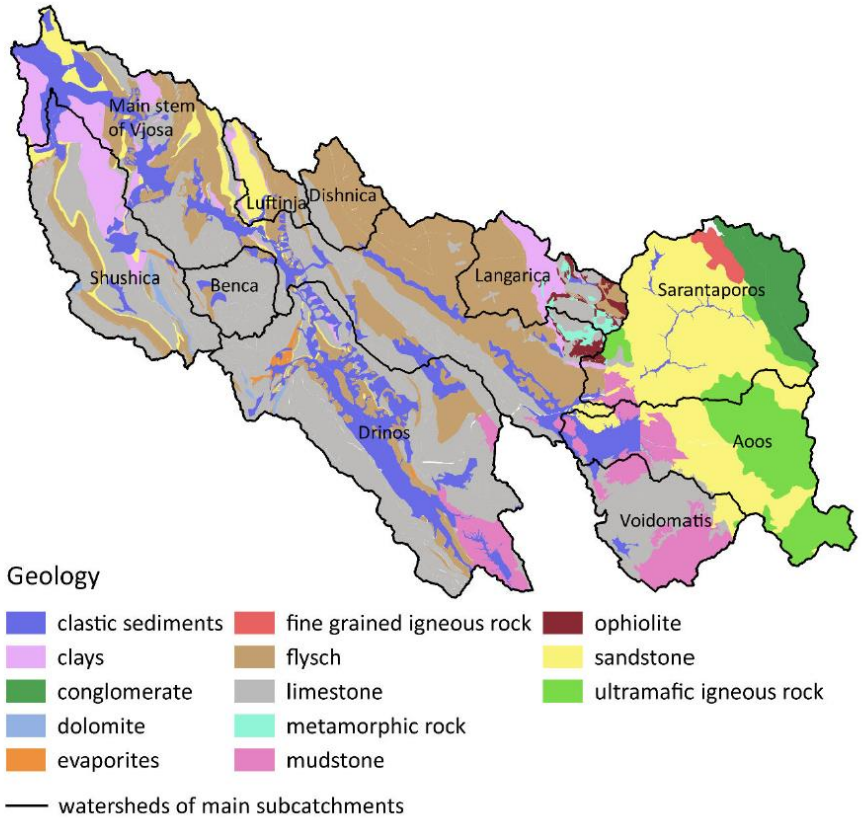
Many topics:

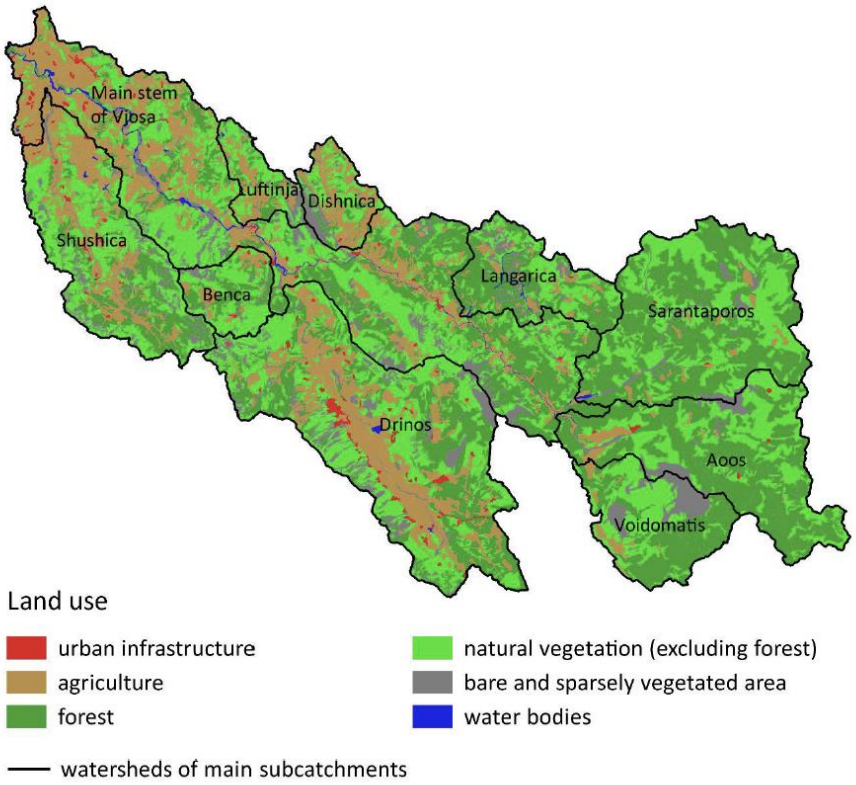
- Invertebrate biodiversity (MHS, eDNA, metabarcoding) and food web structure
- Microbial biodiversity (periphyton algae and bacteria, 16S/18S-rDNA)
- DOM-molecular diversity and nutrient chemistry
- Periphyton physiology (PI-curves)
- Extracellular enzyme activity
- Ecosystem metabolism (oxygen-based)
- Greenhouse gas (CO_2 and CH_4) evasion


