Environmental-territorial diagnosis of polje's watershed systems in Bosnia and Herzegovina (BiH)

Case study of four karst poljes in Canton 10 (Duvanjsko, Glamočko, Kupreško and Livanjsko)

Pauline Bricault, Bertille Daras Siffait de Moncourt, Santiago Debono, Théo Durand, Augustin Fiévet, Lucie Fresel, Adélaïde Naudin, Hermelan Kouaho, Jean Legay, Gaël Montillot, Camille Piechon, Léa Piedigrossi, Guillaume Pouthé, Juliette Pretesacque, and Bernardo Sanchez

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In association with:

Disclaimer

This study was carried out as part of a collective field mission of the Specialised Master programme FNS-MI (Forest, Nature and Society, International Management) of AgroParisTech, with the aim of providing answes to questions posed by the NGOs AIDA and the CZZS in particular, in this later case in the project "*The Sustainable Future for the freshwater ecosystem Livanjsko polje in Bosnia and Herzegovina*". This report was written by the authors, students of FNS-MI, with the knowledge available, as part of an educational exercise and in a very short space of time.

The aim of this report, which contains a territorial diagnosis and possible actions for sustainable management of the area, is to provide elements for discussion with local, national and international stakeholders. It is not an expert report providing top-down solutions.

The information and points of view set out in this study are those of the authors and do not necessarily reflect the opinion of the study partners.

Authors:

A collective report written by:

The 2023 promotion of AgroParisTech “Forest, Nature, Society, International Management” Specialized master’s degree

Pauline Bricault, Bertille Daras Siffait de Moncourt, Santiago Debono, Théo Durand, Augustin Fiévet, Lucie Fresel, Adélaïde Naudin, Hermelan Kouaho, Jean Legay, Gaël Montillot, Camille Piechon, Léa Piedigrossi, Guillaume Pouthé, Juliette Pretesacque, and Bernardo Sanchez

Contributors and translators during the field work:

Nina Brnic, Anela Dervic, Selma Genjac and Amra Huntic

Under the supervision of:

Coralie Calvet[1], Orianne Crouteix[1,2], François Lerin[2], Jeremy Vendé[1]

[1] AgroParisTech, UFR G-ENV (https://www.genv-agroparistech.fr/en/)

[2] AIDA association (http://www.courrierdelaplanete.org/)

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About the authors of this report

We are a group of 15 students of the Specialized Master Forest, Nature and Society, International Management (FNS-MI) delivered by AgroParisTech. Coming from 3 main fields of expertise: some of us are general engineers, some have high skills in agriculture and environment and others have a more socio-economic profile. And our common interest unites us in our passion for nature conservation.

We were supervised by four lecturer and researcher: three from AgroParisTech: Jérémy Vendé (Head of the Specialized Master "Forest, Nature and Society - International Management" (MS FNS-MI)), Coralie Calvet (Lecturer in economical sciences) and Orianne Crouteix (Lecturer in geography), and one from the French NGO AIDA: François Lerin (social scientist in agro-environment).

The objective of this master's degree is to train students in the sustainable management of ecosystems while considering the major social dynamics. This specialized Master's degree is a multidisciplinary training taking place on four different campuses, starting with the AgroParisTech campus in Kourou, French Guiana, then continuing in Nancy and Paris and ending in Montpellier where particular attention is paid to social sciences and strategic analysis of environmental management. Each year, the students of this Master's program follow the module "Evaluation of an environmental project in an international context" which includes a three-week collective field mission in a foreign country. This year, thanks to the partnership with CZZS, the promotion had the opportunity to study karst polje territories in Bosnia and Herzegovina in March 2023, which gave rise to this report.

Foreword

This report was written as a final debrief of the group internship realized in March 2023 by 15 students of the specialized Master of AgroParisTech entitled "Forest, Nature and Society - International Management". AgroParisTech, also known as the Paris Institute of Technology for Life, Food and Environmental Sciences, is a higher education and research institute. The study is conducted in partnership with the CZZS Association, an ecological NGO of Bosnia-Herzegovina and AIDA a French NGO promoting actions for the agro-environment.

The main objective of our mission is to carry out a territorial diagnosis based on social sciences in support of the CZZS project aiming at protecting the ecosystems present on the Livanjsko polje which is the west of Bosnia and Herzegovina. To carry out this study, seven weeks of work were mobilized which four weeks of desk work and three weeks of field work in the study area.

The wetlands of the Balkans are unique environments, harboring a rich biodiversity that is essential to protect, according to the final text of the historic Kunming-Montreal Global Biodiversity Framework, agreed at the 15th meeting of the Conference of Parties to the UN Convention on Biological Diversity. Indeed, biodiversity is declining worldwide, with bird, mammal, reptile, amphibian, and fish populations declining by an average of 69% since 1970, according to the latest WWF Living Planet Index. Climate change is more talked about than the disappearance of wild species and habitats, but these two crises are closely linked: the alarming degradation of natural environments is not only leading them to lose their storage capacity but also to emit more greenhouse gases. As a result, more carbon dioxide is entering the atmosphere, accelerating global warming (WWF, 2022).

The Sustainable Future for the freshwater ecosystem Livanjsko polje in Bosnia and Herzegovina project supported by EuroNatur is part of this issue, which the DIMFE (Donor Initiative for Mediterranean Freshwater Ecosystems) structure is funding.

EuroNatur has partnered with the Center for Environment (CZZS) and Naše Ptice to carry out this project. Naše Ptice brings, among other things, its expertise in ornithology and its knowledge of karst poljes. Center for Environment has specific objectives such as the implementation of restoration measures or the way to influence of the legal framework of nature conservation. The collaboration between CZZS and AgroParisTech aims to develop scientific and pedagogical exchanges around the use of knowledge, methods and tools of social sciences for biodiversity conservation. By targeting different actors such as citizens and people from administration, all levels of authorities, farmers and other local stakeholders as well as local initiatives, it aims to build a strong network for conservation and sustainable management of karst poljes in Bosnia and Herzegovina through the coexistence between humans and nature.

Our action consists in studying the conservation and sustainable management of karst poljes in Bosnia and Herzegovina through the connection between man and nature.

Acknowledgements

We warmly thank all the people we interviewed on the field, from all the Canton 10, your answers and your confidence helped us enormously to move forward in our study.

We would like to salute the support and patience of our 4 companions and reviewers during this mission, Jérémy Vendé, Coralie Calvet, Orianne Crouteix and François Lerin, who supervised us with a lot of kindness and enthusiasm, despite the fatigue, the snow and the cold.

We would also like to thank Milica Končar and her colleagues from CZZS as well as Biljana Rankovic and Goran Topić from Naše Ptice, who were very supportive during the preparation of this project and for the partnership with AgroParisTech and gave us very relevant feedback for our analyzes following our presentation at Livno.

Also, a huge thank you to Nina Brnic, Anela Dervic, Selma Genjac and Amra Huntic, the four students from the Faculty of Agriculture and Food Science of Sarajevo who volunteered their time to help us with the translation of the interviews, and more generally for sharing their culture and good mood with us.

Abstract

Livanjsko polje, known as the world's largest seasonally flooded polje, is in Canton 10 of the Federation of Bosnia-Herzegovina. Using a resolutely inductive and iterative approach, we carried out a comprehensive territorial diagnosis by integrating this polje into a larger territory which covers three other large poljes: Duvanjsko, Kupreško and Glamočko poljes.

The first result of this territorial analysis is the interweaving of five landscape units in the area: karst poljes, benchlands, mountain crests, slopes, karst plateaus. These units need to be considered in terms of their dynamics (seasonal or on these last decades) and the socio-economic activities that run through them. The second result is the identification, spatialization and ranking of the main environmental issues present in the area, i.e. the pollution of water, the fragmentation of bird habitats, the landscape alteration, the fragmentation of hydrological continuity, the degradation of flora.

The aim of establishing a territorial diagnosis of this kind is to be able to propose for discussion a set of protection tools (protected areas, registration on international lists as UNESCO etc.) in terms of their relevance to the territory, to these environmental issues and to local and national governance and management systems.

The report is divided into four parts, the introduction presents first the study area, the main approach, and the research project. The second part is based on the method used for the study, including the program followed during the project with the main missions and feedback. Then, the results obtained thanks to the territorial diagnosis will be analyzed and finally in a last part, the various investigation tracks will be presented as well as the potential paths of action that have emerged thought the study.

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List of acronyms

AIDA: International Association for AgroEnvironment Development (*Association Internationale pour le Développement de l'Agroenvironnement*), Association under French law which brings expertise on agri-environmental issues in the Balkans and is behind this territorial diagnosis project.

BiH: Bosnia and Herzegovina (*Bosna i Hercegovina*), refers to the country, the State, at national level, which includes two entities (FBiH and RS) and the condominium of Brčko.

CLC: Corine Land Cover, European map database about land cover and land use.

CZZS: Centre for Environment (*Centar za životnu sredinu*), Bosnian NGO based in Banja Luka involved in the international project to protect poljes in the area of Livno.

FBiH: Federation of Bosnia and Herzegovina, one of the two entities of BiH. This Federation gathers ten autonomous cantons with their own governments and legislatures.

FNE: France Nature Environment (*France Nature Environnement*), federation of associations for the protection of nature and the environment in France.

FNS – MI: Forest, Nature and Society, International Management (*Forêt, nature et société – Management international*), Specialized Master delivered by AgroParisTech.

GIAHS: Globally Important Agricultural Heritage Systems, programme leads by the FAO (Food and Agriculture Organization of the United Nation) which recognize remarkable land use systems and landscape based on agricultural heritage.

IBA: Important Bird Areas, sites recognized at international level to support specific groups of birds: threatened birds, large groups of birds, and birds restricted by range or by habitat.

NGO: Non-Governmental Organisation.

PA: Protected Area.

PAwSUR: Protected Area with Sustainable Use of Resources, specific kind of protected areas depending of the Bosnian law.

PGI: Protected Geographical Identification

PS: Product Specifications

RS: Republic of Srpska (Republika Srpska), one of the two entities of BiH, recognized in December 1995 with Dayton Agreement.

List of units

ha: hectare, a square of 10 000 m^2

KM: Convertible mark, currency of BiH (1KM = 0,51€)

M€: million euros

MW: megawatt

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I. Protecting four karst poljes of the federation of Bosnia and Herzegovina

Due to its rich history, legacy of various kingdoms and conquests, from the Illyrians and the Romans, through the Ottoman conquest and the Austro-Hungarian Empire to its independence from Yugoslavia and the Dayton Agreement in 1995, Bosnia and Herzegovina has witnessed the gradual change of its landscapes, successive peoples and food and forage practices that have shaped its territories. Indeed, independence from Yugoslavia was obtained following a war of several years, the agreements of Dayton put an end to this war with a new territorial division of Bosnia and Herzegovina into two entities with the Federation of Bosnia and Herzegovina (FBiH) and the Republika Srpska (RS) and one condominium, the Brčko District (BD). The study area is a flagrant witness of this, as much by the richness of the landscapes as by its use and domestication by the men who settled there for hundreds of years: "*Bosnia-Herzegovina is a country with a triangular shape, like a wedge embedded in Croatia. This shape is a legacy of the domination of the Ottoman Empire on the Bosnian territory, in front of the Hungarian Empire which then included Croatia. The boundary between the two Empires, stabilized in the late 17th and early 18th centuries, still serves as the northern border of Bosnia and Herzegovina*" (Chaveneau *et al.*, 2023).

Encompassing a good part of the central Dinaric Alps, the country is mountainous. Mainly of limestone composition, these mountains surround in the south remarkable plains that the authors had the privilege to study and to observe: the poljes.

1. The karst poljes: a specific landscape very common in the Dinaric Alps and southern BiH

Polje is a word coming from the south Slavic language and designates a field. Indeed, it is a very particular geological formation strongly present in the Balkan region. The word karst is the German name for the plateaus and limestone massifs of the Kras region located between Italy, Slovenia and Croatia. Nowadays, in the karst poljes of the mountains of Bosnia and Herezegovina, there are very rural activities, many traditional farming and breeding practices shaped the landscape of the poljes. Characterized by a karst depression forming flat land often surrounded by rocky walls, it is the reservoir of biodiversity of the adjoining areas. In the form of a large plain, it is part of the emblematic landscape of Bosnia. The study area comprises the 4 karst poljes of Livanjsko, Duvanjsko, Glamočko and Kupreško mainly in FBiH.

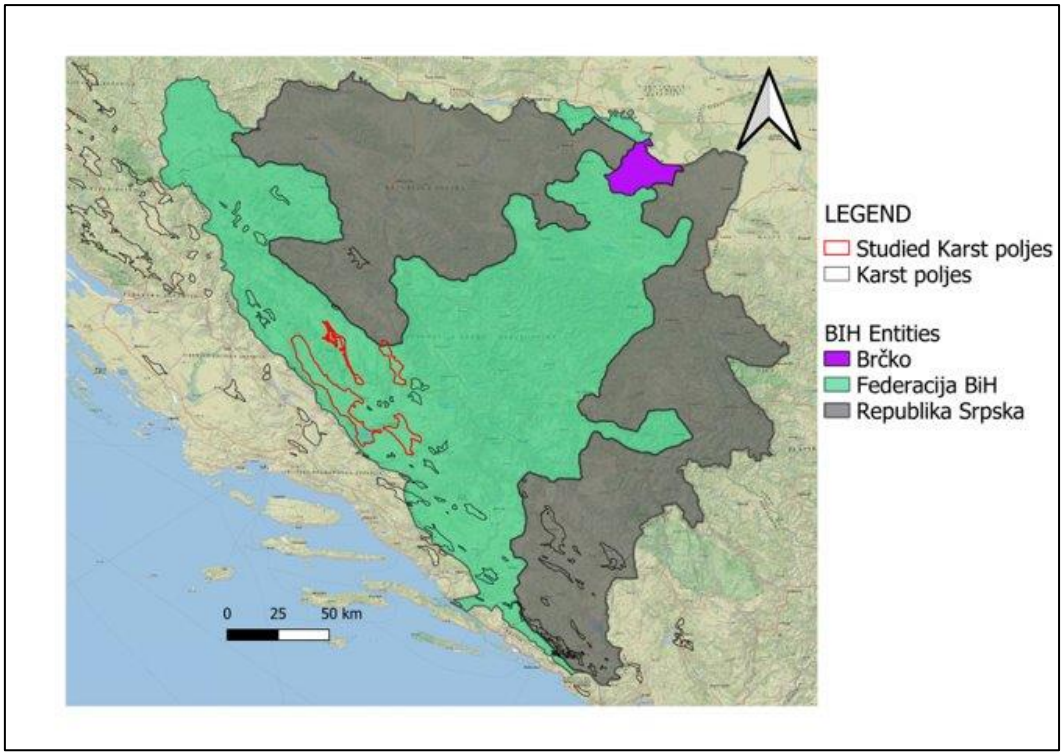

Figure 1: Administrative boundaries in Bosnia and Herzegovina, QGIS (production: FNS-MI, 2023)

The Figure 1 shows the political division of the country following the Dayton agreements. The four poljes outlined in red are partly in the Federation of Bosnia and Herzegovina, and only a small part of the Kupreško polje is in the Republika Srpska. The study focuses on the management of the poljes in FBiH.

Karst areas have a complex hydrogeological network: with many underground interconnections and sometimes on the surface some wetlands.

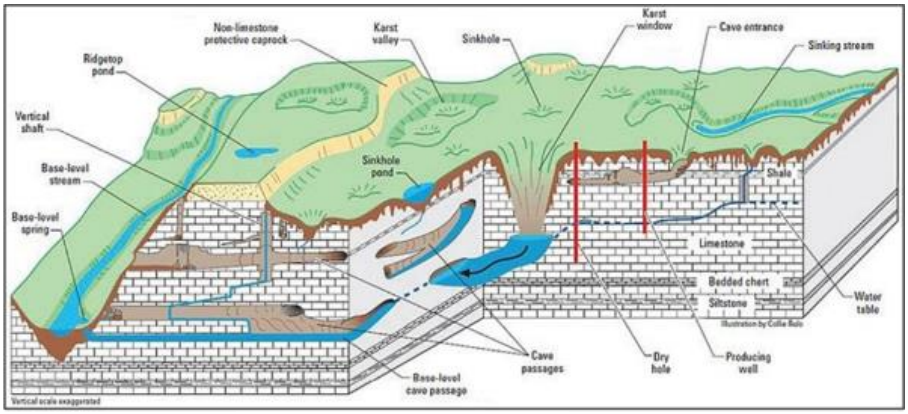

Figure 2: Hydrological diagram in karstic zone (Source: Taylor, C., & Earl A., Hydrogeologic characterization and methods used in the investigation of karst hydrology. 2008.)

This is a closed basin containing one or more underground and surface hydrological networks (Figure 2). The poljes are surrounded by mountains which pour their water flows directly onto the plain of the poljes. In the absence of valleys, water seeps into the cracks and caves and generate a wetland or underground complex hydrological system. One of the most

characteristic elements of these karstic reliefs and water networks is the ponor. It is a natural karst opening of a polje through which surface water disappears and becomes underground. In addition, there are many other sinkholes, sources, rivers, and lakes which constitutes a habitat for many species of fauna and flora.

These environments are also highly sought after by migratory bird species, forming wetlands that are sources of habitant for many species of passages and other more sedentary ones.

2. Four poljes in the upstream part of the same watershed

The Livanjsko polje is the largest periodically flooded karst depression in the world. The Figure 3 below shows the spatial arrangement of the poljes.

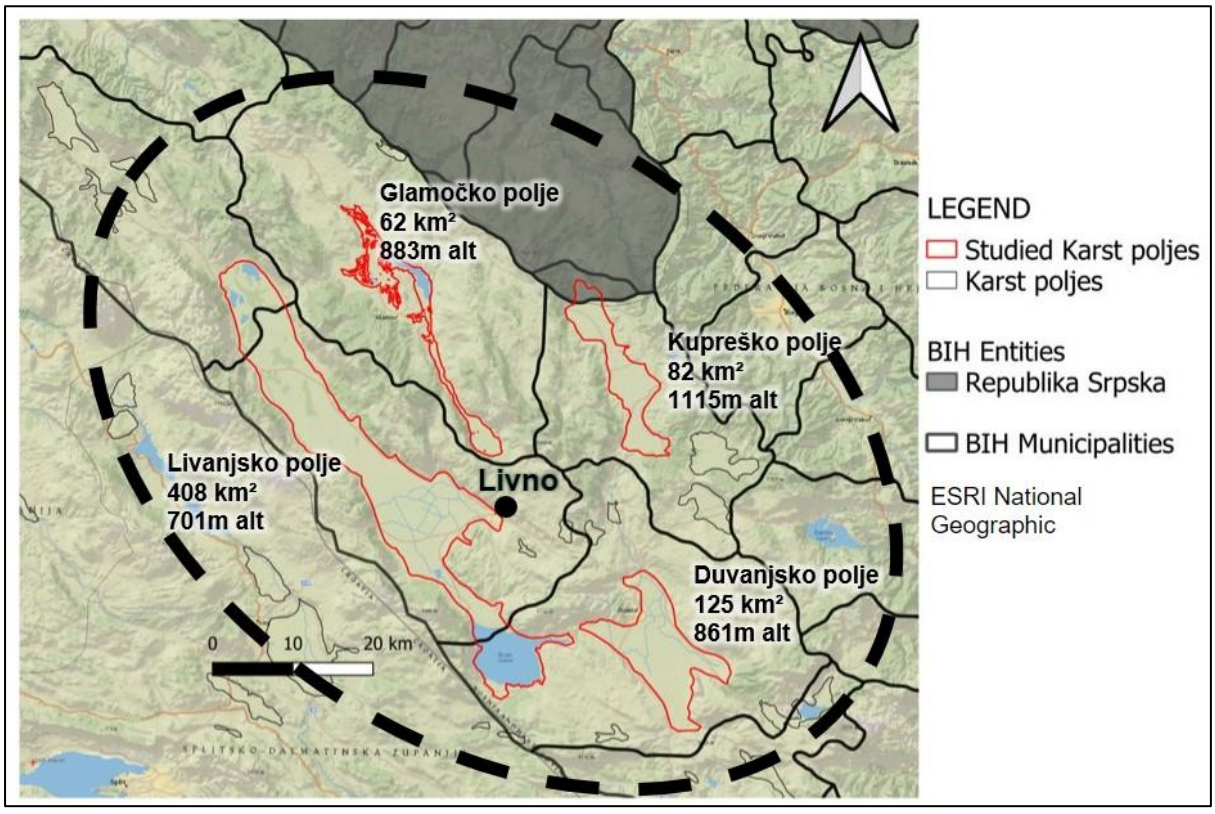

Figure 3: Map of the 4 poljes, QGIS (production: FNS-MI March 2023)

- Livanjsko polje:

The Livanjsko polje located in the west of Bosnia and Herzegovina in the municipalities of Livno, Bosansko Grahovo and Tomislavgrad is considered one of the largest poljes in the

Dinaric Alps. It is also the polje with the highest hydrological pressure, especially through periods of heavy flooding.

In 2008, this particularly famous polje was granted as a Ramsar site to protect and promote the use of wetlands. Since 2013, it has also been included in the list of Important Bird Areas (IBAs).

- **Duvanjsko, Glamočko and Kupreško polje:**

There are many underground and surface hydrological connections between the Livanjsko polje and the three poljes located nearby as shown in the Figure 13 below. The Duvanjsko, Glamočko and Kupreško poljes are directly connected (upstream/downstream) to it.

In fact, the water flows form a profitable interconnection with the Duvanjsko polje, the Glamočko polje and the Kupreško polje. "*Generally, it could be argued that the water moves from Glamoč and Kupres field towards the sources and estavelles surrounding the Livno field (Buško Blato and the outskirts of the middle part of Livno). From the Livno field and Buško Blato, the water gushes to the west, towards Cetina (Croatian river), and the sources near the north-eastern margin of the Sinj field"* (IUCN, 2000, p 23).

3. An area of high environmental value

These poljes are reservoirs of biodiversity, there are exceptional habitats such as seasonally flooded plains, agricultural land and alluvial forests, seasonal marshes and pools, peatlands, meadows and permanent streams. The study area is at the crossroads of important bird migration corridors, particularly the Livanjsko polje, with its connection to Buško Lake. It is a good migration route for certain bird species such as the Common Crane (*Grus grus*), the Eurasian Spoonbill (*Platalea leucorodia*) or the Common Pochard (*Aythya ferina*) making it an incredibly diverse region (BirdLife International, 2023).

Traditional agricultural practices, like for example the extensive pastoralism, have shaped landscapes with large meadows. A diversified local economy relies a lot on natural and agricultural systems in the study area. In addition to the unique nature of the area, Livanjsko and Duvanjsko poljes and their surrounding area provide many other cultural, artistic, and traditional values, as well as local products and handicrafts. Producers of traditional cheeses, honey, blackberry wine, national costumes, and various artists with unique artwork contribute to the overall value of this area (UNDP, 2012).