hf

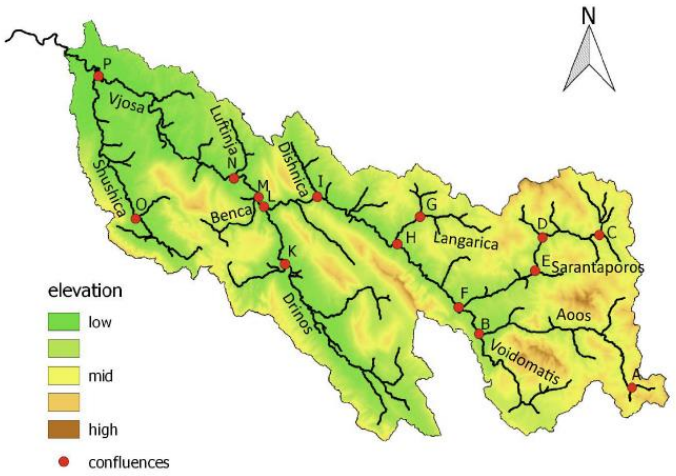

GRABNER

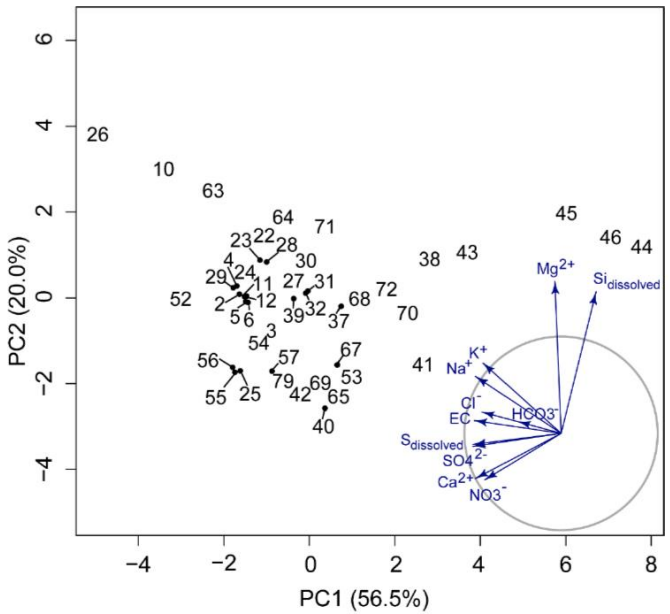
Geology and landuse

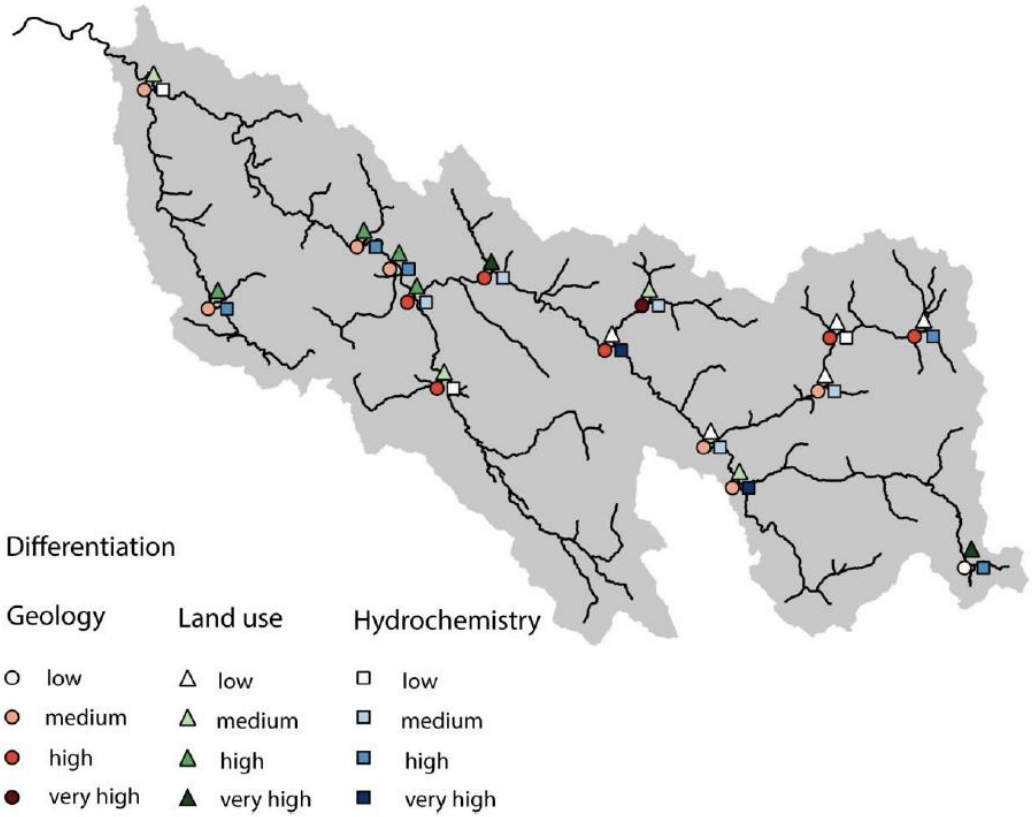




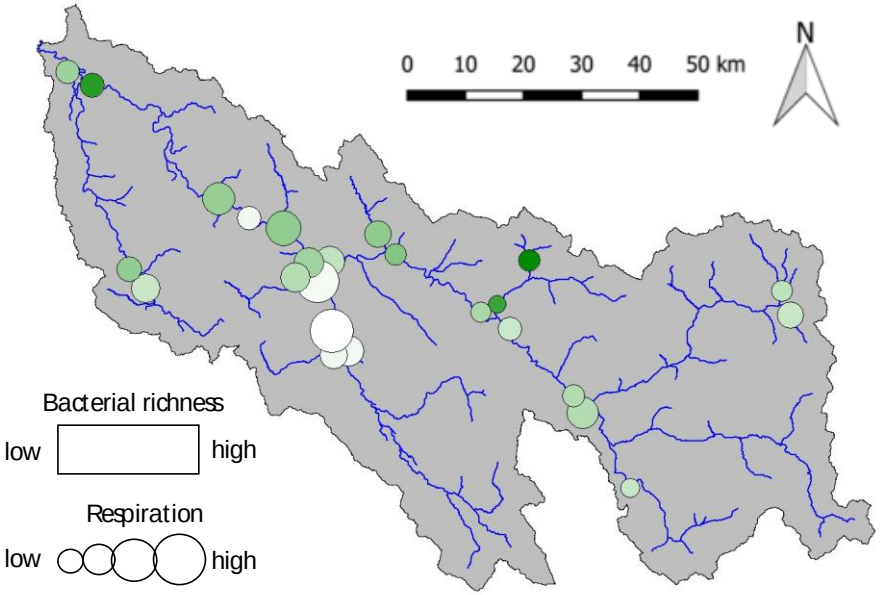
Analyzing differentiation of tributaries at confluences.