On the other hand, the territory is also subject to impacts that need to be controlled. There are several energy projects in the study area, with namely a lot of wind farms projects and hydropower plants between karst poljes, and there are other threats such as poaching and fires which may pressure natural systems.

The information and data on the environmental interest of the area in terms of biodiversity, hydrology and ecosystems that we gathered prior to our fieldwork are gather in annexe 10. But all the poljes are not subject to the same institutional organization. This aspect will be explored further in the next section.

4. A particular territorial management due to a fragmented land organization

a. A multi-level and complex political division

The country is divided into two entities, the *Republika Srpska* and the Federation of Bosnia and Herzegovina. The Brčko district, an autonomous territory, is a condominium with a self-governing administration.

The current political structure of BiH is a legacy of the Dayton Agreements (1995). These agreements divide the country in entities following more or less the “front line” and after negotiations with each part of the war to restore peace. A consequence of the Dayton Agreements is the establishment of a collegiate presidency, based on the three largest ethnicities: Serbs, Croats and Bosniaks still effective in 2023. The Presidency is one of the centralized institutions of the BiH state, together with the Central bank and the Constitutional court.

- The Federation of Bosnia and Herzegovina is divided into 10 cantons with a Bosniak and Croat majority. There are 79 municipalities representing 51% of the total territory of the country. The study area is almost entirely located in Canton 10, which is the largest one (Figure 4).
- *Republika Srpska* has a Serbian majority. There are 64 municipalities representing 49% of the total territory of the country. A small part of Kupreško polje is located there.
- Brčko District is an autonomous and neutral territory of Bosnia and Herzegovina, whose capital is the town of Brčko.

The population of Bosnia and Herzegovina is today represented by three major ethnicities: Croats (mostly Catholic), Bosniaks (mostly Muslim) and Serbs (mostly Orthodox). The latest census (2013) shows the composition of the population in each territory (Figure 4). There is also a fourth category, "other", which is an extreme minority.

Some entities, cantons and municipalities have a clearly dominant majority of one of the three ethnicities, due to various displacements in the course of history, which influence the inter-community and demographic dynamics of the country and have change drastically, over the last thirty years.

In addition, complex parameters such as depopulation, ethnic structure, war destruction, post-war renewal and return of displaced persons, as well as inter-ethnic tensions, through the 'hidden geographies' (Krevs *et al.*, 2021), influence or have strongly influenced the change of practices and demography of the territory. .

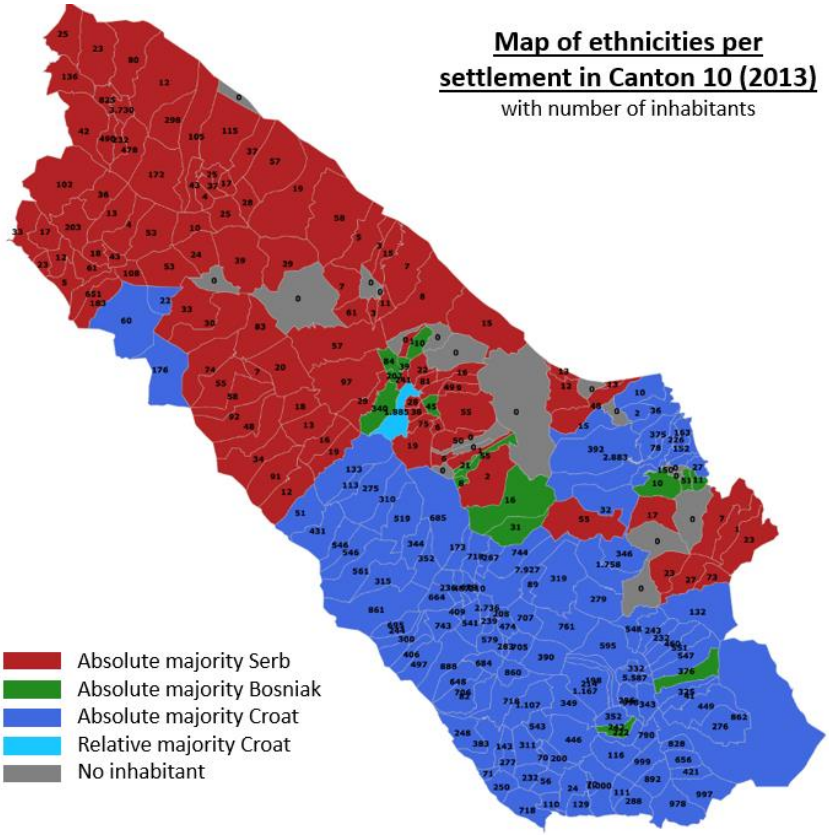

Figure 4: Map of ethnicities per settlement in Canton 10 (data: http://www.statistika.ba/ (2013) & production: FNS-MI March, 2023)

This political-administrative canvas has real effects on the daily lives of Bosnian citizens. On the one hand, the *Republika Srpska* and the Federation manage their territory almost autonomously with self-administrations, laws and management rules. On the other hand, this system pushes political movements to organize themselves separately, even if some of them claim to be independent. Thus, minorities who are not Serbs, Croats or Bosniaks are very poorly represented in the country's institutions and cannot be elected.

The studied poljes are located in five municipalities of the Canton 10: Bosansko Grahovo, Livno, Tomislavgrad, Kupres and Glamoč. These municipalities group together settlements which are towns or villages. For instance, Livno and Glamoč designate both a municipality and a settlement.

b. Economic activities

Nowadays, Canton 10 (with a population density of 17 inhabitants per square kilometre) is the most rural canton in Bosnia-Herzegovina. Agricultural activities, and in particular livestock farming, play a central role in the territory’s economy. To this day, much of this agriculture remains subsistence farming.

In 2021, 83% of jobs are in the areas of Livno (41%), Tomislavgrad (29%) and Kupres (13%) municipalities. Most of the jobs in the Canton are in wholesale and retail trade, automotive and

motorcycle (16.7%) manufacturing industry (14.4%) public administration and defence (military), compulsory social insurance (13.6%) agriculture (12.2%) *(Agencija za statistiku & Bosne i Hercegovine*, 2022)

Although the Canton is the less touristic from the country, *(Agencija za statistiku & Bosne i Hercegovine*, 2022) the richness of the landscapes, traditions and wild and endemic fauna are major assets for the development of a touristic activity, which already exists in certain municipalities such as Livno (wild horses, quad bike rides, bird watching), Tomislavgrad (speleology, traditional Ganga singing), and Kupres with a ski resort.

The information and data on the socio-economic aspects and the governance of the area that we gathered prior to our fieldwork are gather in annexes 11 and 12.

5. Beyond a conservation project: stakeholders involved

Wetlands, marsh vegetations and meadows, bushlands and more typical underground and land species make the poljes within the Balkans a unique environment, harboring a rich biodiversity. This is why the Bosnians and internationals NGOs Naše Ptice, CZZS and EuroNatur (presented below) are carrying the project *Sustainable Future for the Freshwater Ecosystem Livanjsko polje in Bosnia and Herzegovina*.

Naše Ptice is a non-governmental association involved in the field of ornithology, ecology, bird ringing and protection and monitoring of birds and birds' habitats. The society is strongly involved in projects which aim at raising general public awareness about bird protection in Bosnia and Herzegovina by implementing educational program, research and conservation program.

The Center for Environment (CZZS in Bosnian) was created in Bosnia and Herzegovina in 1999 focuses on environmental issues. It is recognized as an organization that tries to influence the relevant public policies in a reasoned and active way, raise public awareness of environmental issues, and achieve constructive cooperation with other associations, networks, institutions, and international organizations. It's the biggest association in the country carrying out those topics, counting around 20 employees.

EuroNatur has joined forces with Center for Environment and Naše Ptice to carry out this project (cf annexe 12). This German foundation set up cooperation between existing nature conservation organizations which have excellent connections in their immediate environment and are working successfully there.

The main project around these biodiversity issues targets five main specific goals:

- Enabling long term sustainable protection of Livanjsko polje and surrounding karst poljes as an important freshwater ecosystem in BiH;
- Conservation and restoration of freshwater ecosystems and their biodiversity in Livanjsko polje through fostering and improving of environmentally beneficial land use practices;
- Reduction of illegal and harmful activities to the freshwater ecosystem of Livanjsko polje;

- Strengthening local initiatives that contribute to nature conservation and sustainable management of the freshwater ecosystem of Livanjsko polje and surrounding karst poljes;
- Increased awareness and knowledge in the general public about the natural and cultural values of karst poljes.

These five objectives have led to the formulation of a problematic and a set of questions that have guided the reflection around the project and the production of data.

6. Research questions

The intervention of AgroParisTech aims to clarify the territorial dynamics of the poljes concerned by this project. Indeed, this complex territory leads to the definition of several issues such as these:

What links can be made between landscapes attributes and activities?

What are the most important environmental attributes of the territory and how can they be protected?

To globalize its problems, and strive to answer the following question: what could be the protection tools best suited to the environmental characteristics of this territory?

A work of bibliography and field allowed to confront these problems with the reality of the territory considered and to contribute to the development of certain suggestions and lines of investigation necessary for the protection of this territory.

II. Methodology and method

The project of data collection and territorial diagnosis is anchored in a broader environmental analysis strategy work with the aim of supporting preservation measures for the improvement of natural resource management. This section describes and details the approaches and theoretical framework adopted.

1. Terms of reference of the order

In order to understand the territory, local NGOs are taking up the subject and their role as protectors. The work carried out here is part of this process. The aim is to establish an environmental diagnosis. The mission statement brings up the following objectives, (i) establishing a benchmark of national and international environmental protection tools, (ii) conduct a territorial diagnosis , (iii) propose different ways to improve environmental protection (cf Terms of Reference in annexe 13).

a. Benchmark: environmental protection labels and tools

The benchmark is a material that is based on a state of the art of tools, labels and networks for the conservation and protection of a territory. It is based both on the bibliography and on the analysis of the semi-structured interviews. It provides a global vision of the different possibilities in the sector, including local tools already in place, as well as external tools and labels that could potentially be mobilized. This list takes into account the different geographical scales: local, regional, national and international. The inventory enables the scope and power of each of the tools to be understood and thus determine their impact on the territory in question. This understanding is possible by determining for each environmental stake, the number and proportion of threats countered by the tool in question. It should be noted that the assessment includes potential avenues involving different types of organizations (private, public -executive, legislative-, local, international...). The benchmark aims to provide multi-level information that can be used to assist decision making (Wu et al., 2015).

b. Territorial diagnosis

There is a lack of understanding of systemic activities organisations and interconnectedness in the study area. The diagnosis is a tool that aims to identify the socio-environmental problems and dynamics, strengths, and weaknesses of the study area.

By considering the different realities of a given territory, it identifies the divergent perceptions of the actors and raises the potential for collective action. The approach is intended to be cooperative. A successful diagnosis leaves an important place for coordination, which is the foundation and safeguard of the operational stage that follows.

Before embarking on this process, it is necessary to ask some preliminary questions. The answers to these questions must provide keys to understanding the territory and environmental managements present, its objectives (by whom? why? on what theme?), as well as the territory in which it is located (limits, actors involved, targets, etc.).

The territorial diagnosis combines semi-structured interviews with landscape and cartographic analysis. It relies on an iterative and comparative methodology explain below.

It must not only characterize the area analysed, but also say whether it forms an organized and autonomous system. The diagnosis of the territory also aims to initiate change. It is an opportunity to mobilize stakeholders, who can take advantage of the process to formulate an observation, define the issues at stake and discuss priorities for action. It makes it possible to carry out an inventory of the territory studied.

The territorial diagnosis allows issues to be prioritized, for example according to their spatial extent or the intensity of the problem to be addressed (Piveteau et Lardon, 2002). This tool feed into our theoretical grounding of the Strategic Environmental Management Analysis (SEMA), and in particular the parts of the normative framework and actual management, which is developed further below.

This work is part of an environmental management issue, and to tackle the problem it is necessary to define the framework: what is the theoretical framework.

The territorial diagnosis is a material which, in addition to the benchmark, is the foundation on which the environmental strategy is based. This strategy is carried out by an environmental actor (Mermet, 2014) (cf Figure 5).

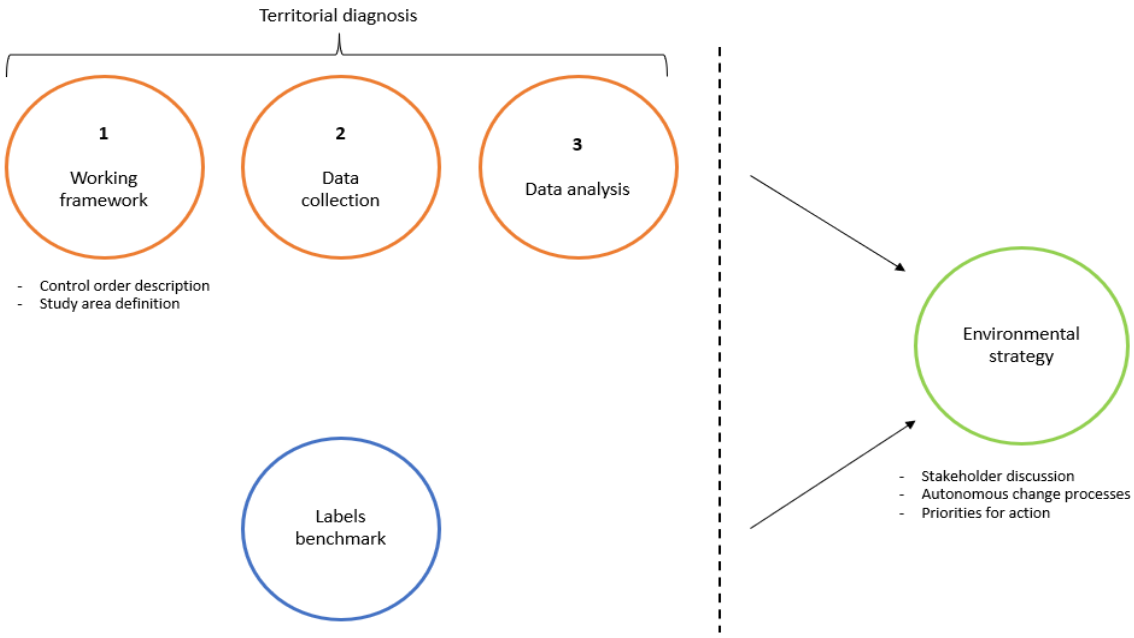

Figure 5: Methodological approach (source: FNS-MI March 2023)

2. Theoretical framework: SEMA

To produce a strong benchmark and a structured territorial diagnosis, it is necessary to operate in a conceptual framework. The theorical framework will be based on the Strategic Environmental Management Analysis (SEMA) (Mermet, 2014).

a. The SEMA method

Taking up the framing of organizational sociology, SEMA responds to a collaborative paradigm according to which it is necessary that all stakeholders discuss environmental issues collectively. SEMA aims to provide an adequate theoretical framework for work on the issue of coherence and effectiveness of action in relation to environmental responsibilities (Mermet et al., 2005). It proposes to reintroduce the balance of power between actors, to highlight these relations and to detail the missing information. More particularly, the SEMA frames an approach that focuses on an analysis of the study area and all activities of actors who oversee the management of the territory. This method is based on four main principles (Mermet, 2011):

- Environmental baseline

The first step of the methodology consists in the identification of the environmental baseline. Its definition will be a central element for our strategy because it allows us to keep an objective in mind. Moreover, establishing a single environmental concern will make analysis less complex and action more effective. A single environmental baseline can be composed by

several environmental stakes especially as the analysis is not complete because of a lack of time. The field study is the way to validate these environmental stakes or to discover another.

- Actual management

Then, there is the actual management defined by the facts and the actors involved in the environmental concern. The analysis of actual interactions makes it possible to detail this management and its effects on the environment. This part of the analysis is crucial to identify the origins of the environmental issues.

- Intentional management

Also, the intentional management is the set of actions and actors whose main goal is to achieve environmental improvement of the established environmental baseline. Several actors of intentional management were identified previous to the field work, namely NGOs such as: AIDA, EuroNatur and Naše Ptice.

The distinction between the two types of management related to the identified environmental stake enables to direct the strategic recommendations towards the increase in the relative bargaining power of the intentional management actors.

- The strategy

The Strategy is the last core element of the SEMA framework. All the former steps allow to determine the main actions and the strategy to establish for environmental conservation. The strategy includes all targeted actions that enable a positive response to change in an environmental issue. The pertinence of the SEMA method is to understand who the key actors are able to reach this positive response and what are the main room for manoeuvre.
The goal of this work is not based on a production issue but is more aimed at bringing the discussion to local actors. In this sense, the strategic principle of the SEMA will only be based on suggestions for protection tools or labels.

b. Reasoning behind the use of the SEMA framework

For the territorial diagnosis, we will focus on the first two steps of the SEMA's method, namely the normative baseline and the effective management. We also consider intentional management and strategy.

Making a territorial diagnosis is the first application of SEMA (Mermet, 2014). As actual management and intentional management are crucial elements of a territorial diagnosis, determining these two types of management will make it possible to respond to the second objective of the term of reference which is the production of a territorial and global analysis (cf Annexe 13).

A second application of SEMA is the production of a strategy. The goal is to identify the first avenues for solutions and to try to use our understanding of intentional management to

propose a preservation solution. In this sense, thanks to SEMA's method, we will be able to identify an environmental issue that will be the focus of our proposal action strategies. The first proposal will be the benchmark (first objective of the term of reference) and then a more global strategy (third objective of the term of reference). SEMA’s method helps to provide a clear explanation of an environmental entity's management arrangements, useful for the implementations of actions by local actors.

3. Fieldwork

Different types of data were collected on the field and processed with different methods before being used for the SEMA analysis.

a. Organisation of fieldwork

The fieldwork was carried out from 28th February 2023 to 10th March 2022. Each day, 4 cars with 3 or 4 students in each, 1 translator, and sometimes a supervisor left for the field at destinations chosen collectively the day before according to the appointments made or the needs of the survey (depending on the missing information). With this methodology, the study include landscape analysis and semi-structured interview on the four poljes and five municipalities (Figure 6). A group of 3 or 4 students stayed at the base camp in order to transcribe the interviews and to begin the analysis of the data collected. The smooth running of the fieldwork was subject to the vagaries of the weather. The heavy snowfall of the first few days delayed the arrival of the translators and made it difficult to access certain villages. The translated interviews could only begin on 2nd March 2023.

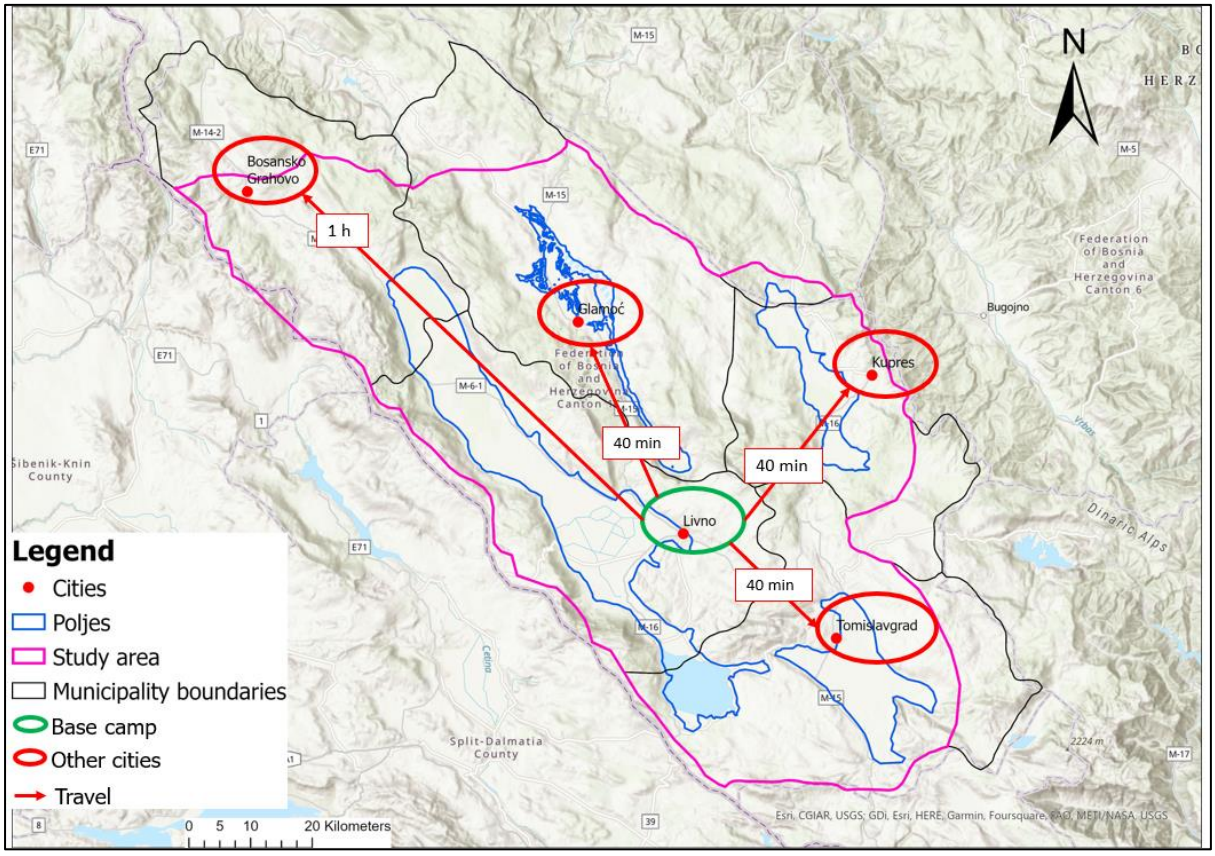

Figure 6: Map of the exploratory approach used, ArcGIS (Production: FNS-MI March 2023)

b. Methodological approach

An exploratory and network enlarging approach to fieldwork was favoured during the study. By dividing into several groups, each group can explore a different part of the study area in order to collect initial contacts with a view to organising interviews or even conducting interviews at a later stage.

The use of a network enlarging method is also important in collecting contacts and thus new data. Indeed, each person met gives new contacts who can then be interviewed in turn. This creates a large sample of contacts. Based on the information collected from previous interviews or informal discussions, the following people were selected for interview, whose testimony would supposedly be the most useful (Beaud et Weber, 2010). The objective is to meet different actors without seeking to be representative in terms of numbers, but rather based on aspects of saturation. Saturation is the phenomenon of a decrease in new information as the same subject is explored. It is then advisable not to concentrate on this subject but on those where there is still a lack of data (Olivier de Sardan, 2008).

The data was collected and analysed using a qualitative, inductive, iterative and comparative approach:

- Qualitative: The representativeness of the data is more important than the quantity. The data collected in the field are raw data that need to be described, analysed, classified and connected with each other to create new analysis (Schneider, 2006).