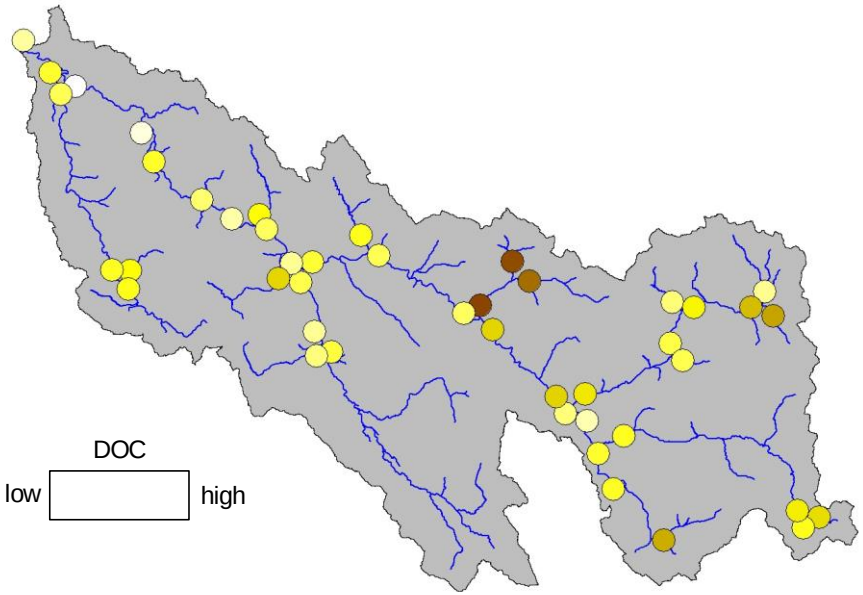






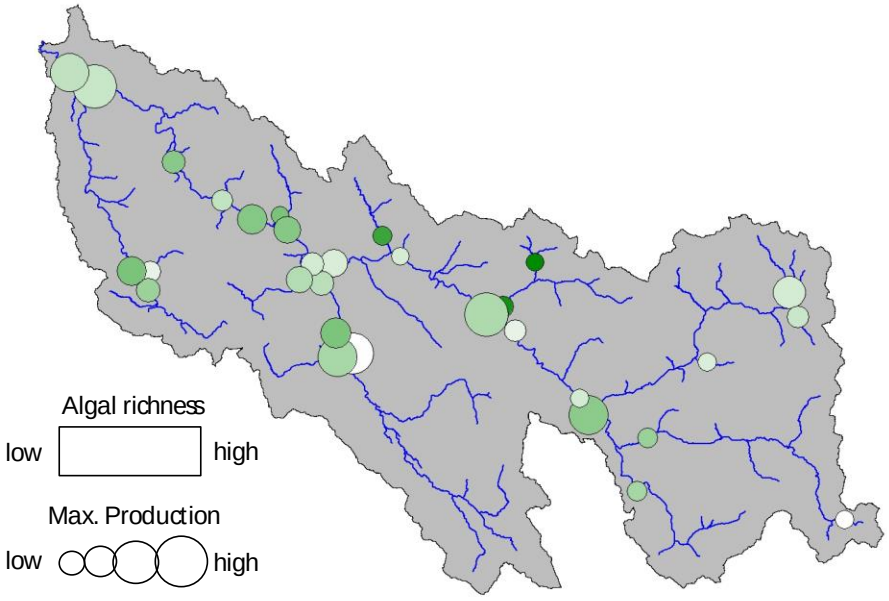
Diversity and function of bacteria.
Network-scale variance in richness, community composition and resources.