- Iterative: The analysis is continuously adjusted as well as the working hypotheses based on the gathered data and consequently the sample is re-evaluated. Iteration *"means going back and forth between problems and data, interpretation and results. Each interview, each observation, each interaction is an opportunity to find new avenues of research, to modify hypotheses and to develop new ones." [Our translation]* (Olivier de Sardan, 2008, p.82)
- Inductive: The data collected in the field is used to construct or re-construct hypotheses. The fieldwork makes it possible to refine the working hypotheses put forward beforehand.
- Comparative: The information obtained is cross-checked in order to increase the understanding of the territory and its management methods, this is "triangulation" (Olivier de Sardan, 2008).

With the iterative-inductive-comparative method, the gathered data is compared, analysed to create new hypotheses or to confirm or transform the ones already formulated. Then, the comprehension of the studied subject increases over time.

c. Semi-structured interviews

Semi-structured interviews were used because they are "*great for finding out Why rather than How many or How much*" (Miles et Gilbert, 2005, p.66.

During semi-structured interviews you *"have a set of questions to ask and a good idea of what topics will be covered - but the conversation is free to vary and is likely to change substantially between participants*" (Miles et Gilbert, 2005, p.65. Interview guide for each type of stakeholder were drawn up prior to the fieldwork (cf Interview guides in annexe 9)

The production and analysis of qualitative data via in-depth semi-structured interviews allows to gain an insight into the point of view of the actors, starting from their activities. This instrument enables to understand the interviewees and their practices by letting them express themselves freely on open questions (Schneider, 2006).

The interviews, when the interviewee agreed, were recorded. Whether or not this was the case, a note was taken during the discussion. The interviews were then transcribed, either completely from the recordings or partially using the notes taken. Roles were allocated during the meeting. For groups of three and a translator, one student led the interview, another took notes, while the last one ensured that the interview went smoothly and noted interesting questions to ask at the end of the interview once the first student had run out of ideas.

When the interlocutors spoke English, the interview were conducted in English. Otherwise, they were conducted in the local language with the help of students from the University of Sarajevo as translators. The translation was done during the interview. This live translation is more time-consuming but makes it possible to conduct a semi-directive interview by bouncing off what the interviewee has said.

Some interviews were conducted spontaneously at the first meeting, while others required a prior appointment. A brief presentation of the group and the study carried out was made to the

interlocutors at the time of contact. Interviews lasted an average of one hour. The shortest interviews lasted about 30 minutes, while the longest ones lasted more than two hours.

59 people have been interviewed (Figure 7) from the five municipalities of the study area (Livno, Tomislavgrad, Kupres, Glamoč and Bosansko Grahovo) with some exceptions (Banja Luka, Sarajevo and Mostar) (Table 1). People interviewed were stakeholders that have some interest regarding the subject of the study and who were able to give some information about their practices. The goal is to understand the practices to then grasp the complexity of the territory. They are distributed between different sectors of activity. The objective was to have a panel of interviewees that was as representative as possible of the territory and the activities that are practiced there and to have as many as elected representatives and public management agencies to learn more about the functioning and the management of the territory.

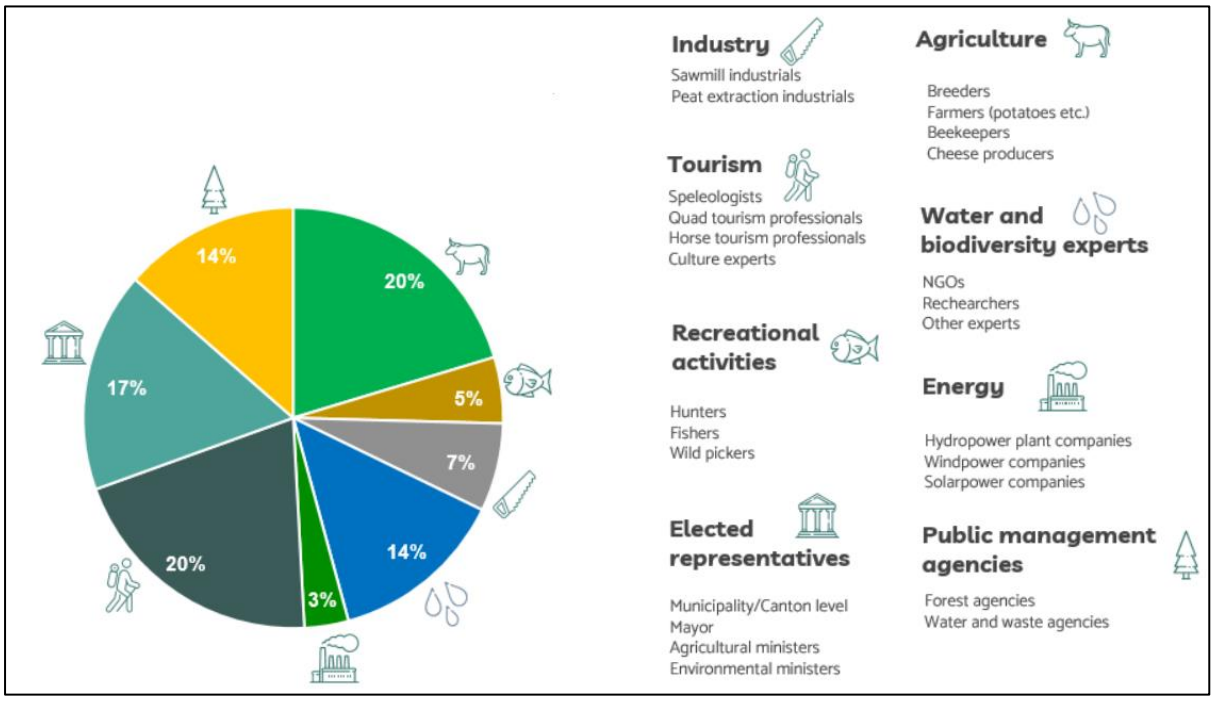

Figure 7: Diagram of the interviewees' distribution by sector of activity (Source: FNS-MI March 2023)

Municipality	Number of interviews
Bosansko Grahovo	6
Glamoč	6
Kupres	9
Livno	18
Tomislavgrad	16
Others	4
Total	**59**

Table 1: Number of interviews per municipality (Source: FNS-MI March 2023)

All those interviewed during the fieldwork were invited to a meeting in Livno on the 16th March 2023. This meeting was an opportunity to present our results and initial analyses. The meeting, which was attended by around twenty people, provided an opportunity to discuss the preliminary results with local stakeholders and to use these discussions to collect new data in order to refine the analyses. A second feedback session was held on the 17th March 2023 at the University of Sarajevo.

Where quotes or information from interviews appear in the report, the interview in question is cited as the source, but in code form to respect the anonymity of the interviewees. The code includes the field of activity, the municipality of the interviewee and a number. For example, for an inhabitant of Tomislavgrad working in agriculture, the code could be AT1 with A for agriculture and T for Tomislavgrad (cf. List of interviews conducted and their coding in the report, FNS-M in annexe 1)

d. Landscape analysis

During the fieldwork, in order to understand what shapes, the poljes and how Humans have adapted their activity to their environment in these territories, which are exceptional in many aspects, one of the tools that was favoured during the study was landscape analysis.

"The notion of landscape expresses the human gaze on a visible area of territory as much as the sensitive experience of it. [...] Landscapes can thus be understood as a social construction with an economic purpose, built on a natural support [...] The meaning given to what is looked at depends as much on what is seen and how it is seen, as on the cultural models that have formed its representation." [our translation] (Périgord et al., 2012, p 27 and 28).

Landscape analysis is used to understand and interpret how a territory works and to deduct its hot spots, or the elements to be highlighted by learning how *"to link these objective and subjective approaches to set in motion a project dynamic"* [our translation] (Ambroise et al., 2000, p 18).

The landscape analysis is carried out in 3 stages:

1. Reading the landscape with the eyes to identify the landscape units and sub-units (perception of space, geometry). It is important to also take photos and make sketches.
2. Understanding the landscape and its links to the activities seen in the area.
3. Interpretation: the observed landscapes must be cross-referenced with the maps obtained and produced and the interviews conducted in order to deduce why a particular landscape unit is observed in a particular place.

To get the best reading of the landscape, it is important to bring together and cross-reference different approaches:

- The sensitive approach
    - The appearance and perception of the landscape by the inhabitants

    - The beauty of the landscape is important for many activities. It is important to know how people perceive the environment in order to know what to focus on during the analysis.
- The geomorphological approach
    - The landform, the hydrographic system...
    - The slopes can be analysed to understand the functioning of the different catchment areas and the subsurface connections between the poljes
- The ecosystem approach
    - Fauna (feral horses, amphibians, birds...), flora and habitats (Wetlands, forests...)
    - It is then possible to link the constraints of the interviewees with the ecosystems observed or with the presence of certain wild animals.
- The agronomic forestry & historical approach
    - Forestry, pastoral and cultivated areas and the organisation of land use
    - The map obtained during the interviews and the analysis of the Corine land cover are interesting to learn more about how the landscape has changed in recent years.
- The socio-economic approach
    - Urbanisation, industries, shops...
    - The presence or absence of dwellings, their condition and the percentage of occupation of the villages crossed are important data for the landscape analysis.

During the first week of fieldwork, due to heavy snowfall, it was difficult to conduct the landscape analysis. It was therefore impossible to recognize a field for crops, pastures or rocky areas (Figure 8).

Figure 8: Snow on the lands near Šuica (Source: FNS-MI March 2023)

e. Cartographic analysis

To better understand the territory and the associated management, the data collected during the exploratory phase from different sources (mainly interviews and landscape analyses) were mobilised to produce transects, using Google Earth, and maps, using QGIS and ArcGIS, geographic information systems.

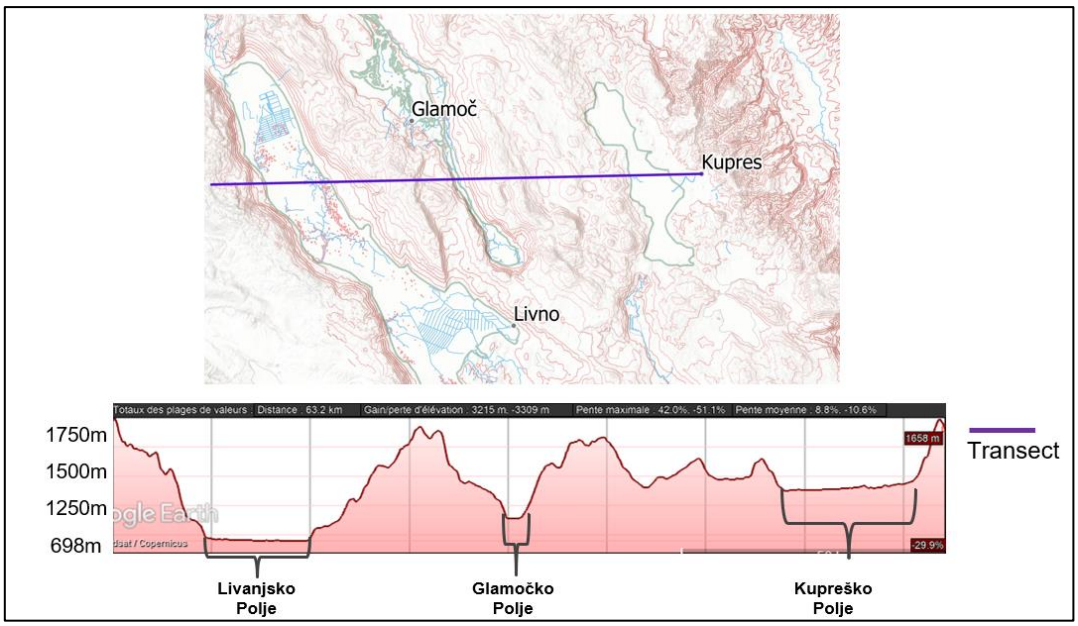

Figure 9: Topography sequence from Kupreško polje to Livanjsko polje through Glamočko polje, QGIS and Google Earth (Production: FNS-MI March 2023)

The transects make it possible to simply represent the topography on a selected part of the territory and to establish links between this topography, the landscapes and activities observed during the landscape analysis and the activities drawn from the interviews. This approach validates or invalidates the hypotheses linked to the landscape analysis.

The aim of such an analysis is to facilitate the understanding of the sector and its issues in relation to the subject of the study.

- Summarize

Selecting relevant data, prioritising essential information.

- Make sense

By creating a link between the categories of data available and by relating them to the issues at stake in the study, its problems, and its scope. These analyses must bring coherence to the scale of the project. Their results must be of wider strategic interest to the partners and stakeholders. The focus here is on the substance of the message to be shared.

- Represent

By making decisions about the ways in which messages are to be conveyed. These choices are crucial in the description and visualisation of the study area. Thus, the different systems

of figures, different types of layers used will define the angles of approach of the presentation and guide its reading.

This mapping analysis is used at all levels of the study. It provides a multi-sectoral understanding of the area. In other words, it must ultimately enable to understand the articulation of the systems of actors and activities linked to the issues on our territory and its sub-entities. Thus, to take a concrete example, it must be able to identify and represent that a silvicultural practice on a parcel of land in the north-west of the study area can impact with chain reactions an environmental attribute or a food production actor further south.

4. Data analysis

As shown in the schedule (The planning of the study, FNS-MI :) the data analysis phase started during the second week of the fieldwork. This was a gradual process. The idea was to start this work as soon as possible, and until the quantity and quality of the data collected was sufficient. Thus, in parallel to the explorations carried out each day by four groups going in different directions to cover our study area, the group that remained at the base camp was assigned the first tasks of analysing the data obtained the previous days. Each member began to cross-check the data on a particular topic or with a defined approach. They were selected in such a way as to respond precisely to the order given and depending on data collected.

The work started by some students was enriched by the group as a whole, with the aim of triangulating the data. Thematic workshops were created at the end of the fieldwork period, with a view to pooling and standardising the reflections of each participant. The analyses covered three main areas: "Environmental issues", "Effective management" and "Labels and tools". The students were then divided into these three areas to continue the analysis during the last week in Bosnia-Herzegovina and to prepare the two presentations (on the 16th and 17th of March) on site. For a better understanding of the information analysed and cross-referenced, visualisation tools such as drawings, matrices or diagrams are very important. They help to structure the mass of data collected.

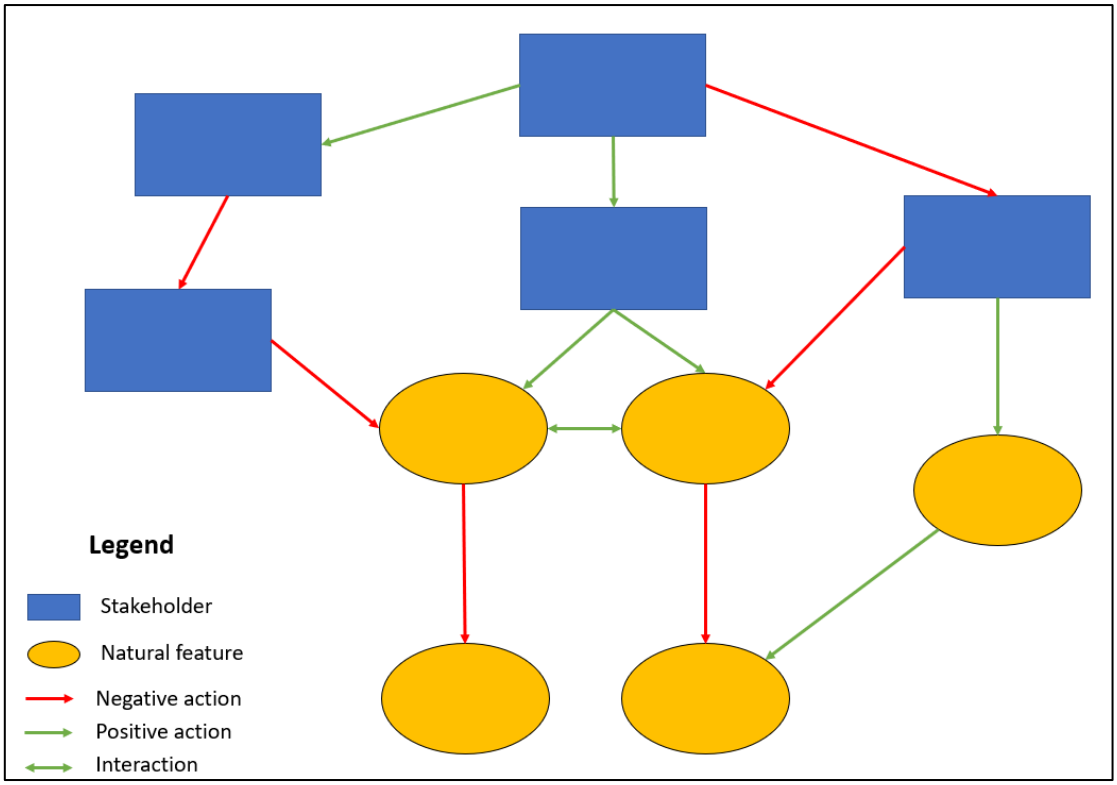

Figure 10: Example of a descriptive chart used in the analysis (Source: FNS-MI March 2023)

The choice was made to concentrate the research on the first two themes, the question of labels and tools being less relevant to present to the Livno audience (16 March) and requiring more detailed work. This exercise was extended and intensified during the last two weeks in Montpellier, in parallel with the writing of the report, until 31 March (date of submission).

III. Territorial Diagnosis

1. Characteristics of the study area

The first objective of the territorial diagnosis is to characterize the study area. Based on bibliographical research, observations and the interviews made on the field, this first part aims to define the "study area" by carrying out a landscape analysis.

Characterization of the study area aims to understand dynamics to be able to identify the possible pressures afterwards. To do this, the delimitation of the study area geographically and administratively is needed before exposing different land-uses that exist.

a. Administrative delimitation

The four karst poljes are in the Canton 10 of the federation of Bosnia and Herzegovina. It is on the West side of the state at the border with Croatia. The study area's delimitation is based on the municipalities which include the 4-karst poljes: Livanjsko polje, Kupreško polje, Glamočko polje and Duvanjsko polje (cf Figure 11 below).

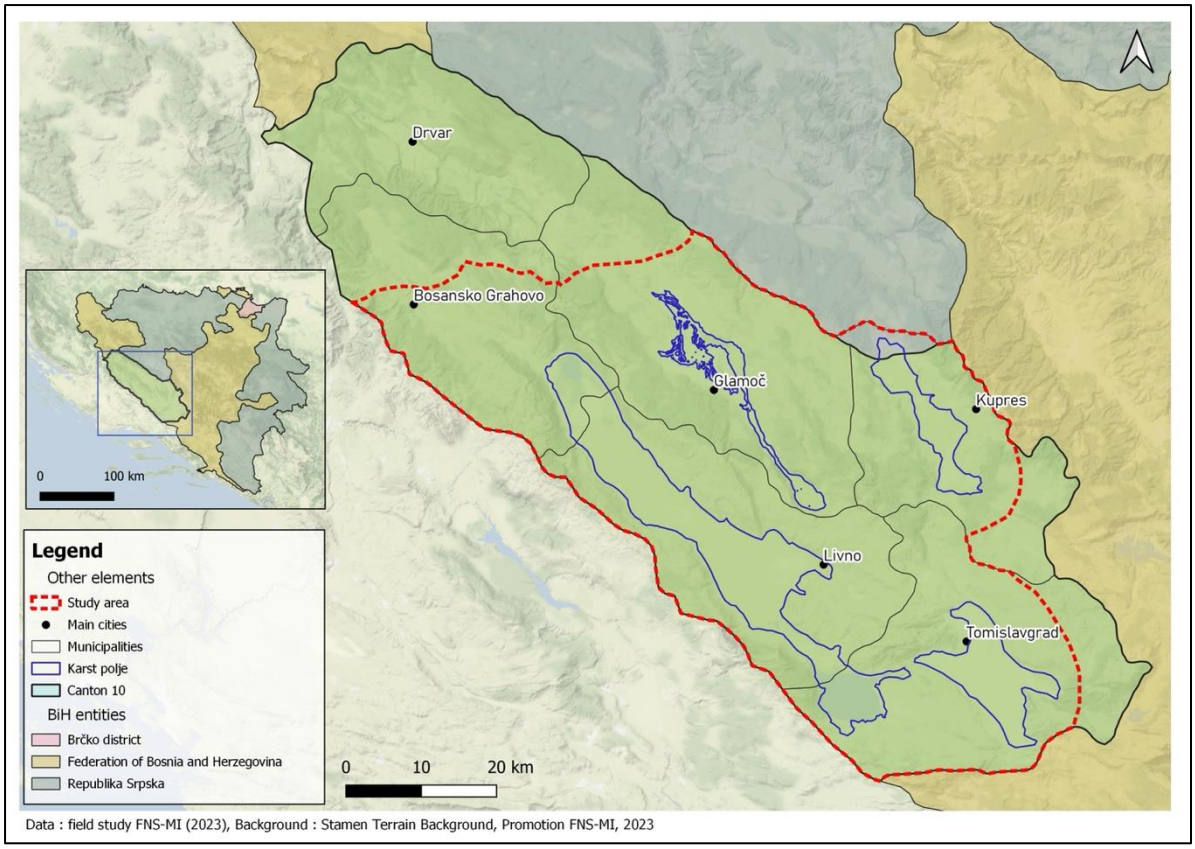

Figure 11: Map of the study area, QGIS (Production: FNS-MI March 2023)

- **Livanjsko polje** has an elongated shape and extends over almost all Livno municipality, including a southern part located in Tomislavgrad municipality and a northern part located in of Bosansko Grahovo municipality.

  It is the biggest polje of the state with a land-surface of 408 km^2 (Altitude: 700 m).

- **Duvanjsko polje** – located in Tomislavgrad municipality – has a land-surface of 125 km^2 (Altitude:865 m).
- **Glamočko polje** – located in Glamoč municipality – has a land-surface of 62.4 km^2 (Altitude: 883 m).
- **Kupreško polje** – located in Kupres municipality – has a surface of 81.2 km^2 (Altitude: 1,115 m). It goes through a small area in the *Republika Srpska*, but the current analysis does not take this part into account. Indeed, the administrative organization of RS is different from the FBiH as each sates' entity governs independently. This is why it is preferable to focus only on FBiH first in this current analysis.

The study area includes 5 out of the 6 municipalities of the Canton 10 concerned: Glamoč, Livno, Kupres, Bosansko Grahovo, Tomislavgrad. Indeed, areas outside the 4-karst poljes – like Drvar municipality located at the north – weren't visited for the territorial diagnosis. This is why the study area stops before the administrative delimitation of municipalities (Sackl *et al.*, 2014).