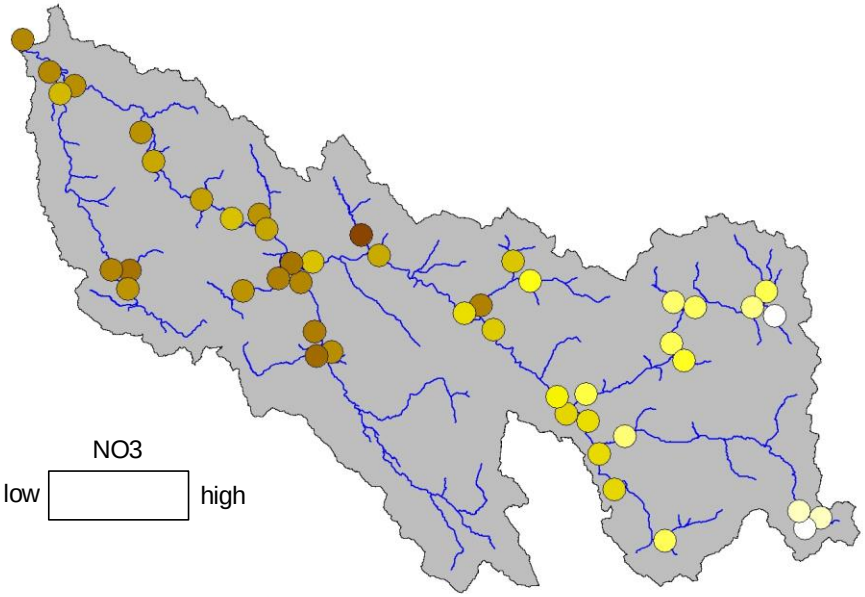


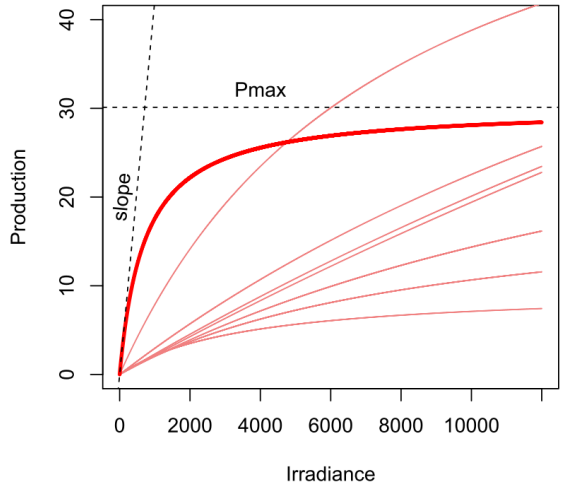


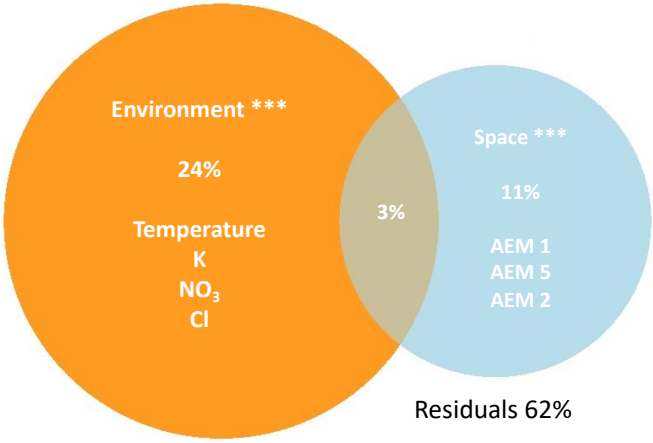
- Pollution influence from Gjirokastr, Tepelena, Permet
- Hydrothermal influence (Langarica)
- Karstic springs

Diversity and function of periphytic algae.
Network-scale variance in richness, community composition, resources and physiology.

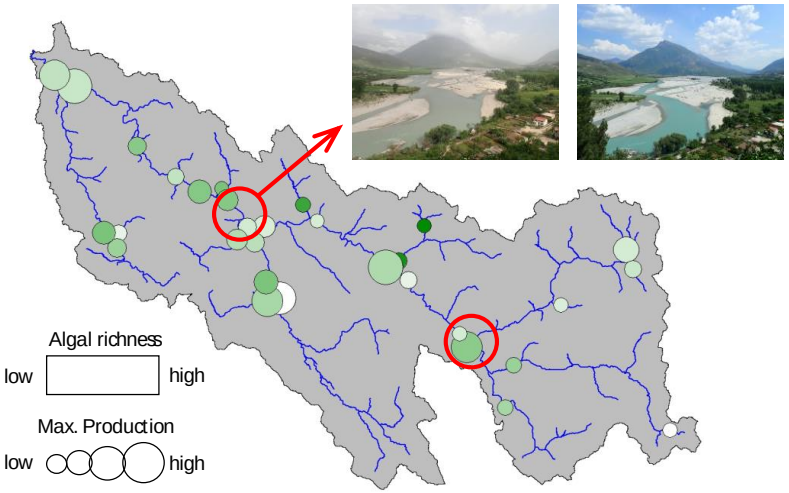








Diversity and function of periphytic algae…. continued in 2019.
MSc thesis of Ledi Hyseni, in the team: Dea Zyruku and Kliti Lofca



A network-wide study of turbidity dynamics by:

1. In-situ loggers
2. Remote sensing data
3. (Citizen science)

… with 4 aims:

- Continuous representation
- TSS loads
- Algal diversity-function
- Citizen awareness