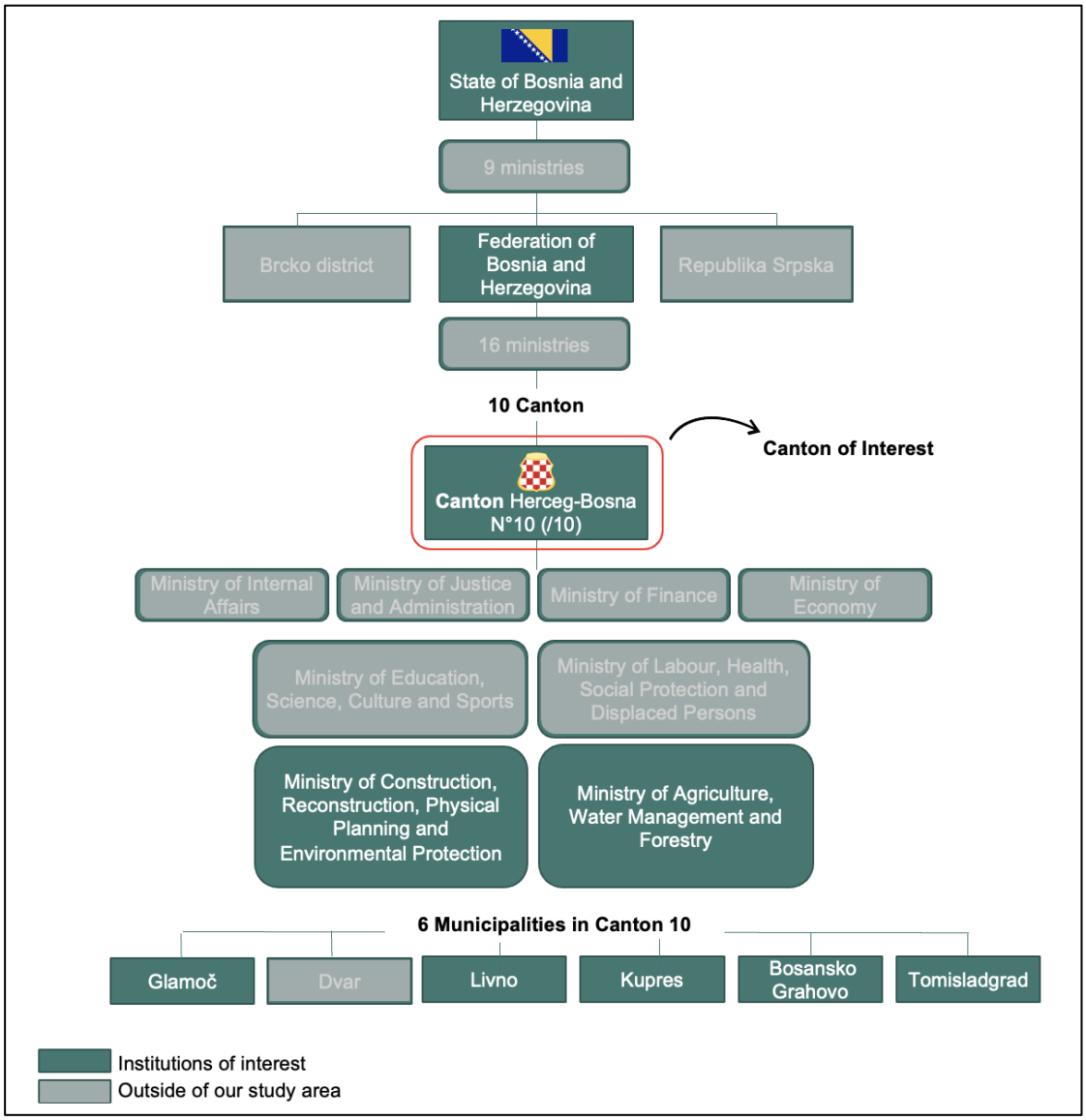

Figure 12: Schematic administrative representation of the study area (Source: FNS-MI March 2023)

In Canton 10, two main Ministries have been identified for the current analysis as "institution of interest": the Ministry of Construction, Reconstruction, Physical Planning and Environmental Protection, and the Ministry of Agriculture, Water Management and Forestry (Figure 12).

Municipalities have a local self-governance. Indeed, each municipality has a status which is consistent with FBiH Constitution, the Cantonal Constitution, and the Cantonal legislation. The Municipal Council and the Municipal Mayor are directly elected. For instance, the municipality of Tomislavgrad has the following authorities in charge: Urbanism, Legal right of ownership, Economy, Defenders, Investment, Building, Finance, and Agriculture (ET1). It should be quite the same organization in other municipalities. However, this division can change as municipalities are independent one to each other. This hometown's Tomislavgrad organization should not be taken as universal.

Now that the study area has been administratively and geographically delimited, it is appropriate to describe the different landscape units identified and activities running in this study area.

b. Landscape units & land use description

A landscape observation highlights landscape patterns. A Google Earth transect (cf Figure 9) confirms that there are regular landscape patterns in the study area. It illustrates the most complete topography sequence from Kupreško polje to Livanjsko polje through Glamočko polje.

These patterns can be found at different heights, and they drive the direction of underground waterflows. Indeed, the Figure 13 highlights the fact that the underground water system between karst poljes is connected: the water travels underground from Kupreško polje to Livanjsko polje and flows into the Adriatic Sea in Croatia.

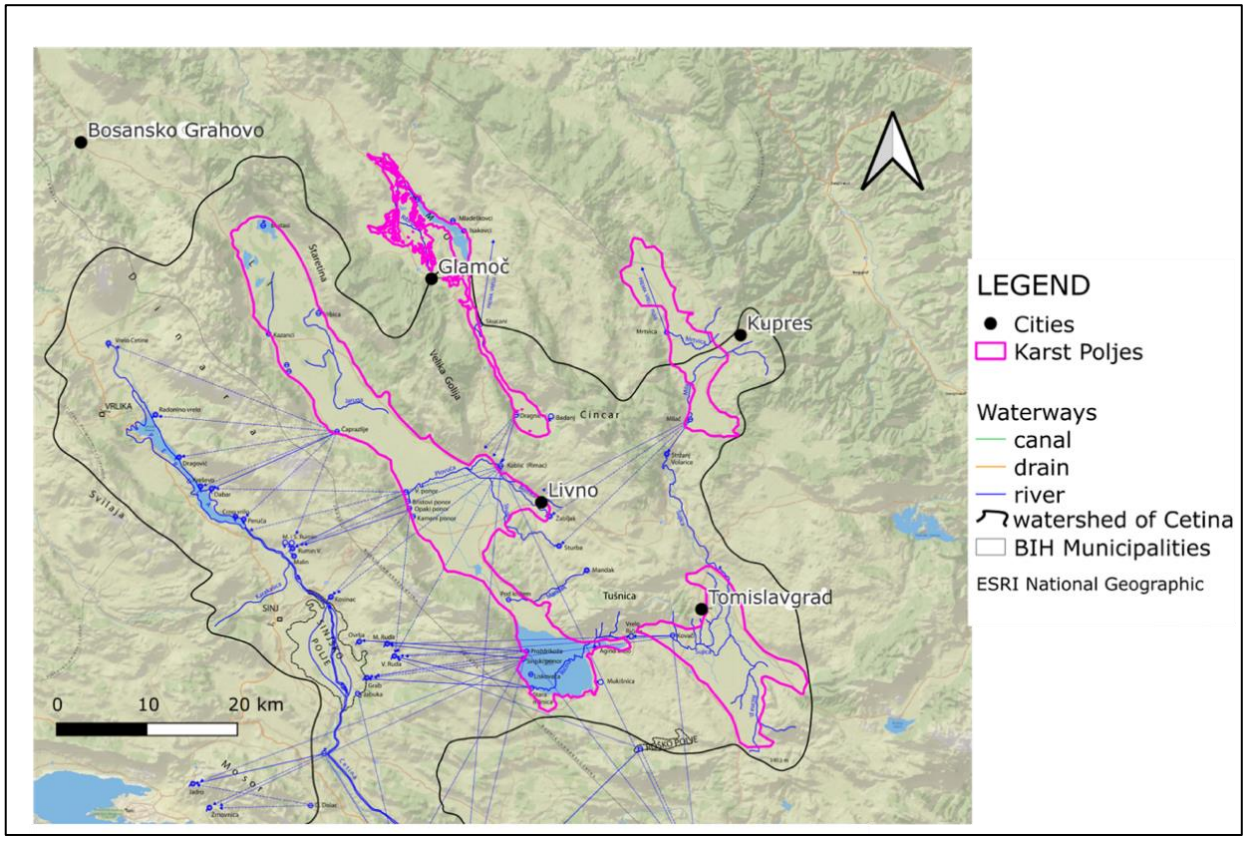

Figure 13: Underground waters of the Cetina watershed (Data: administrations from Yugoslavia period transmitted by WWF Dinarica, Production: FNS-MI March 2023)

However, these undergrounds waters are not directly observable.

Therefore, our observations on the field and with Google Earth transect highlights regular patterns of different heights and shapes. It reveals five landscapes units: karst poljes, benchland, slopes, karst plateaus, and crests which will be detailed in the next paragraph. Then, it is possible to represent those five units of schematic below (Figure 14).

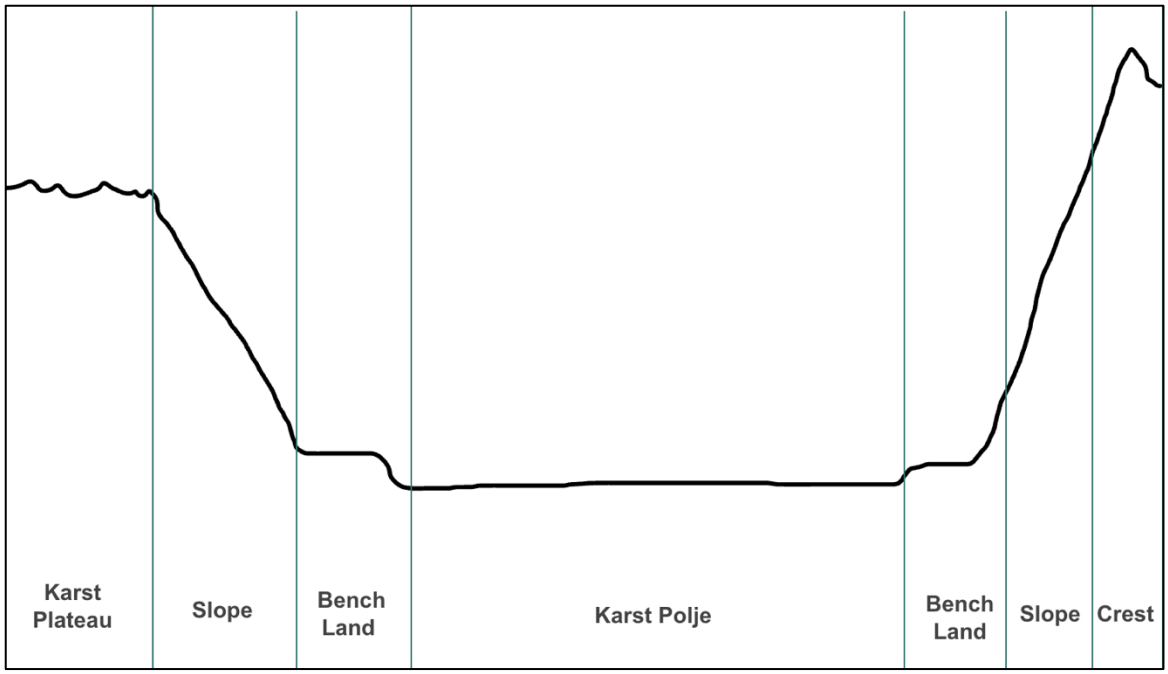

Figure 14: Schematic Transect (Source: FNS-MI March 2023)

The regular patterns can also be found when looking at the map of the different land use (Figure 15). The land use observed in the study area is very diverse, which can be explained by various landscapes. There is a clear difference of land use in and outside the poljes.

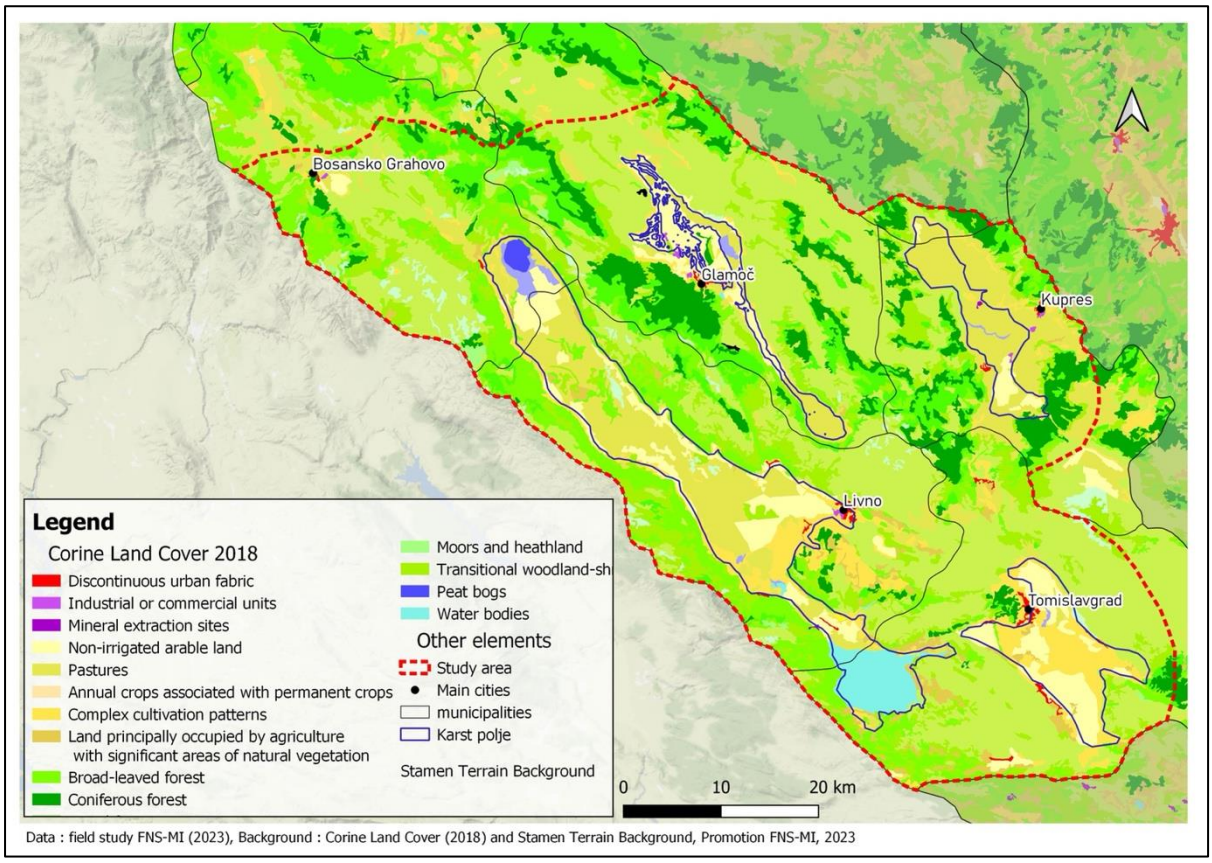

Figure 15: Map of the different land use in the study area using CLC layer, QGIS (Production: FNS-MI March 2023)

Each of these five landscapes units is defined by their pattern's characteristics (general description, key landscapes, and land-use).

Landscape Units	Characteristics	Sub-Units	Characteristics
Karst poljes	- Basin with flat karst floor - Surrounded by rocky walls - Large dimensions (kilometres or even tens kilometres in length and width) - Historically prized for their high fertility	Wetlands	- Transition zones between dry land and open water - Presence of fresh water - Soil saturated with water - Characteristic (and endemic) animal and plant species (reeds, amphibians)
		Lakes	
		Forests	- Low quality - Alluvial - Rarely exploited - Birch - Beech
		Rivers (channels & drains)	Very winding
		Underground water system: spring and ponors	- Connect poljes by a complex water network - Waste can be found
		Arable lands (used & abandoned)	- Temporarily flooded throughout the year - Can be burnt - Agriculture for potatoes, wheat, barley, corn, cabbage…
Benchlands	- Long, relatively narrow, rather level strip of land - Bounded by a difference in level above and below - Here the slopes are much steeper above	Villages	- Never flooded - Usable all year - Agriculture for cereals
		Farms	
		Arable lands (used & abandoned)	
		Sinkholes	Very fertile soil
		Stones field	Limestone rocks
Slopes	- Forested or not - For human activities or natural	Forests	- Species that have an adapted root system - Black and white pines plantation - Beech - Spruce
		Pastures	Depends on season
Karst plateaus	- Transition in between poljes - Limestone rocks dissolved by atmospheric agents (usually rain) - Rocks have various forms, giving rise to the phenomenon of karst erosion - Can be very windy	Sinkholes	Agriculture usually for self-consumption
		Pastures	Usually for self-consumption
		Stones field	Windfarms
		Wild horses	
Crests	- Line of high points in a relief - Separate two opposite slopes - Only found in high mountain ranges - Very windy - Not much vegetation visible		Windfarms

Table 2: Characteristics of the landscape units and sub-units (Source: FNS-MI March 2023)

Karst poljes

Karst poljes are very specific because they are large flat plains often flooded or interspersed with streams. Through the year, some parts are "*wetlands by themselves*" and some other parts are becoming "*dry by themselves*" (TT4). This is a specificity of karstic system.

Figure 16: Flooded area in Duvanjsko polje flooded (left) and lake in south of Glamočko polje (right) (Source: FNS-MI March 2023)

Figure 17: Ponor near Buško Lake – South of Livno Municipality (left); winding river and canyon near Šuica (right) (Source: FNS-MI March 2023)

These wetlands are biodiversity hotspots. Located between higher grounds, karst poljes are the study area's main geographical features. Key landscapes found here are lakes, wetlands, springs, ponors, and lands for agriculture. A small difference can be made between Livanjsko polje and the three others. Indeed, in the north of the Livanjsko polje it is possible to see low value broad-leaved forests and nowhere else in other karst poljes. On those, land uses observed are agriculture, peat extraction, and others.

First, agriculture is well-present but depends on the area located. Observations show that cultivation is mainly present in the flooded part of the polje. In fact, the fertility and thickness of the soil, the presence of water and the sparse distribution of rocks and stones make the flat parts of the poljes particularly interesting for farming. The Figure 15 provides a view of the

agricultural activities. It shows that the cultivation is gathered at the south part of the Livanjsko polje (near Buško Lake). There are some cultivation activities but in small proportion compared to the plains surface that seems to be for the majority not used. Potatoes, cereals and blackberries cultures for human consumption have been recorded in the EuroNatur report (Sackl *et al.*, 2014). Also, many barley cultures for cattle feeding have been observed in the whole study area. Also, new wine culture growing in Duvanjsko polje, even if "*It is rare to have grapes at this altitude"* explains TT2 in Tomislavgrad. The development of this activity is possible by exploiting a "*cepage from Switzerland which allow to put some wine farm at 950 m in Duvanjsko polje."* (TT2).

Figure 18: Kupres vineyard (Source: FNS-MI March 2023)

There is also black peat extraction company (for soil fertilizer and gardening). It is operating north of Livanjsko polje. It is visible on the map (Figure 15). Here, "Peatlands" (code CLC : 412 (European Environment Agency, 2009) refers to moist spongy soils consisting mainly of mosses and decomposed plant material, exploited peatlands or not. The existing company operates on an area of 770 hectares under a 30-years concession.

Benchlands

They are alternative slopes, long, relatively narrow, and gently sloping terrain bounded by steeper slopes clearly above. On benchlands there are mostly human activities because they remain out of flooding risk all over the year.

Figure 19 : Village on benchland near Buško Lake (Source: FNS-MI March 2023)

Land uses observed are human infrastructures such as villages and industries, arable lands, landfills, and dams.

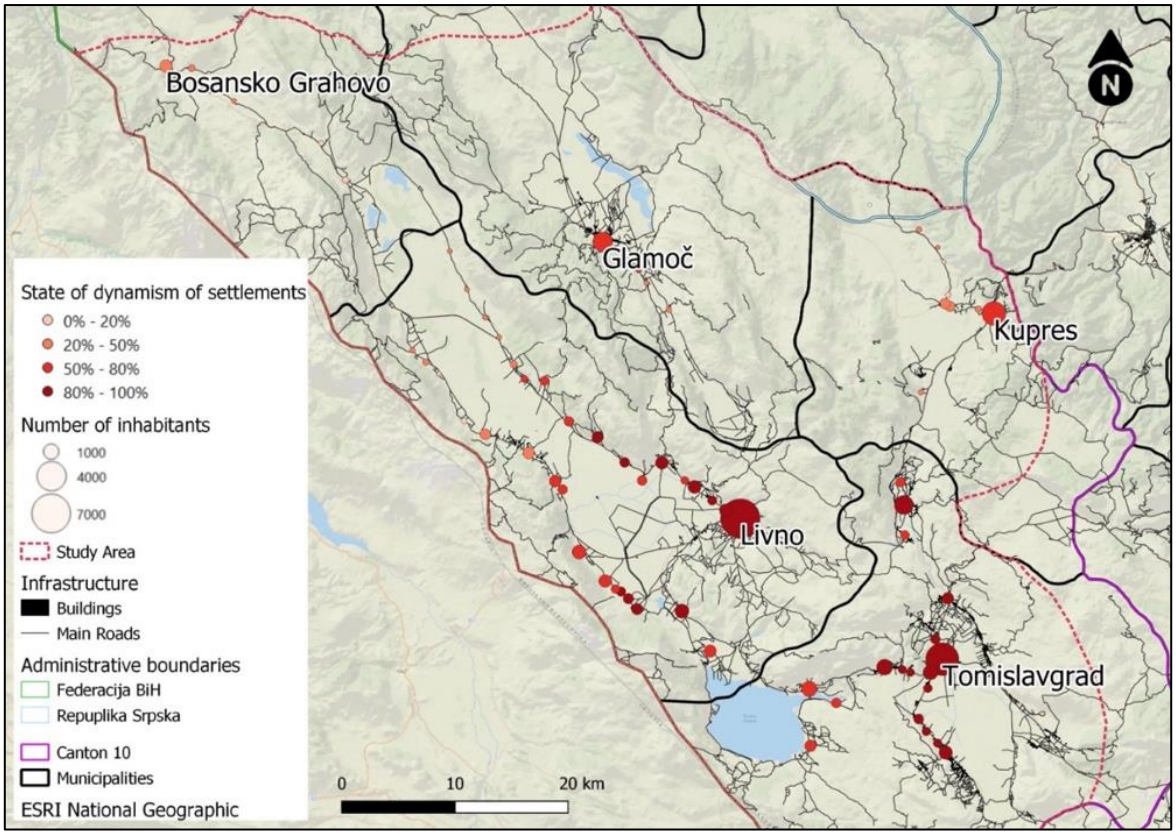

Figure 20: Dynamism of visited settlements, QGIS. (Production: FNS-MI March 2023)

Firstly, this map provides an overview of the territorial coverage that was carried out during the field phase. It completes the territorial analysis and gives an account of the current dynamics of the settlements that were visited. It seems that some areas are undergoing depopulation dynamics, some dwellings are completely ruined (Figure 21). The northern part of Livanjsko polje goes up while the Bosansko Grahovo population decline. This is the place where the most ruins have been visible in the study area. The main reason is the global depopulation of the country since the war started. At the national level: numbers are going from 4.3 million inhabitants in 1985 to approximately 3.2 million in 2020 (data from the World Bank). Furthermore, the Canton 10 is facing the most depopulation.

Figure 21: One of many abandoned houses in the north of the Livanjsko polje (Source: FNS-MI March 2023)

Depending on the dynamics observed, there may be very different environmental issues. Indeed, it is easier to notice illegal activities developing in areas that are gradually being abandoned, the appearance of open-air dumps, etc. In the expanding and dynamic areas, it is possible to see a progressive urbanization, more waste on the roadsides, more water pollution etc. For example, in Duvanjsko polje, the town of Tomislavgrad is expanding. Indeed, the urban center is developing, has been observed new activities setting up like vineyards and tourism. Between these two dynamics, there are many houses which are in good condition, but are completely closed. This corresponds to a seasonal population dynamic, which returns for the summer only sometimes named *gastarbajteri* (Siegel, 2022).

Second thing that has been noticed on benchlands during fieldwork was the number of rubbishes on the roadside and 2 open air landfill sites. One is in the north of Livanjsko polje and the other has been seen between Duvanjsko polje and Kupreško polje. It is a concern because it alters visual landscape and creates pollution of land and water. The population is used to depositing waste in caves and sinkholes because there are "*no official waste disposal units*" (TT3). Those caves may contain rare, undiscovered remains of the past that may be important for the history of the country and global archaeology (TT3).

Thirdly, it is also possible to see industrial activities. Some mineral extraction/processing companies and many sawmills are visible from the roadside and spread around the study area in benchlands. The wood industry seems to be well established in the area, as a lot of forests covers the slopes in between poljes. In the north of Glamoč, there is a large concentration of sawmills, as it is possible to point around eight companies in the same sector.

Slopes

They are slanted and provide an easy transition from the higher zones to the lowest. The main land use of slope is forest and pastures.

Different types of forests have been seen during fieldwork. It was possible to see broad-leaved forests as well as coniferous forests and mixed forests. Some black and white pine plantations are also visible on the roadside. Those forests seem to be planted 40-50 years ago, and after logging, or other cutting type. Pines are pioneers of forest cover and after them, come other types of valuable plants (PB1). It is possible to see those different types of forests on the map (Figure 15). In the Corine Land Cover legend (European Environment Agency, 2009), more details can be found about the characterisation of these elements, described as "Broad-leaved Forest". It corresponds to plant formations consisting mainly of trees, but also bushes and shrubs, dominated by deciduous forest species (code 311). It is the same thing for Coniferous forests, dominated by coniferous species (code 312). The mixed forest is dominated by neither of them (code 313).

Figure 22 : Black and white pine plantation on slopes (road from Livno to Tomislavgrad. (Source: FNS-MI March 2023)

Secondly, there are pasture on slopes. The pastoral vegetation of coastal karst areas is partly characterized by dry Mediterranean grasslands (hay meadows). And in some areas, it looks like expansive rocky pastures. These areas may include rocky surfaces, brambles, and bush (Sackl *et al.*, 2014)..

According to the land cover map, pasture is well-present especially at the center of the Livanjsko and Duvanjsko poljes (Figure 15). Also, the map “Land use of the study area” confirms that a lot of pasture are present at the center of Livanjsko polje. However, it does not show pasture on the hyper-center of Duvanjsko polje. Therefore, this observation does not allow to confirm or infirm that there is pasture at the center of Duvanjsko polje. This map shows a lot of pasture in Glamočko and Kupreško polje. Thus, direct observations confirm that there is pasture in both Glamočko and Kupreško polje also. Furthermore, cattle observed reveal the presence of pasture in the studied area (Figure 23).

Figure 23: Duvanjsko polje (big barn away) (Source: FNS-MI March 2023)

Figure 24: Duvanjsko polje under the snow (left) and sheep cattle grazing (right) (Source: FNS-MI March 2023)

Figure 25: Glamočko polje under the snow (left) and small sheep cattle (right) (Source: FNS-MI March 2023)

Karst plateaus

Karst plateaus- or causses are high limestone plateaus characteristic of the Dinaric Alps area. The key landscapes are plateaus and sinkholes. On those have been observed forest activities, pasture, landfill, and windfarms.

Figure 26: Kart plateau (left) and sinkhole (right) (Source: FNS-MI March 2023)

Mountain crests

The crests are the highest geographical features of the study area. They are the highest parts of the hills and mountains surrounding the poljes. It is mostly exposed to the wind; thus, windfarms are generally located on crests.

Figure 27: Mountain Crest (left) and windfarm at Tomislavgrad Municipality (Source: FNS-MI March 2023)

To have a better idea of their geographical position, these 5 landscapes units (karst poljes, benchlands, slopes, karst plateaus, mountain crests) have been represented in a map below (Figure 28).

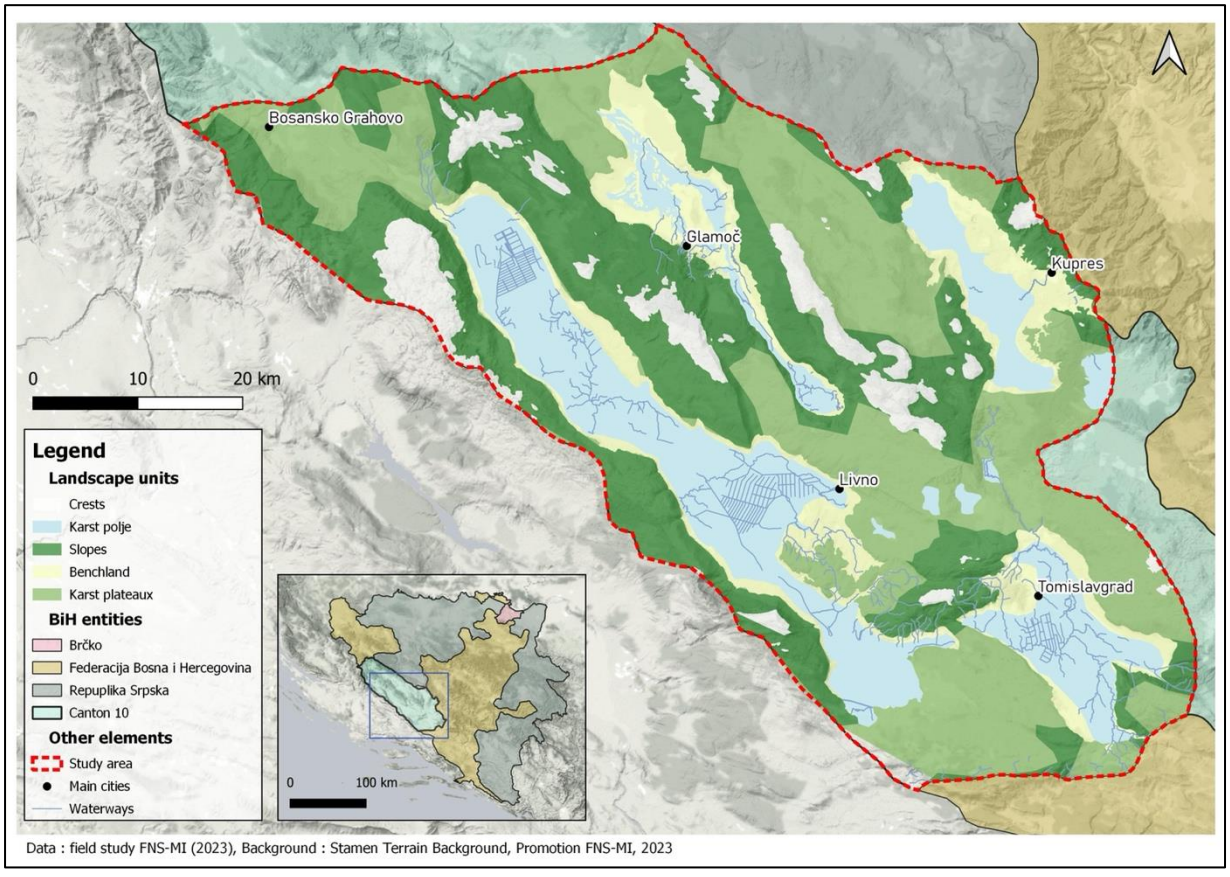

Figure 28: Map of the identified landscape units in the study area (Production: FNS-MI March 2023)

The activities just described can be a threat for natural attributes and landscape features. The next part focuses on identifying those natural attributes and the threats linked.

2. Identification, prioritization and spatialization of five environmental stakes affecting the study area

The landscape analysis combined with the data extracted from the interviews enabled to better understand the environmental context of the study area and to point out potential threats that impact this environment. First of all, a list of natural attributes was established, corresponding to remarkable natural elements of the territory which preservation is important. Then, several threats that impact these environmental attributes were identified. Finally, the goal was to extract from this the main environmental stakes on the study area, which result from the combination of the environmental attributes and the threats that weigh on them. Then, these environmental stakes were mapped on the study area to assess the importance of each of them in the different municipalities. From that, a classification was made to prioritize the environmental stakes depending on their impact level on the environment.

a. Identification of natural attributes

From all the environmental knowledge gathered during the interviews and the landscape analysis, four natural attributes were singled out. These attributes correspond to natural elements which preservation is important because of their uniqueness and their major role in the regulation of ecosystems. They can be described as follows:

- **Water quality and quantity.** In karst poljes, the hydrogeological system is very developed in both underground water systems and open-air water systems. This particularity creates unique ecosystems in this area with wetlands, lakes, rivers, ponors etc. Wetlands particularly host a very rich biodiversity and are considered as one of the most important ecosystem to preserve in the world. This preservation relies primarily on the maintenance of hydrological systems, and in particular on the parameters of water quality and quantity throughout the year. On this topic of water quality, an expert testifies:

  "*Springs in the kart poljes are full of water. The groundwater is very good to drink, with good physical characteristics, but it may contain bacteria from industries or households that cannot be filtered. This is due to the fact that the soil is not compact, so polluted water can easily infiltrate the soil and then end up in downstream sources.*" (WL1)

  For this reason, this natural attribute -the hydrological system- appeared to be very interesting from an ecological point of view since it represents a powerful indicator to evaluate the quality of wetlands present in karst poljes and therefore also to evaluate the biodiversity that nests there.

- **Unicity and integrity of the landscape.** As seen previously in the landscape analysis, the karst poljes are unique areas due to the presence of landscape units that are both very characteristic and distributed in an organized manner throughout the territory. In addition, karst poljes remain particularly rare and unique geological formations in the world, especially Livanjsko polje which is the the largest periodically flooded karst depression in the world. This landscape has also been shaped by agropastoralism for centuries as this activity maintains the wetland ecosystem against encroachment and afforestation. It has therefore a heritage value in some way. That is why the unity and

integrity of the landscape appeared as an important natural attribute to be preserved, due to their visual particularity.

- **Avifauna biodiversity.** Avifauna is a particularly important ecological aspect within the karst polje of Bosnia and Herzegovina, and especially for Livanjsko polje, which represents the most important wintering, migration, and breeding site for waterbirds and raptors in the country and a key site of the Central European Flyway. For example, different migratory species can be seen there such as Lesser Grey Shrike (*Lanius minor* or *ružičasti svračak* in local language), Eurasian Eagle-owl (*bubo bubo* or *euroazijska sova orao*) or Corncrake (*crex crex*). Moreover, 3 karst poljes (Livanjsko polje and Buško lake, Kupreško polje, Duvanjsko polje) of the study area are classified as Important Bird Areas by BirdLife International, which aims to secure the long-term conservation of sites that are of significant importance for birds and biodiversity (BirdLife International, 2023). Avifauna biodiversity is thus a major natural attribute to protect because a disturbance of this fauna could modify the migration paths on a large scale. In addition, thanks to this rich avifauna biodiversity, birdwatching has become a recreational activity and also a source of income for local people who launched their business in tourism. Here is the testimony of two of them *"we started to do birdwatching tours quite accidentally and we kind of linked it. My wife fell in love with birds!" (TL1)* This anchoring in the local communities highlights even more the need to protect avifauna biodiversity.

- **Endemic fauna (including aquatic fauna) and flora.** The karst poljes of Bosnia and Herzegovina have been little disturbed from an ecological point of view by human activities (such as pollution, urbanization, etc.), resulting in a high level of endemism in the fauna and flora. This endemism contributes to the resilience of local ecosystems and the maintenance of wetlands in particular, which is why it is a natural attribute to preserve. Concerning the aquatic fauna, five fish species are endemic to the Dinaric karst with small area of occupancy: *Telestes turskyi*, *Chondrostoma phoxinus* (minnow-nase or *podbila* in local language), *Squalius microlepis*, *Aulopyge huegelii* (dalmatian barbelgudgeon or *Dalmatinski mren* in local language) and *Phoxinellus alepidotus*. For terrestrial fauna, many protected species are also present as *Lanius minor* (lesser grey shrike or *ružičasti svračak*), *Canis lupus* (wolf or *vuk* in local language) and *Ursus arctos* (brown bear or *smeđi medvjed* in local language). Finally, for the endemic flora, many plant species are important to protect for the conservation of local biodiversity, such as *Sesleria uliginosa* (*Serija blata* in local language), *Serratula lycopifolia* (or *Klasea lycopifolia*), or *Centaurea angustifolia* (perennial cornflower or *Višegodišnji različak* in local language) (Stumberger and Gotovac, 2008). Mushrooms, which are part of the local flora, are also interesting bioindicators to assess the quality of the ecosystem, such as *Scutellinia peloponnesiaca*, *Lamprospora leptodictya*, or *Scutellinia subhirtella* (Sackl and al., 2019).

This list represents a selection of the natural attributes that appeared to be most relevant and important to the interviews and analyses conducted, however it should not be seen as an exhaustive list. A selection was made based on those that seemed to be the most important from an ecological point of view. For example, it was found that the attribute of water quality and quantity covered both biodiversity and landscape aspects. This means that by taking this attribute as a reference, biodiversity and landscape attributes will also be taken into account.

These attributes will then be used as baseline indicators to assess potential environmental impacts on the study area.

b. Identification of environmental threats

Once these natural attributes of the territory were identified, the goal was to determine the threats that could potentially impact them. To do this, all the different activities and dynamics of the territory were listed to see if they could represent a threat to the environment. The activities taken into account are of all types: agriculture, breeding, forestry, land clearing, hydrological and energy infrastructures, etc. The work was to determine the impact (positive, negative or neutral) of each activity on the four natural attributes previously listed. This analysis was based on field observations as well as testimonies collected during interviews, which made it possible to measure these impacts in a weighted manner. For example, some interviewees claimed that there were no specific problems with illegal dumping, yet the team identified many such problems during its fieldwork. Therefore, the final decision was to still consider this activity as a threat to the environment because, from the observations made, it was deduced that this waste could have an impact on water quality. Thus, both sources of information were considered, but the final decisions were made subjectively, based on the team's perception and knowledge.

As a result of this analysis, 10 main threats were identified:

- **No water filtration system**. This leads to a major problem of water pollution because wastewater from households and water polluted by livestock effluents are discharged directly into nature without being purified. In particular for nitrate pollution from agricultural fertilizers, a water researcher explains: *"Nitrate pollution is the hardest to clean because the process is complicated and expensive"* (WL1). Concerning pollution form households, he adds: *"These pollutions happen all the time. For example, faecal pollution from Glamoč can come here in Livno and appear in the spring. Because the soil is not compact and flows arrive without filtration. The only solution is to disinfect it. There are several ways to do it, depending on which chemical is used"* (WL1). There is also a hypothesis to be made concerning the wastewater cleaning system of certain industries such as cheese producers, which could participate in water pollution.

- **Windfarms.** They are mainly present on the ridge areas and in the height of the karst poljes because of the strong exposure to the winds. However, windmills have a major impact on biodiversity and in particular on birds that do not always perceive the blades of the propellers. A member of an ornithological organization testifies: *"We are very concerned about windmills because they are disturbing birds and animals" (TL1)*. A member of the national electricity company also recognizes this threat to the birds: "*At first we had problems because some birds were killed by windfarms*" (EnL2). Furthermore, wind turbines represent a threat to the integrity of the landscape. This is accentuated by the increasing number of wind projects registered in the study area, and by the failure of impact studies that minimize the effects of these installations on the environment.

- **Intensive agriculture/breeding.** Although the area is experiencing and a significant decline in population, a rural exodus and a significant decline in population over the last 30 years news farms are being created with significant investment. These farms

are often . These new farms often focus on livestock farming, with large herds (500 cows, 1000 ewes) producing cheese or meat. We can speculate that the intensification of livestock farming and the concentration of animals has resulted in an increase in the use of phytosanitary products and a massive discharge of effluents, which has a direct impact on water quality. In addition, the increase in intensive livestock farming could also require more water resources and thus impact the amount of water available in the karst poles.

- **Abandoned lands.** They are particularly present in the study area, due to the massive exodus after the war. The main threat they pose is the change in land use, from agricultural activity to progressive land clearing. This results in afforestation in the core areas of the karst poles, thus modifying the wetland ecosystem shaped and maintained for centuries by agriculture.

- **Hydrological infrastructures (hydro-power dams, drains etc.).** Important hydraulic works were carried out during the Yugoslav period, particularly at Livanjsko polje. Several amendments, canals, irrigated areas and a retention lake (Buško Lake) were built in the 1970's to enable agricultural development in the south of the polje, but above all to power a hydroelectric plant now located in Croatia. These infrastructures have impacts mainly on water cycles since they capture or release water without respecting the seasonality of wetlands. There may therefore be a threat to the quantity of water but also to the aquatic fauna, which is very dependent on this seasonality. Finally, large infrastructures such as dams can also alter the visual quality of landscapes. Various projects of hydro-power dams are underway or finalized in the region, such as one in Livno which will be finished in 7 years, and one on the Buško Lake.

- **Urbanization.** This threat mainly concerns water quality because of household pollution as mentioned above, but also affects the visual integrity of the landscape. However, this threat is confined to certain areas near Livno and Tomislavgrad. It follows the rural exodus and the return of the population to their hometowns several years after the war. This urbanization is mainly characterized by urban sprawl and the construction of second homes.

- **Open-air landfills.** These are often illegal landfills and thus affect the quality of the landscapes as well as water quality. But the problem also comes from the fact that there is almost no waste management, as testified by a member of the waste and water management agency: "*Collected Garbage is buried in the land. Burning and recycling are not part of the local practice as it demands more funds*" (PK2). Thus, it could harm certain tourist activities as testified by this tourist agency manager "*Open-air landfills are the biggest problem in this area, and I can say in all BiH. We don't have conscious about that and there is a terrible situation with that*" (TL2).

- **Solar-power panels.** Their main impact concerns the disturbance of migratory birds due to the reflection of sunlight, thus altering their trajectory. Solar panels, when installed massively, can also disrupt the uniqueness of the landscape. A member of the national electricity company testifies: *"Solar power plant in Livanjsko polje, for instance, cannot work because of Ramsar"* (EnL2). Thus it is recognized that this kind

of energy production has an impact on wetlands, since Ramsar aims to protect these areas.

- **Peat extraction.** This activity persists in Livanjsko polje particularly and disturbs the wetland ecosystem due to the extraction of underground resources. It therefore has an impact on endemic fauna and flora as well as on birds because wetlands are important breeding areas.

- **Poaching.** This threat particularly concerns migratory birds that nest in karst poljes throughout the year. People who are doing birdwatching tours can clearly see that poaching threat: *"There all a lot of Italian people killing the birds and transporting them. It is forbidden but many people organize that kind of tourism tours and policemen cannot do anything against it"* (TL1).

Other threats were identified during the field study but were not selected as having sufficient impacts to threaten natural attributes. This is the case for wildfire, which was initially identified as a potential threat. However, as the interviews progressed, the team realized that this was a traditional practice that was becoming more and more of a minority over time. The initial hypothesis was therefore not validated because it was not a real threat to the local fauna and flora. However, it is possible that the time of the survey did not allow for a full understanding of this threat. All of the threats listed here are therefore to be put into perspective as they were the subject of a incomplete and time-limited field work and perhaps imperfect analysis.

Finally, all these threats and their impacts on the different natural attributes have been summarized in the following diagram (cf Figure 29). The first observation that can be made is that threats can affect multiple attributes at once. A first analysis would therefore consider that the more a threat has multiple impacts, the more important it is to consider. The second observation is that not all attributes are impacted in the same way. Thus, one attribute being highly impacted will be considered more important than another. However, this diagram only describes the relationships between attributes and threats but does not quantify these relationships. Therefore, an attribute with multiple threats will not necessarily be the most vulnerable attribute if all threats have a low impact on it. The observations made on the diagram should therefore be relativized.

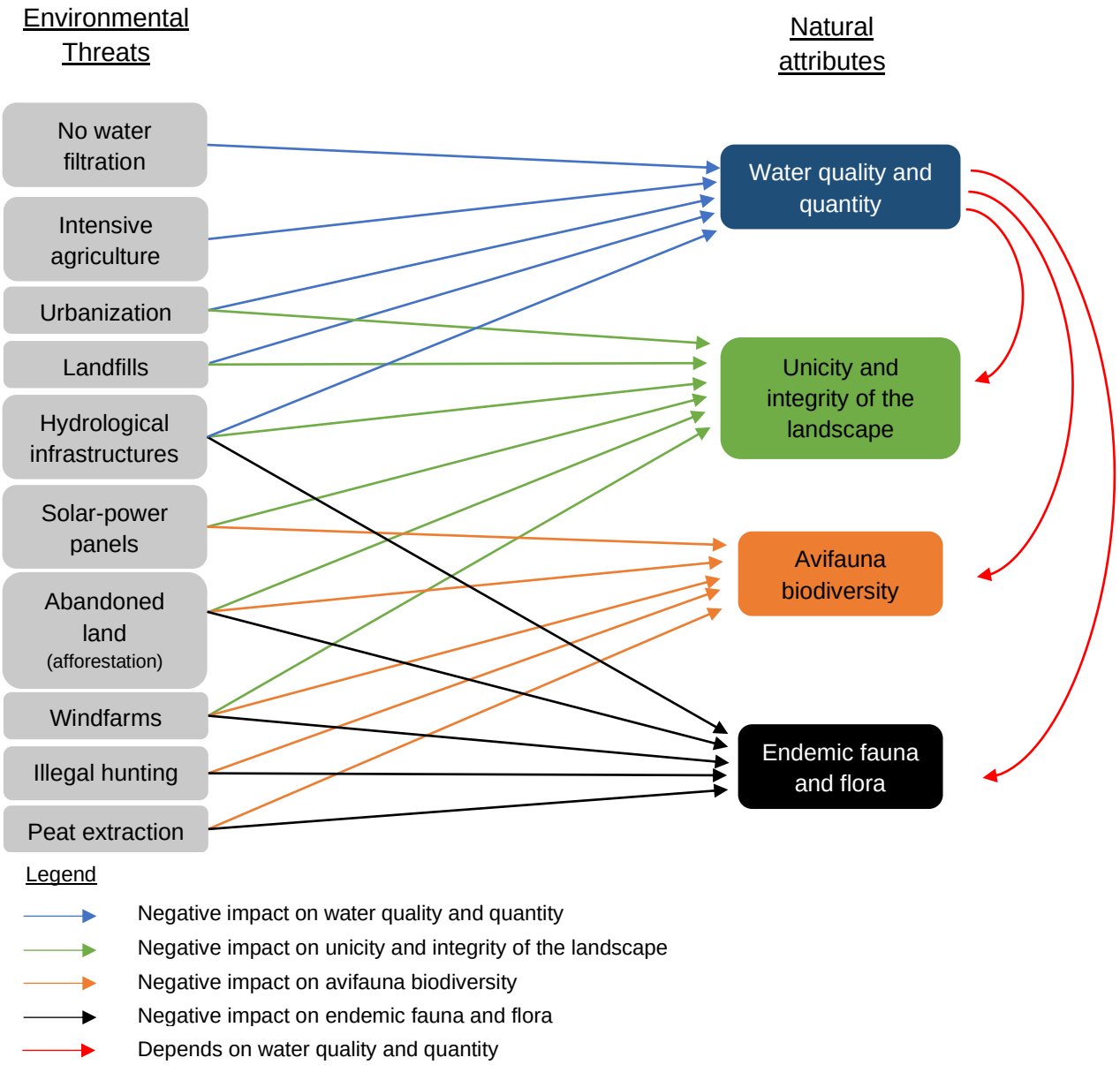

Figure 29: Diagram showing the different environmental threats and their impact on the natural attributes, *(Source: FNS-MI March 2023)*

c. Definition of environmental stakes

The previous work on identification of the environmental threats has allowed to have a more precise idea of the most vulnerable natural attributes and therefore that must be protected as a priority. The goal was then to bring out environmental issues, defined as the result of the addition of vulnerability of natural attributes and impacts on them:

Environmental stakes = Natural attributes + environmental threats

These issues will constitute the normative frame of reference for the SEMA methodology and will form the basis for future thinking on environmental management.

As mentioned above, the ranking of environmental impacts is difficult to estimate given the lack of quantitative information A subjective decision was therefore taken by the team when

deciding the importance of the various issues. As the previous chart shows, not all natural attributes are impacted by the same number of threats. For example, the uniqueness and integrity of landscapes appears to be more threatened than other attributes. However, it was noted that the last three attributes depended on the first, namely water quality and quantity. For this reason, the attribute of water quality and quantity was considered the one to be protected as a priority. Secondly, the different threats for each attribute were analyzed to see if they had the same environmental impact. For example, for the attribute water quality and quantity, nearly all the threats play a role in the degradation of water quality, namely the lack of filtration systems, landfills, urbanization, and intensive agriculture. Only water infrastructures do not impact water quality but its quantity, so this threat was dealt separately. From this analysis, it emerged that there is a major stake on water pollution, which results from both the importance of water quality for biodiversity and the number of threats it faces.

Regarding the threat of water quantity, particularly because of hydrological infrastructure, it was concluded that the main attribute that was threatened was aquatic biodiversity. Indeed, a discontinuity of hydrological systems and in particular a disruption of seasonal water cycles are detrimental to this biodiversity. A second stake was therefore defined on the fragmentation of the hydrogeological continuity.

Then, as far as avifauna is concerned, an issue of habitat fragmentation has been defined. This fragmentation is mainly due to energy infrastructures such as wind turbines or solar panels which disturb the migration paths of birds. Such disturbances could have serious consequences on the presence of birds and therefore on the regulation of the whole ecosystem.

Another issue was also identified regarding the visual alteration of landscapes. Indeed, the karst poljes constitute unique landscapes in the world but can be altered by numerous installations and human activities such as dams, afforestation, or landfills. It is therefore an important stake to be taken into account, especially since the visual quality of the landscapes increases the awareness of the local population to environmental protection.

Finally, the last issue identified concerns the degradation of the flora. Although this issue was less emphasized during the various interviews and landscape analyses, it was very present in the literature concerning the study area. Indeed, the karst poljes are home to a very rich biodiversity of flora, including many species of flowers and fungi. However, the various activities present on the territory such as intensive agriculture or landfills also constitute a potential threat for this endemic flora. This stake therefore appeared to be important to take into account.

These 5 environmental stakes have been summarized in the table below (cf Table 3), including the natural attributes they address and their respective threats. They constitute the normative reference frame which will be used as a basis for the continuation of the analyses.

Stakes	Water pollution	Fragmentation of birds' habitats	Landscape alteration	Fragmentation of hydrogeological continuity	Degradation of flora
Natural attributes concerned	- Water quality and quantity - Avifauna - Aquatic fauna	- Avifauna (including migratory birds)	- Pastures - Wetlands - Karst plateaus - Crests - Forests - Cultural elements (ruins)	- Aquatic fauna - Wetlands	- Endemic Flora - Mushrooms - Insects
Environ-mental threats concerned	- No filtration system - Intensive agriculture/ breeding - Waste (landfills)	- Windmills - Peat extraction - Illegal hunting - Abandoned lands (afforestation)	- Waste (landfills) - Windmills - Hydrological infrastructures (dams etc.) - Urbanization - Solar power plants - Abandoned lands (afforestation)	- Hydrological infrastructures (dams etc.) - Activities that consume a massive amount of water (intensive agriculture/ breeding, mining etc.)	- Intensive agriculture/ breeding - Peat extraction - Energy production projects (windmills, hydro-power dams etc.)

Table 3: Environmental issues and their associated natural attributes and threats, *(Source: FNS-MI March 2023)*

3. Spatialization of pressures per environmental stake

The different pressures are spread unevenly on the territory. Some attributes are more precious in some specific zones, whereas some specific pressures can be found everywhere. To further strengthen the territorial diagnosis, it is necessary to have a better understanding of all existing threats and their location on the study area.

a. Pressures causing water pollution

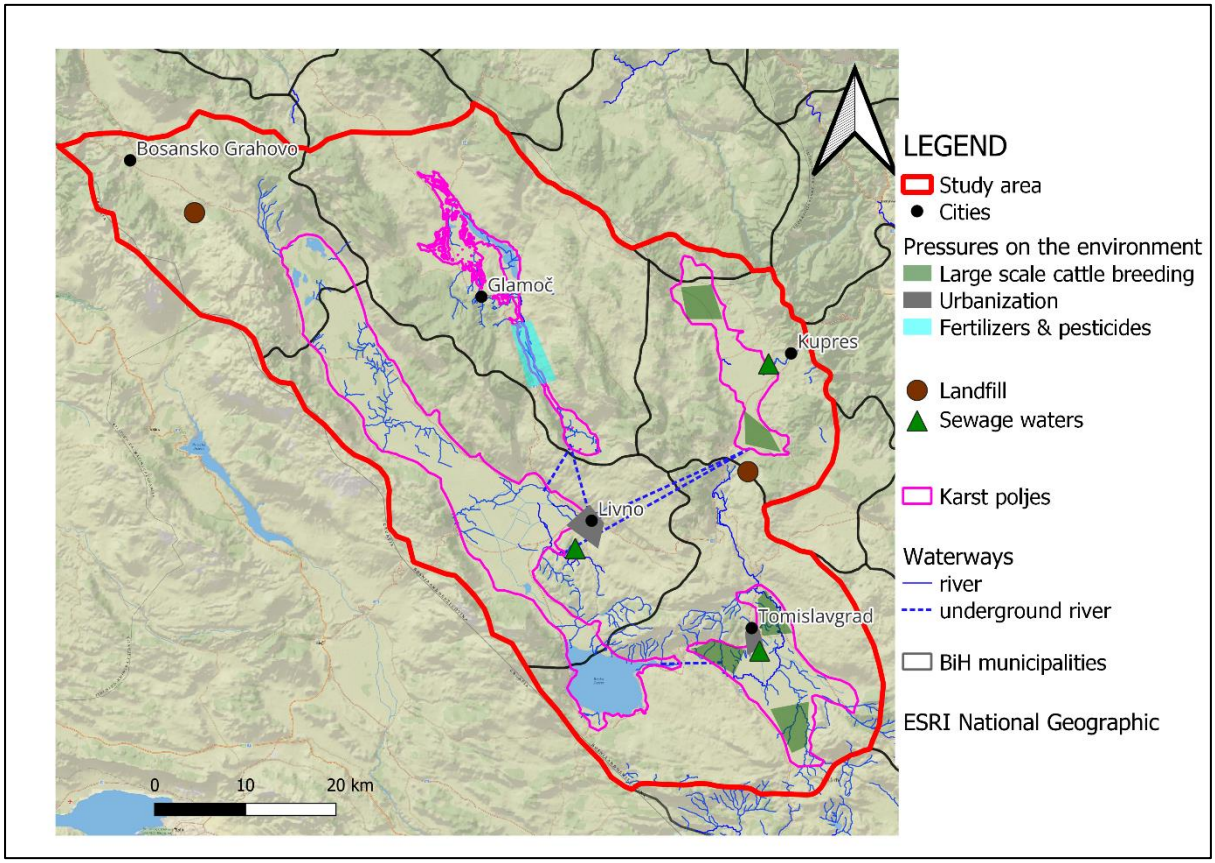

Figure 30: Map of the pressures causing water pollution in the study area, (QGIS, Production: FNS-MI 2022-2023)

Several pressures are identified for this first environmental stake:

- **Large scale cattle breeding**. The data compiled showed that this phenomenon mostly happens in the landscape unit karst polje, the flattest and more accessible to cows, out of the five types of landscape units. And this intensification of agriculture, though there are some plans in Livanjsko polje for the future, for now mostly happens in Duvanjsko polje and Kupreško polje. After interviewing around fifteen farmers, we know that there are large herds in the area. This study should be backed up by an in-depth analysis of farming practices around these herds. It can be hypothesised that some of these beef and sheep farms are essentially pastoral and help to maintain open landscapes, whereas others, such as pig and dairy farms, may be exclusively cowshed-based and generate large quantities of effluent that contributes to water pollution.

- **Sewage waters.** Untreated, coming from cities are an issue in all settlements. But the bigger the city, the most sewage it emits and the direr the issue. Livno and Tomislavgrad being the largest cities of the study area, it is there that the pressure is greater. The large number of second homes also raises the question of how to calibrate evacuation systems for large seasonal peaks in population.

- **Urbanization**. Around the growing cities that are Tomislavgrad and Livno, new construction projects, rising number of citizens and increasing demand in freshwater and supply of grey water are pressures that local water management agencies evoked. The territory being mostly rural, this specific pressure is only located very close to Livno and Tomislavgrad.

- **Fertilizers and pesticides**. Some crops culture heavily rely on chemicals in order to be productive. The Glamočko potato, which culture is located on the narrow part of Glamočko polje, was pointed out as using an important quantity of these products. However, the production of organic food being negligeable in the study area, there could be several other sites not identified on this map that would use fertilizers and pesticides, thus polluting water.

- **Landfills**. Whether legal or illegal, landfills also play a role in water pollution since rainfalls will carry detritus in rivers and impact the water quality. Two landfills were placed on this map, one in Bosansko Grahovo and another south of Kupres – though many more could exist.

A key point to understanding the importance of this stake is the interconnectivity of the landscape units and the poljes of the study area in terms of hydrology, (cf Figure 13). Kupreško waters flow to Duvanjsko, to Livanjsko, and up North to another watershed basin. Duvanjsko waters flow to Livanjsko and Croatia. Glamočko waters partly flow north to the Black Sea watershed basin, and south to Livanjsko. This means that any pollution originating in the study zone will end up polluting downstream poljes, namely Livanjsko, where this pressure is thus multiplied.

b. Pressures causing fragmentation of birds' habitats

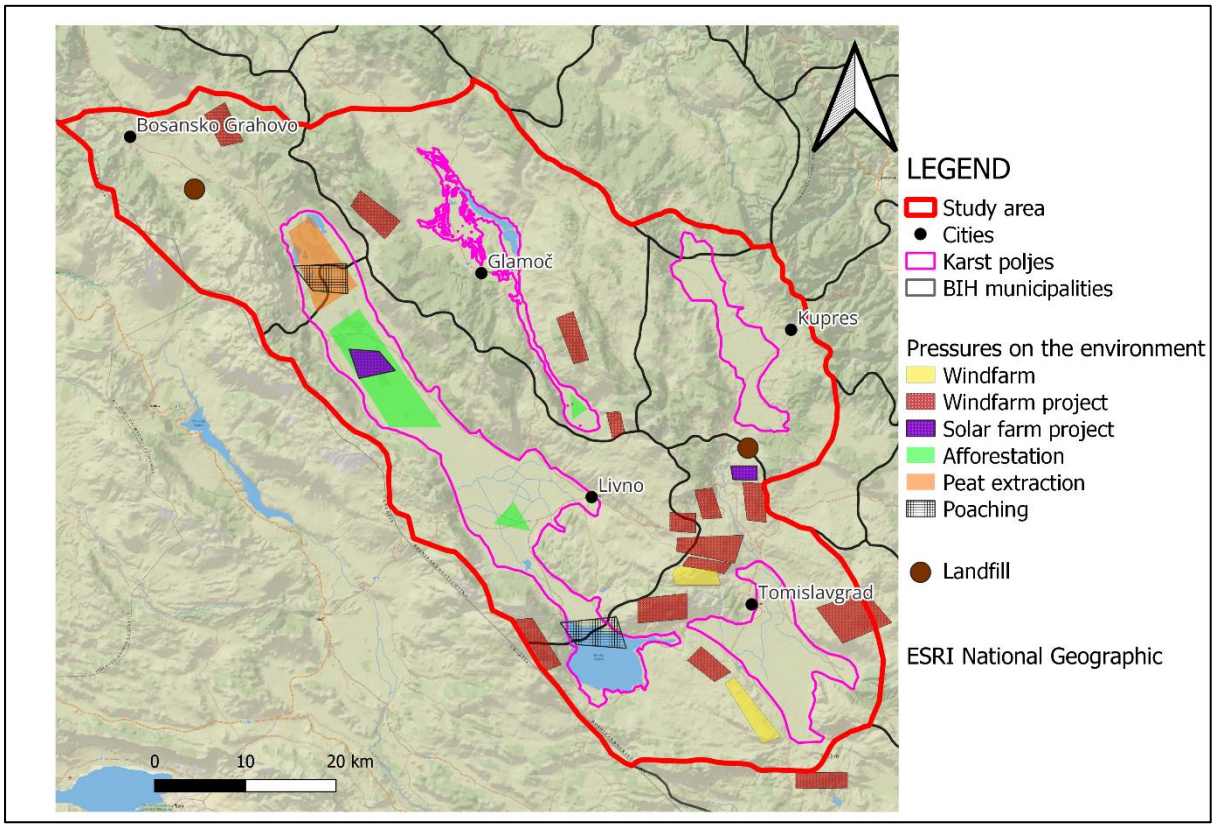

Figure 31: Map of the pressures causing fragmentation of birds' habitats in the study area, QGIS, FNS-MI 2022-2023

Eight pressures that have consequences on the continuity of avifauna habitat were identified and spatialized:

- **Windfarm**. Two windfarms have been functional for a few years in the study area: Mesihovina southwest of Duvanjsko polje and Jelovača northwest of Tomislavgrad. The two projects put together account for 40 turbines of 2 MW that border Duvanjsko et Livanjsko polje. This pressure is located in a single municipality, but this region being a migratory corridor for many vulnerable species, their positioning right at the exit of Livanjsko polje could be an issue for the migratory birds.

- **Windfarm projects**. At least fourteen windfarm projects are ongoing in the study area (cf Annexe 5) and one just past the southern border of Tomislavgrad municipality. These projects are at different advancement levels, some being currently built in March 2023, like Ivovik north of Tomislavgrad (EnL2), others having just obtained their authorization from the Federation. The numbers of turbines are known only for the most advanced projects, but a first estimate based on the published figures would raise the current number from 40 to 240, with at least three different heights. As the map shows there is a very high concentration of projects in the plateaux between Livno and Tomislavgrad, that gathers more than half of the future projects. In the middle of the

four poljes, just south of the largest polje, this could create an important barrier for avifauna, preventing their passage or even killing some of them. This environmental issue is more detail in the discussion, in the part III.5.d..

- **Solar farm projects**. Two large solar farm projects are in the making in the study area (cf Annexe 5). One north of Tomislavgrad, that is well advanced and that should be operation by the end of 2023; and another in the centre of Livanjsko polje, which is still to be started. This last one is supposed to be on a very large surface, in an otherwise rather preserved environment, close to the local birds' hotspot north of the polje and could have non negligible consequences on the local ecosystem (artificialization of the soils, wood clearing, soils compacting microclimates above and below panels), that would impact avifauna.

- **Afforestation**. This phenomenon is mostly visible in Livanjsko polje, though it also happens at a smaller and more fragmented scale in all four poljes. Right in the middle of the larger polje of the area, where avifauna biodiversity is the richest, this land use change could reduce meadows' fauna and flora biodiversity and quantity and lead to birds having to go hunt elsewhere.

- **Peat extraction**. North of Livanjsko polje, on a 770 ha area, the company Eko Terra has been extracting peat since 1996. This company has a 30-year operating concession in the municipality of Bosansko Grahovo. The peat is packaged either in small bags (between 10 and 20 litres) for sale to private individuals and in garden centres, or in larger bags (around 80 litres) as fertiliser for agricultural businesses. This area is a wetland, rich in black peat, and seen as a haven for many migrating birds and a reproduction spot for several other avifauna species. It is again Livanjsko polje that is most impacted here, and that sees one of its most important ecosystems for birds being drained by the industry. Though there is only one company and one site that legally exploits peat in the area, it is not impossible that others do so illegally – peat-rich land is common in the regularly flooded parts of the four poljes.

- **Poaching**. Poaching of rare birds again mostly happens in Livanjsko polje, where the number and diversity of birds is highest. Two zones, near the wetlands up north and the Buško lake down south were identified as preferred by poachers. They match the zoning proposed by the landscape protection law, which aims to put these areas under the highest level of protection to stop any harm done to the avifauna.

- **Landfills**. As said above, two landfills were identified and placed on the map though many exist throughout the study area.

Polluted waters, caused by the pressures, also has an impact on all biodiversity, including avifauna.

c. Pressures causing landscape alteration

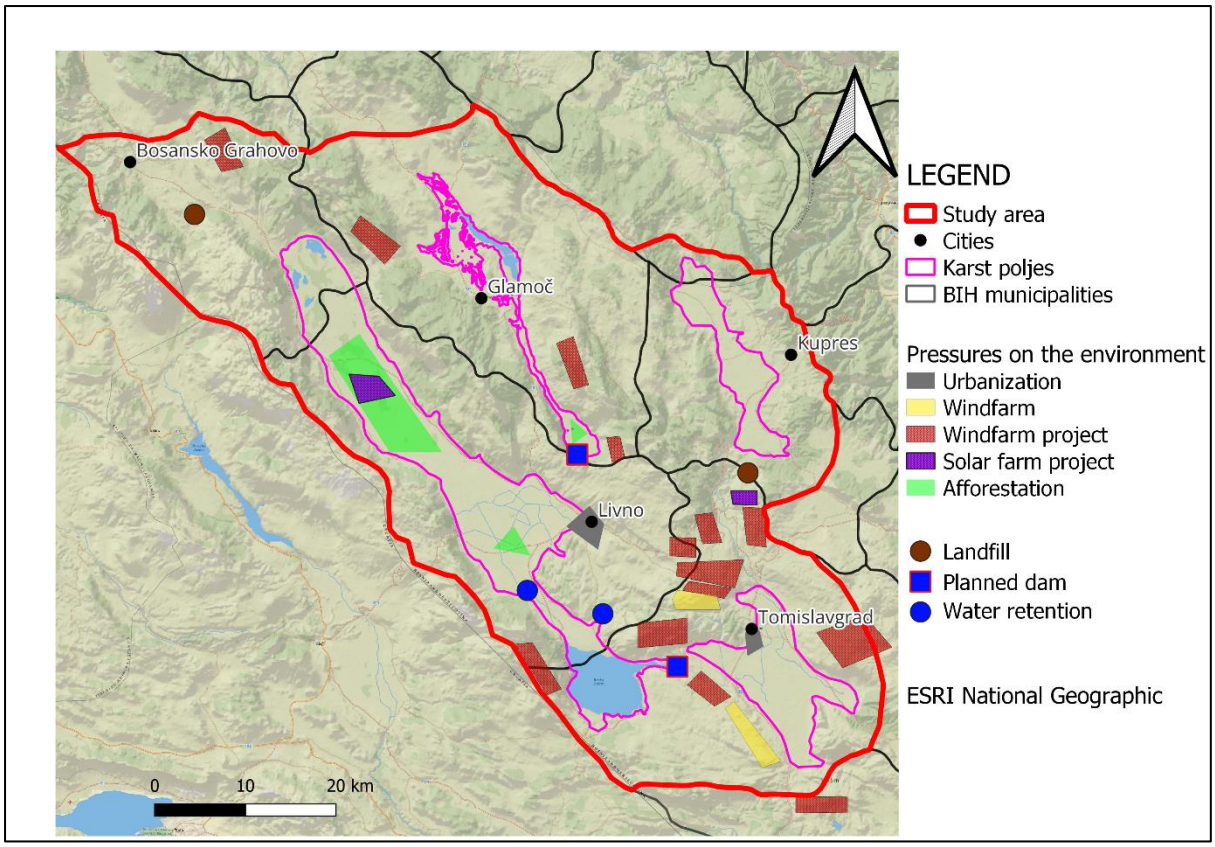

Figure 32: Map of the pressures causing landscape alteration, QGIS, FNS-MI 2022-2023

Several notable pressures can be identified that alter the integrity of the landscape. Some, like windfarms or afforestation, already contributed to threaten other attributes.

- **Urbanization**. Quite visible in Livno and obvious in Tomislavgrad, the cities spread to the outskirts and buildings emerge here and there. Though both towns are far from colonizing the whole poljes, their progress is still noticeable and modifies the landscape.

- **Windfarm and windfarm projects**. Most visible recent infrastructure, the two existing windfarms are visible from anywhere in Duvanjsko polje, as well as from Livno. If 200 new turbines (cf Annexe 5) built in the coming years, the mountainous landscape will be drastically changed, and its rather untouched aspect will be no more.

- **Solar farm projects.** Covering hectares of land, these projects change not only the ecosystem but also the look of the places they are built in. The clearings needed to erect them will be artificialized, and the previous land cover clear-cut if deemed necessary.

- **Afforestation**. One of the main changes in the poljes. Since lands are less and less cultivated, the once open landscape is slowly closing as forests start to grow in the middle of the fields. As explained above, biodiversity will be impacted, but so will the visual aspect of the region. Livanjsko and Glamočko poljes are the most concerned by this threat, as they are the most subject to land abandonment.

- **Planned dams**. When these projects are operational, reservoir lakes and canals will need to be built and existing streams could be deviated, which will change the current water mapping on the surface and underground of the territory. Livanjsko polje is most impacted here, as it is linked to the two projects.

- **Landfills.** With little to no burning or recycling stations in the Canton, landfills are growing in size and numbers, and heavily degrade the beauty of the region.

d. Pressures causing hydrological discontinuity

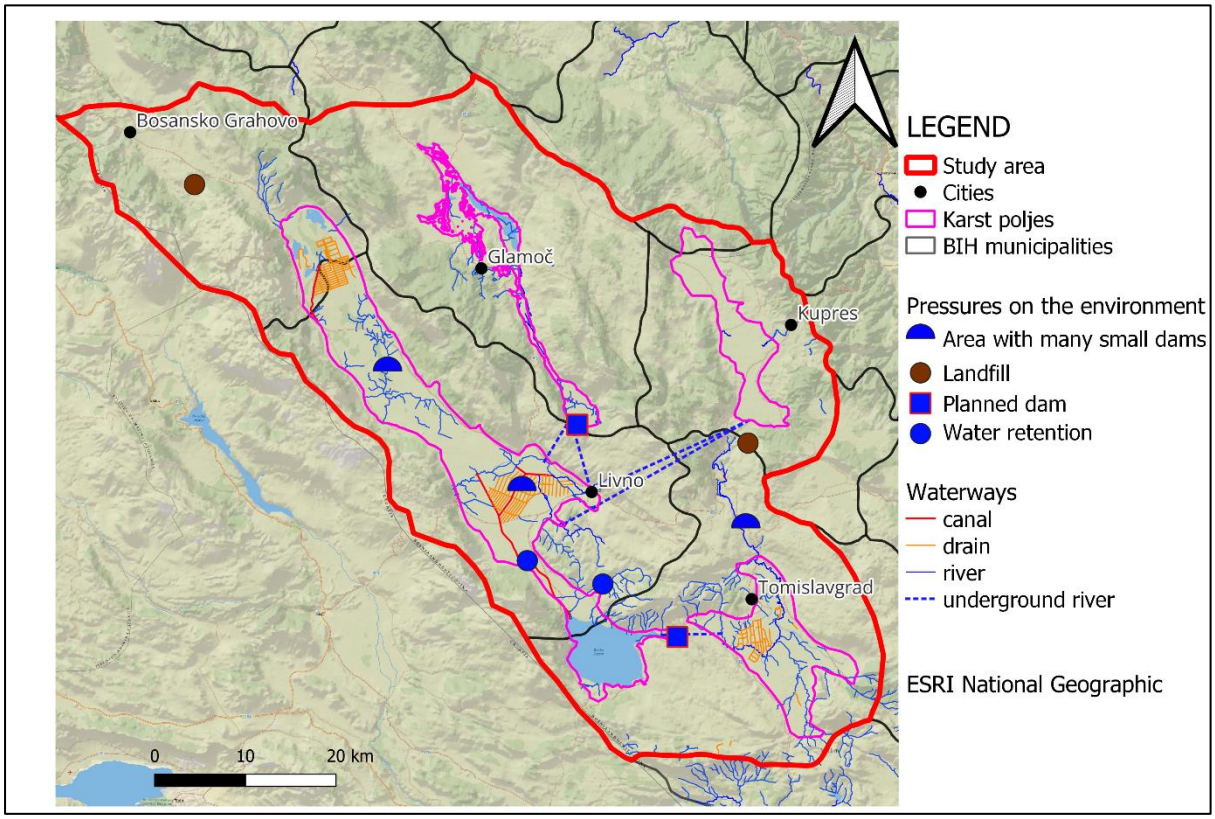

Figure 33: Map of the pressures causing hydrological discontinuity, QGIS, FNS-MI 2022-2023

Spatializing the threats on this environmental stake allows again to have a better understanding of which zone is most at risk and how.

- **Planned dams**. The two planned dams, between Buško Lake in Livanjsko polje and Duvanjsko ponor, and between Glamočko and Livanjsko poljes, are federal projects that should be completed in the coming years. By building concrete installations, artificializing the entrance and exit of the underground tunnels, and by blocking periodically these flows of water, these projects could be a barrier for aquatic ecological continuity, as well as harm the fauna that needs to dig in the soils of the river to lay their eggs – which they will not be able to do anymore when they are concreted. The dams are planned on the main water flows from Glamočko and Duvanjsko to Livanjsko poljes, which means that if this issue is not properly taken into account, it could have dramatic impact on the ecological continuity of this region.

- **Drains**. In Duvanjsko and Livanjsko poljes, which are the most downstream poljes of the area and thus the most often flooded, many drains were dug to dry the land and allow agriculture. When it is done without consultation with someone in charge of the water of the region, it can lead to large areas being dried up and profoundly modified, at the detriment of the local aquatic flora and fauna. Projects are still ongoing in Livanjsko polje in order to allow new farms to be installed.

- **Water retention**. Several water reservoirs are built in Livanjsko polje which regulate the water levels in Buško Lake and gather the water from the agriculture drains. Indeed, Buško Lake was built (with dams, the sealing of ponors, the construction of canals etc.) during the Yugoslav period and is a reservoir to supply a hydroelectric plant based in Croatia. The entire hydrological system of southern Livanjsko polje was modified to ensure the supply of water to this reservoir These large concreted artificial basins alter the natural water flows.

- **Small dams**. In the past centuries, many small dams aimed at deviating water from their beds to canals that fed watermills to produce flour. Watermills are now no longer operational, but sometimes the dams are still there, that can block the natural flow of rivers and prevent species of fish from travelling in these streams. Livanjsko polje having the most rivers, it is once again the most impacted by these infrastructures. These small dams can be seen as a break in the ecological continuity of rivers or as part of the region's cultural heritage. It is therefore important to understand their impact on local biodiversity precisely and to adapt solutions to the context.

e. Map of all the pressures on all environmental stakes

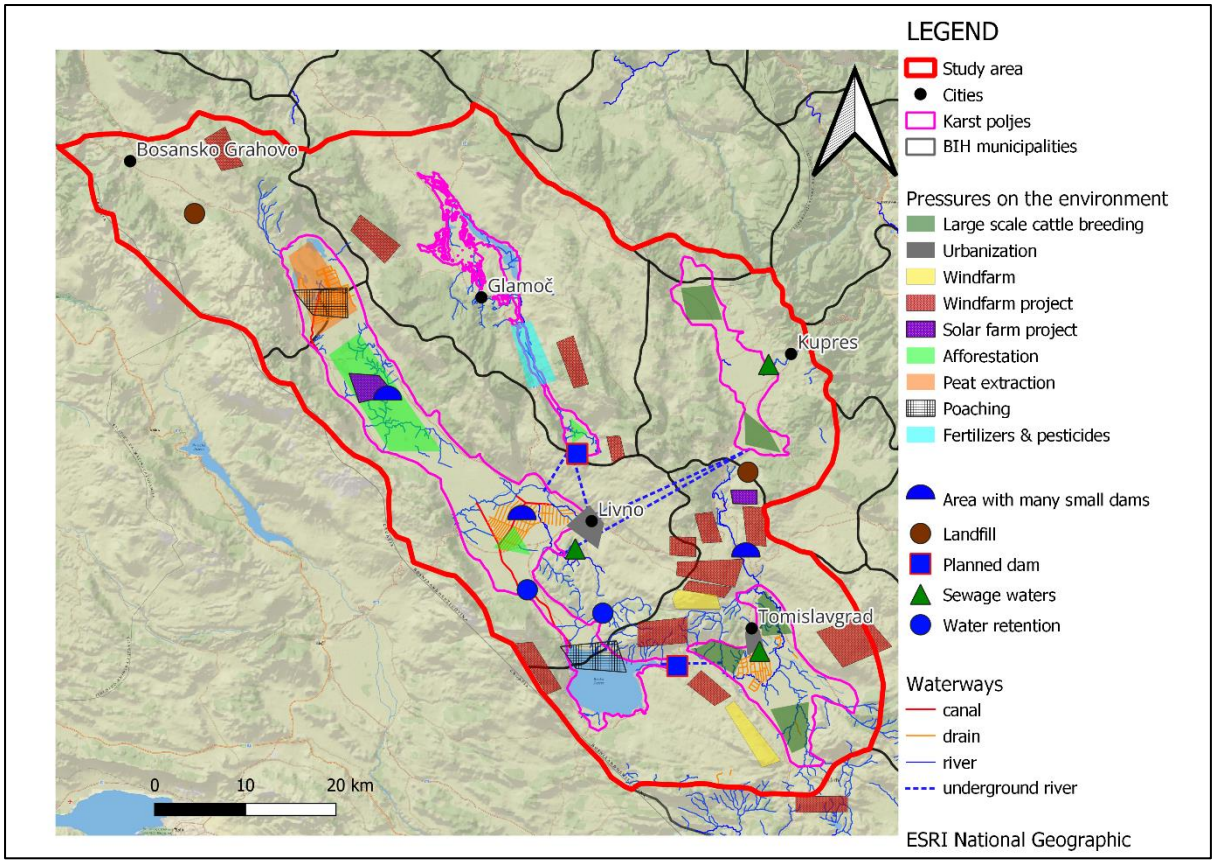

Figure 34: Map of all pressures on all environmental stakes, QGIS, FNS-MI 2022-2023

Combining all pressures related to all environmental stakes leads to this map. Though overcrowded, it allows us to see that there is a gradient in the number of threats, with the northeast side of the study area (Glamočko, Kupreško poljes) being less under pressure than the southwest side (Livanjsko, Duvanjsko poljes). The economic dynamism of Tomislavgrad municipality and the several investments in windfarms and intensive agriculture put Duvanjsko polje at risk. Livanjsko is almost as concerned with windfarms as is Duvanjsko polje, but it could be even more of an issue on this territory due to its very rich avifauna biodiversity. Agriculture there is not intensifying though, but disappearing, which leads to afforestation and an ecosystem and landscape change.

At the municipality scale, pressures differ, and all environmental stakes are not evenly represented. Understanding this hierarchy allows for a better comprehension of the study area, and for an overall ranking of the environmental stakes.

4. Priority of the five environmental stakes

a. Priority per municipality

Observations on the field, the mapping above and actors' interviews allowed for a ranking of the different stakes per municipality, as detailed below:

Bosansko Grahovo (north of Livanjsko polje):

1. Water pollution
    - Linked pressures: landfills, bankruptcy of the local water agency Komunalno (see below the part Waste and water management and p. 63), no sewage water treatment.
2. Fragmentation of birds' habitats
    - Linked pressures: peat extraction; poaching, windfarm project

Glamoč (Glamočko polje):

3. Water pollution
    - Linked pressures: no sewage water treatment, use of fertilizers and pesticides, landfills
4. Landscape alteration
    - Linked pressures: abandoned lands, planned dam, windfarm project

Kupres (Kupreško polje):

5. Water pollution
    - Linked pressures: no sewage water treatment; intensive cattle breeding; landfills
6. Landscape alteration
    - Linked pressures : landfills

Tomislavgrad (Duvanjsko polje):

7. Fragmentation of birds' habitats
    - Linked pressures: windfarms, many windfarm projects, poaching, polluted waters
8. Landscape alteration
    - Linked pressures: windfarms, many windfarm projects, planned dam, urbanization, irrigation drains, solar farm
9. Water pollution
    - Linked pressures: no sewage water treatment; intensive cattle breeding, urbanization; landfills, Duvanjsko gathers waters from Kupreško polje
10. Hydrological discontinuity
    - Linked pressures: planned dam, irrigation drains, old unused small dams

Livno (center of Livanjsko polje):

11. Water pollution

- Linked pressures: no sewage water treatment; urbanization; landfills, Livanjsko gathers water from all three upstream poljes

12. Hydrological discontinuity
    - Linked pressures: planned dam, several water basins, many small unused dams, irrigation drains
13. Fragmentation of birds' habitat
    - Linked pressures: afforestation, peat extraction, windfarm projects, poaching, polluted waters
14. Landscape alteration
    - Linked pressures: windfarm projects, afforestation, solar farm project, urbanization, planned dam, landfills

This spatialized hierarchy is summarized in the table below.

Environmental stakes priority per municipality	1	2	3	4
Livno	Water pollution	Hydrological discontinuity	Fragmentation of birds' habitats	Landscape alteration
Tomislavgrad	Fragmentation of birds' habitats	Landscape alteration	Water pollution	Hydrological discontinuity
Glamoč	Water pollution	Landscape alteration	Fragmentation of birds' habitats	
Kupres	Water pollution	Landscape alteration		
Bosansko Grahovo	Water pollution	Fragmentation of birds' habitats		

Table 4: Environmental stakes' priority per municipality (Source: FNS-MI March 2023)

b. Priority in the study area

This additional hierarchy above, added to all the other analysis, allowed for an overall priority of environmental stakes in the study area:

1. Water pollution
2. Fragmentation of birds' habitats
3. Landscape alteration
4. Hydrological alteration
5. Degradation of flora

5. Actual management

In order to highlight the actors that impact the five major environmental stakes described above, this section aims to explain the main actor systems and their organization in order to understand how these pressures on environmental issues are formed.

Four major stakeholder systems were identified: Waste & Water, Agriculture, Forestry and Energy. All are links to public administration.

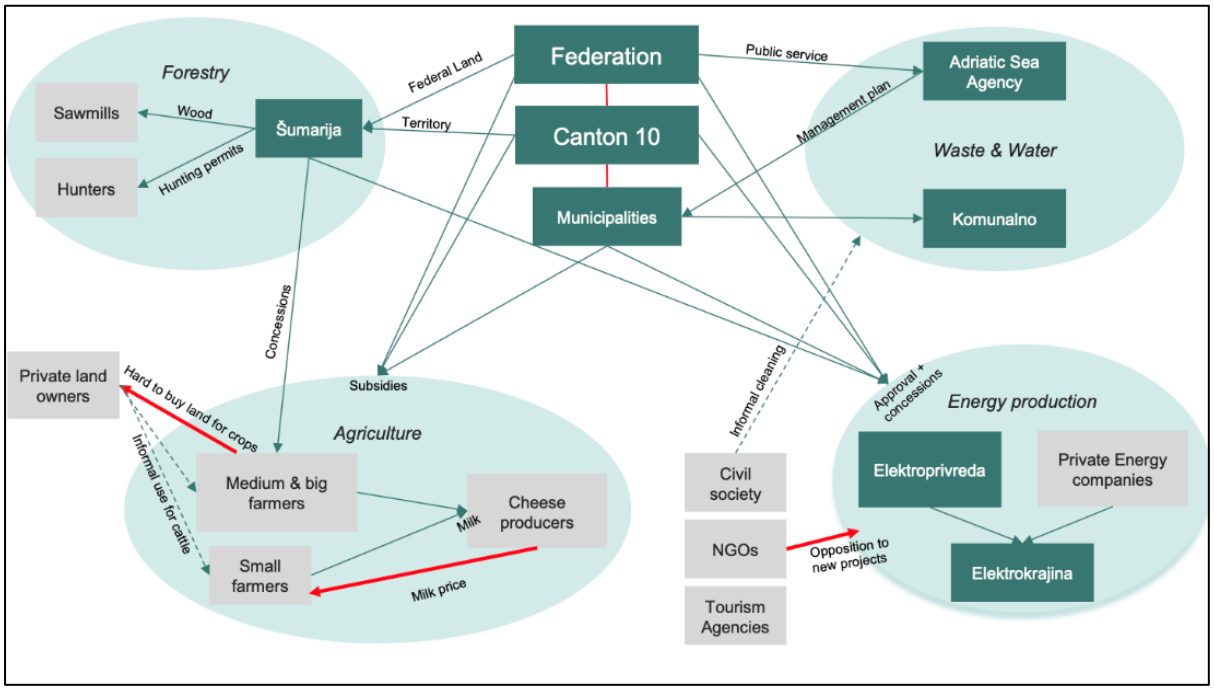

Figure 35: Main stakeholder systems in the study area (source: FNS-MI 2023)

Water quality being identified as the first environmental stake in terms of severity, the management of water and waste deserves to be explained prior to anything else.

a. Waste and water management

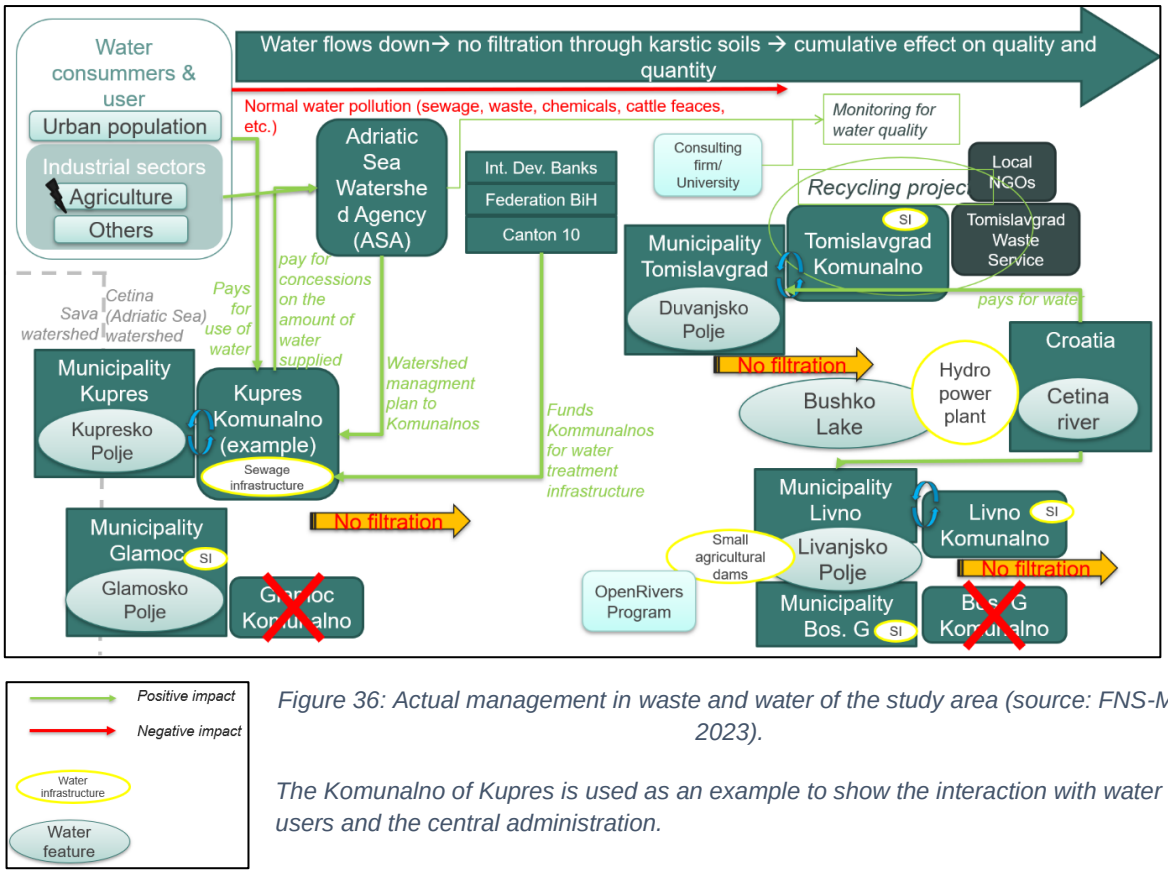

Figure 36: Actual management in waste and water of the study area (source: FNS-MI 2023).

The Komunalno of Kupres is used as an example to show the interaction with water users and the central administration.

The actual management of water is multi-stakeholder, and the vast majority of stakeholders also participate in the actual management of waste. These two types of management are linked and sometimes have similar functions and impacts, but sometimes they are different. This diagram is not intended to be exhaustive but to present a general picture of the water and waste management system as it is today. Several elements deserve special focus.

Firstly, the study area describes a set of interdependent poljes by the hydrographic network. The water is not filtered by the karstic rocks, so the pollution of the water has a cumulative effect the lower the polje. Thus, the Livanjsko polje as well as the Cetina River in Croatia are particularly sensitive to downstream water quality degradation and water quantity variation. In this sense Croatia has an interest in this water management for the maintenance of a sufficient level of clean water. It can be noted that Croatia pays the municipalities of Livno and Tomislavgrad for the water and the energy produced with the hydropower plant. This may raise some misunderstanding from upstream municipalities. "*Livno and Tomislavgrad are retributed but Kupres as the source for the water is not paid*." (PK2).

Water quantity

Water quantity, which is very important for the preservation of the poljes' wetland, was mentioned by some stakeholders as it is emphasized in the scientific literature (Bonacci, 2013). In this study area, the rainwater quickly goes underground and down of mountains crests and slopes flowing over and in karst rocks. Water can stay a little longer in karst plateau very specific for their sinkholes that can maintain small amounts of water. In the slopes, forests

are also very important for their role of filtration of water. A large part of the water flows through the karst soils and remains in the polje. However, the highest poljes have less water than the Livanjsko polje as water flows. This explains a difference in soils composition and characteristic and thus of land use, explained in the next section on agriculture.

One farmer in Glamoč notes, though, that the soil composition allows him to retain some rainwater for his potatoes, which is the only water he gets (AG3). A fisherman also expressed his worries about the decreasing amount of water.

"*The number of fishes has been decreasing for 5 or 6 years. The 3 rivers […] are connected at a point where there is a canal, and during summer there is less and less water because of climate change*." – RL1

Some touristic actors also noticed a lack of water for wild horses (TL2) even though others have not noticed any change in the level of water of rivers through the years (TL1 and TL3).

On the institutional side, the Adriatic Sea Agency (ASA) looks forward to emitting more concessions for water. Indeed, the actual users, which are mainly Komunalnos in charge of urban running water, industries and medium and large farms that are not connected to urban networks, do not appear to use large quantities of water. One Komunalno, however, expressed some concerns.

"*At the level of the canton, the regulation makes that we cannot use more than 30% of the water according to the flows... Now they use more than 30%. These are temporary authorizations depending on the water flow."* – PT3

It is important to note that hydraulic infrastructures such as dams and hydro power plants certainly affect the quantity and continuity of water. These aspects will therefore be detailed in the section below on agriculture (small dams and drains) and energy (hydropower plants).

Beyond this quantitative aspect, quality has arisen as a more critical and complex issue.

Water quality

As shown in the previous Figure 36, Komunalnos are organized by municipalities (see also Annex VII.6). They may be in relation with the ASA even though they are not in charge of the same tasks: they are more concerned with the urban running water network while the ASA on a smaller scale supervises the management of natural waters in the watershed. However, the Komunalnos of the different municipalities do not seem to work very closely. The Komunalnos of Kupres, Livno and Tomislavgrad state that they communicate, yet it seems that they work mainly on their own. For example, even though the water from Kupres flows underground directly to Livno and springs out of the Duman ponor, the respective Komunalnos have no real formal interactions.

"*They are no real or next to no interactions between Komunalnos. […] They have a team of 3 persons, ensuring the link between the Komunalnos. But their affiliation has not been confirmed, and no contact of them has been obtained. […] The water infrastructure differs from one municipality to another. There is no interaction between Komunalnos*." – PK2

This can be a big issue when there is neither natural filtering system nor artificial water treatment infrastructure. Komunalnos do not always have the means to set up filtering

systems. Therefore, filtering efforts are done on a punctual basis and by local actors (PK2, RL1, TT1).

"*Used water goes to the water courses and it is not treated. Just as like in Tomislavgrad, there is a project to build a facility to filter and clean the used water, but it remains a project. And the fund needed to implement the said project would result in a raise in the price of water to be paid by people*." – PK2

Indeed, even if Komunalnos can receive funding from the state or international development banks, most of the existing infrastructure is old (PK2, PT3), and when something goes wrong, no one seems to know how to fix it.

"[Komunalnos] of Bosansko Grahovo and Glamočko are bankrupted. The population there keeps receiving water due to the existence of the infrastructures, but there is no management etc... […] The infrastructure for water distribution in Kupres was built around 50-60 years. They don't know how to fix it when it's broken and rely on one man who was around and built it at the time." – PK2

Waste management

In addition, the Komunalnos are also in charge of waste management. As they lack means and channels to sort out and recycle the waste, most waste ends up in open landfills and sometimes are pick up by tourist company (PK2, TT1).

"[…] *in near villages that have no official waste disposal units, people drop their waste in sinkholes. A part of our mission is to clean up the mess people do. Because of lack of ecological consciousness and also because of the nature of underground rivers, this waste comes back to us*." - TT1

Ultimately, a part of garbage gets washed away by water. Thus, pollution is generalized. Some karstic caves and underground rivers are polluted with waste that is physically impossible to collect as microplastic.

"[…] *In the sinkhole, when people throw trash, it remains deep down in the caves. We speculate there are over 20 km of channels. You got stuck pieces of plastic which pass through the whole system and got stuck in the system when the water was high so you can't take it out because you can't approach it physically. You can only take single pieces of trash but there are many other pieces in hard to access areas or hidden. But fewer people throw trash in the river now, since the trash is collected in all the villages.*" – TT3

However, this service is limited to the collection of waste, and the deposit in a landfill but not to a real sorting and recycling.

"*We bring it to the waste disposal company, and they bring it to the "deponja", the place where all the trash from the municipality ends up. It's just a landfill*." – TT1

In the municipality of Tomislavgrad, some actors were involved in the organization of waste collection, but this is a relatively unique case in the study area (TT1, TT3, PT3).

"*We have a landfill where we take the waste, with a new management […] we started recycling the waste. Currently we have some sort of recycling yard […] where we separate paper, plastic, and glass. We pack up paper in big cubes and we cooperate with a company that buys this waste, it is called Duga. […] we started this recently, the people are young […]*

they are willing to cooperate with anyone, like the speleological society or any other NGO. They want to rise up a level in waste disposal. This is only in Tomislavgrad. I don't know if they do the same in Livno." – TT3

Thus, some associations are active in certain areas to organize the collection of waste. Though this waste management is quite recent it can have a positive impact on water pollution (TT3, RL1, TL1 and TL3).

"*All the caves that were near the villages were filled with trash. This waste has definitely negatively influenced the underground water*." – TT3

"[…] we work on protecting field, protecting Livansko polje, we work with Naše Ptice, CZZS, EuroNatur, with any project which protect Sturba […] We also organize and participating on cleaning the river, cleaning the field." – TL1 and TL3

Water monitoring

Despite this concern raised by some civil society actors, many of interviews with farmers, Komunalno officers or tourism companies showed that the water quality was not a big matter for them. They sometimes assume that the ground filters the water or that there is no real source of pollution (AG3, TT1).

"*We have a lot of underground waters, so it is mostly clean because the ground cleans it. My village has its own spring from the underground, the water is quite clean and it is the same here in Tomislavgrad*." – TT1

However, checks and analysis seem to be carried out infrequently, or give contradictory results. To get an estimate of the water quality, specialists and local speleologists' associations know they can search for a specific crab, the European crayfish *Astacus astacus* (TT1, PK2, WL3). The more crabs there are, the cleaner the water. It is not surprising that this crab is much more common in Kupreško Polje, the highest in the region.

"*Proof of the overall cleanliness of the water is river crabs that are only present in Kupres.* […] *When it comes to water pollution* [deliberate one – like people throwing their waste into springs]*, there is no such thing in Kupres. An analysis of the quality of the water in Kupres had been conducted and it has been certified as drinkable*." – PK2

"*We don't have empirical data, we have to use stuff like this, the presence of crabs, to determine the changes in water quality in the caves*." – TT1

Local associations also sometimes request their own analysis.

"*The water from the river is not apt for human consumption. People from Livno have come to take samples from the river and send them to a laboratory in Split, Croatia. Results have not been positive*." – AL6

"*We can't estimate the quality of water, but they can take samples and send them to Zagreb or Sarajevo in order to make water analysis*." – RL1

In addition, the ASA monitors water quality and quantity on an annual basis and publishes reports on its website.

"*We are also responsible for monitoring of the water quality in the area of the Adriatic sea [watershed]. We don't have our laboratory we have contracts with the federal institution for*

the health which organize examinations and testing of the water. Based on that […] we have to say in which states are the water bodies." – PM1

On this basis, they design their "Watershed Management Plan" by analyzing all types of pressures related to human activity. In the study area, the main pressure on water is from agriculture, particularly livestock activities, which represent 70% of the water used according to the ASA. The agency attempts to estimate their impacts on surface or groundwater and to determine if it is an acceptable pressure.

In addition, on a very local basis, some municipalities go further correlatively with their means.

"*We have a contract with an environmental control company that checks the water every month for bacteria and chemicals. They plan to publish all the information on the website, but it is not done yet. We use the standards from the federal water law. […] We are going to look for water between 50 and 60 meters deep, the water is very clean here in Tomislavgrad*." – PT3

The analysis showed that two main sources of water pollution have been identified: urban population for sewage and waste and the intensive part of agriculture, for animal faeces and chemical inputs.

Tourism, seen as a development opportunity for several local actors (EG1, TL2), as well as seasonal dynamics (residents living abroad who return during the summer) could, however, put additional pressure on the water and waste management system, which has already exceeded its capacity.

As far as agriculture is concerned, it is its intensification that could lead to a further degradation of water quality and an increase in water needs. This will be dealt with in the following section, along with the irrigation topic.

In summary, the current system of actors in water management has positive effects but also important negative impacts on the main environmental issue which is the preservation of water quality. The negative effects include:

- Inadequate waste management and water quality treatment and control
- Intensification of agriculture (which is detailed in the section below)
- The cumulative effect of water pollution the further down the watershed it goes.

b. Agriculture

Agriculture is an important activity in the territory because of its traditional practices, its growing economic role and its impact on the landscapes that it contributes to design. In this sense, its impacts on environmental stakes are multiple and complex.

The farmers are mostly engaged in several activities. Livestock breeding includes cows for the most part, but also sheep, goats and sometimes pigs. When they have cows, the farmers often choose meat species Simmental (AL1, AT2) in order to be able to sell them to small local butchers, as the territory does not have an industrial-scale slaughterhouse. The Buša, a native cow specie of the western Balkan, is no longer used by large farms nor by subsistence agriculture. It is noteworthy that the Livanjsko polje is not a great grazing area, unlike the other highland polje, which have a grass of better quality.

In terms of crops, potato is the main one, there are also some cereals and fodder crops (mainly wheat, buckwheat, barley), and to a lower extent silage corn, rye, triticale, carrots and onions. In the same way, the potato is rather cultivated in the poljes of altitude which have less water and according to the actors, a soil of better quality. This is particularly the case in Glamoč where farmers would like to create a Protected Geographical Identification, this point is studied in the part IV.3.e. "*They work [in Glamoč] more than in Livno, because they are on more healthy soil. And in Livno they have mostly water.* […] *But* […] *the municipality don't study it*." (EG1). In spite of this, it seems that the use of chemical fertilizer for potatoes is still frequent and could alter the quality of the water (AG3).

To understand the agricultural organization on the territory, several types of farmers can be distinguished.

- Cheese producers own industrial cheese factories; there are about five in the territory, mostly located between Livno and Tomislavgrad. They sometimes own their own livestock, which can be large (around 200 cows), and are therefore also included in the category of largescale farmers. They buy milk from small, medium and large-sized farms (between 20 to 200 cows). These are enterprises that employ several people and often make this work their main activity.

- Large-scale farmers own large numbers of livestock or large hectares of pasture or cropland. They are primarily engaged in livestock production rather than crop production activities. It is interesting to note that although cow and sheep farming is the main agricultural and traditional activity in the territory, it has intensified around the production of traditional cheese, but not around wool production, despite the local know-how in wool products.

- Small and medium-sized farmers are more likely to do both: livestock and crop production.. They therefore sell their milk to cheese factories or produce small quantities of traditional cheese for local markets. They also produce honey, rakija or other types of traditional products in small quantities. It is relevant to highlight that small and medium farmers are not organized in cooperatives. In addition, they seem to rarely interact with the agricultural services of the municipalities except on the subject of subsidies (AG3). However, this category is not homogeneous. It can include small-scale farmers who need seasonal labor (for potato) as well as people who farm as a complement to another income-generating activity.

- Subsistence farmers are consuming most of their animal and crops productions. They sometimes sell a bit of their production at the market. In this food agriculture, which occupied much of the local population before the war, farmers are in fact simple families who own a few animals and a little land.

It is worth noting that agriculture is shaped by a very large proportion of very small farms, describing a still very important subsistence agriculture. Indeed, almost 2/3 of the farms in Livno and Glamoč had less than 3 hectares in 2008 (Bernardoni, Pascal (FAO) *et al.*, 2008). According to data collected at the municipality during the field work, in Glamoč there is no cheese factory but more than 90% of the 400-agriculture holding of the municipality are family farms. The municipality is also characterized by its large number of sheep compared to cows (Agriculture Department, Glamoč municipality).

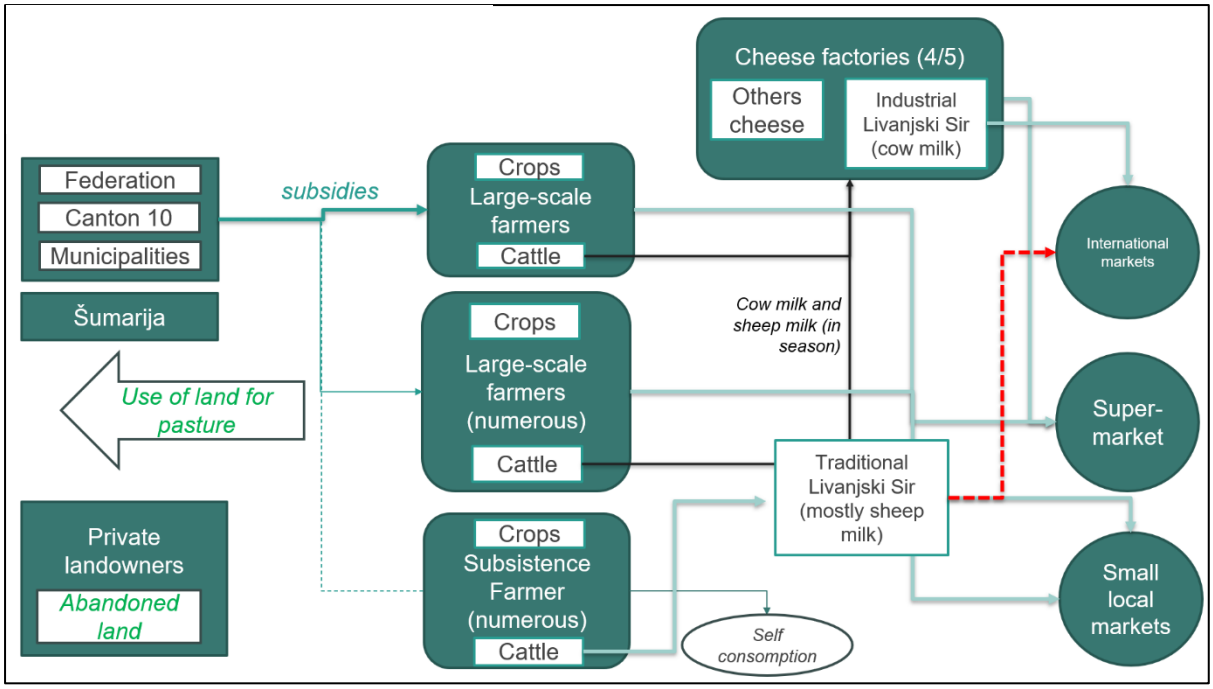

Figure 37: Agriculture actual organization (Source: FNS-MI 2023)

The diagram above describes the general organization of the agricultural sector value chain. In addition, several points appeared important to note in the organization of the sector and its impact on the environmental stakes.

Agriculture intensification

First, there has been a recent intensification of agriculture, particularly livestock production, in the study area. Two factors can explain this recent trend. On the one hand, the largest farms or cheese producers are targeted by subsidies which have criteria based on the number of cattle heads or hectares. There may also be punctual subsidies for the purchase of a machine, for example, but which condition the acquisition to a specific brand for example (AL5). In addition, to obtain aid, it is necessary to register with the municipality, and provide proof such as invoices (AG3).

> "*Controllers come to control all the farms on the list, and they estimate the amount of the subsidies regarding the number of animals, the lands and the cultures. […] Every farmer can have the subsidies. There are 3 types of subsidies. Country and federation give subsidies to every farmer who have animals or lands. That's the biggest number of subsidies. Subsidies from the canton are mainly for young people that want to use lands. The municipality gives subsidies to small farms*." – EK1

On the other hand, the growing popularity of Livanjski Sir – the Livno cheese – on a national and European level has encouraged the structuring of a cheese industry and the intensification of breeding activities on the territory.

On this point, it is essential to differentiate the industrial Livanjski Sir produced with a majority of pasteurized cow's milk from the traditional Livanjski Sir requiring a minimum proportion of unpasteurized sheep's milk (Bernardoni, Pascal (FAO) *et al.*, 2008). The first one can be sold on the European market with this *Livanjski Sir* name. On the contrary, the second one has not

been authorized for export for hygienic reasons related to the use of unpasteurized milk, which is the key element that gives the cheese its particular flavor.

Indeed, the industrial *Livanjski Sir* has transformed the organization of livestock in the territory. In the 1970's, the sales ratio between industrial and artisanal Livanjski cheese was 50% to 50%. In the 2000s, this figure was 70% to 30%, with profits exclusively directed to the four or five most important cheese factories in the study area (*Udruga za zaštitu podrijetla livanjskog sira*, 2019). This evolution of sales figures outlines an overall trend of agricultural intensification in cattle breeding practices. Interviews with dairy production stakeholders indicate similar asymmetric dynamics between small and medium farmers on one side and large farmers that have the economic and technical means to produce Livanjski cheese on a large scale. Large-scale farmers breed cattle to produce dairy. However, they also buy milk from small producers from across the study area, mostly out of Livanjsko poljes, notably Glamočko, Duvanjsko and Kupreško poljes, where the grass is reputedly of better quality due to the altitude.

"*now Livno use Glamočko milk and make a brand. […] The farmers don't have anything of that. […] Maybe if they make cheese, they can get more money. But if they just sell the milk, they don't get anything for it. They get regular prices."* – EG1

"*For the Livanjski sir,* [...] *they [industrial cheese factories] take the milk from 100 km around Livno because a lot of people stopped giving milk here because they couldn't find it there."* TB2 and AL5

The added value from resulting dairy products that benefit from the *Livanjski Sir* name is captured by a few large cheese factories. It should also be noted that they do not limit themselves to *Livanjski Sir* and also make other fresh cheeses for supermarkets and restaurants. They often try to diversify their production and distribution. In this regard, large farms and cheese producers that are concentrated between Livno and Tomislavgrad do not lack ambition and claim to want to expand their activity (AL1, AT2, AL2).

"*We don't have any limits; the world is our goal. […] Now there is another dairy factory in Livno where they are a little bit bigger. They are 20% bigger than us. They employ not much more people, maybe 45-50 people. We started this factory 50 years ago and they already existed. They had production, the market, the farmers, … everything. And we are now almost as big as them*" – AL1

It is to counter this expansion of industrial Livno cheese made mostly from pasteurized cow's milk to the benefit of large cheese producers failing the small milk producers, that the Cincar association pushed for the creation of a Protected Geographical Identification (PGI) on traditional *Livanjski Sir* 15 years ago. At the beginning this PGI project was intended to contribute to the development of dairy production activities through the recognition of their exceptional value. This value was based on the unique features of the sheep milk form which the Livanjski cheese is produced. It also refers to a rich body of local traditional practices such as grazing with transhumance and dairy production techniques which are inherited from long term cultural and historical dynamics. This type of protection system is particularly useful for the economic development of the agricultural sector. Also, it brings a good action lever to avoid traditional food products from becoming industrialized goods with high environmental impacts. But the characteristics of this fabrication process from unpasteurized sheep's milk made this cheese impossible to export to the European market, which was greatly limiting its

economic impact. The project and the specifications of the PGI have therefore gradually evolved to no longer include a minimum proportion of sheep's milk among its central characteristics. It was then adopted in 2019 (as we can read on the document *Udruga za zaštitu podrijetla livanjskog sira* from 2019 that we can translate by Association for the protection of the origin of the Livanjsko cheese) and in its last and actual version has no specification on traditional grazing techniques nor environmental practices. This PGI finally ends up favoring industrial cheese over traditional cheese.

Traditional producers mostly sell to local traders, smugglers, Livno green markets, the *Gastarbeiter* (diaspora) and some local hotels and restaurants. The market for Livno cheese, and especially the EU market, is still monopolized by the cheese made from pasteurized cow's milk instead of the traditional one.

Thus, the trend towards intensification of agriculture and in particular livestock farming, which should be seen in conjunction with a growing need for veterinarians, as one municipality rightly points out (FAO & Ministry of Agriculture, 2019), shows no sign of abating to date.

Land abandonment

A second important point related to agriculture is the phenomenon of land abandonment. The extent of this phenomenon is not well known because it is poorly documented. Although some municipalities have undertaken to update their cadaster, they continue to refer to the Austro-Hungarian cadastral map (EK2, TT1).

"*I recently visited a cadaster office in Tomislavgrad, and I always thought it was a joke that people still used Austro-Hungarian registers. But people still physically use these books on the cadaster*." – TT1

The territorial demographic dynamics described (cf Figure 20) in fact reflect a fairly significant abandonment of agricultural land. Many of the owners are unknown, have left or do not always return. Sometimes it is also due to a generational and economic dynamic that makes many young people go to work in Europe ceasing to work the land as their parents and grandparents did (EG1, EK1). This dynamic also resonates as a loss of labor force for the agricultural sector that constrains many farmers interviewed, who need seasonal workers (AG3) or want to expand their activities (AL1, TT1).

However, it appears from many interviews that it is very difficult, if not impossible, to buy private land, belonging to private owners even if they do not live on it all year round. The reasons for this are diverse: in addition to unknown, untraceable, or non-returning owners, the actors often cited the attachment of locals to their land.

"*It was a school here before the war. [...] Here, as it is state-owned, it was easier to buy. When it is private here it is impossible to buy. It's something that belongs to the family, sentimental link.*"- TB2 and AL5

"[…] *there are a lot of unsolved property problems. During the war, people left.* […] *No there is not* [a law that says that after some time, private land becomes public]. […] *We have Livanjsko karst field, you can see how much space is unused. It's a big problem*." – EL6 and EL7

These abandoned lands represent private and very fragmented plots of land, reflecting a very present subsistence agriculture before the 1990 war.

"*You have absurdly small patches of land. I know of a dola, a whole in the ground, in "Bragovica" that is 300 m² that is fertile and that is owned by 260 people. That is part of the problem and large part of the issue why the land remains uncultivated*." – TT1

For grazing, this is not a real problem; farmers explain that they use the land around their farms, regardless of the ownership of the land. When it is public, they pay for concessions or buy it. When it is privately owned, they make informal arrangements with landowners who do not use their land or are only there part of the year and see this grazing as a way to clean up the soil. The rest of the abandoned land is used freely for grazing around the farms.

"*Very few people rent. If you have cattle and your neighbor doesn't, of course they'll let you mow their parcel for free*." – TT1

"*But it also helps because it cleans the land. People don't have goats or anything, it grows, so grazing cleans up*." (translated) – TB2 and AL5

"*The land 'abandoned' is not really abandoned because some farmer will anyways cultivate them or use them as pasture*." - AG3

For cultivation, the private ownership of much of this abandoned or unused land is more of a problem as this farming practice is less flexible. As the purchase is difficult, it appeared that this could be a brake to the extension of certain agricultural activities.

"[…] *he has an awful issue: he has the money* […] *but he's got a problem with buying land, because people just don't want to sell. Here, you still have the concept of something inherited that has value, which goes beyond money. When you got this sort of parcel owned by 15 people and 14 people want to sell it but 1 does not want to, you simply can't get land, that's the way it works*." – TT1

This lack of space for agricultural expansion can also be perceived as a result of natural features related to landscape units.

"[Farmers] *in the polje actually lack land because most of land is underwater and they don't culture up hills* [due to rocky karst soils]." – AG3

The significant fragmentation of land ownership and the persistence of small-scale subsistence family farming is mostly perceived as a hindrance to agricultural economic development by the municipalities such as Tomislavgrad (Općina Tomislavgrad, 2017), Bosansko Grahovo (FAO & Ministry of Agriculture, 2019),or Livno (Općina Livno, 2021) and the Canton 10 (Općina Canton10, 2021). In their respective strategies, they insist on the potential of valorizing this unused land by intensifying agriculture, notably by increasing the number of livestock or by growing cereals or other crops on arable land.

The demographic trend surveyed between 1990 and 2013 and observations in some parts of the study area (in the northern Livanjsko polje and direction Bosansko Grahovo), indeed describe a dynamic of land abandonment. However, this trend must be balanced. On the one hand, as we have seen, some land that is apparently not used is in fact pastureland, especially in the buffer zones around small, medium and large farms. On the other hand, these figures are a bit dated (2013 census) and it seems people also return here and there punctually, when they can and manage to (AB2). In fact, the situation is more complex than a simple desertion and the return can be complicated by the social inter-ethnic and administrative context. For

example, an inhabitant of Livanjsko polje practicing subsistence farming and returned in 2020 explained the reasons for the non-return of these neighbors.

"*The only criteria [to come back and have material from the Federation] is that I only needed to come back and needed a paper that I lived here before the war. […] Before, a lot of people wanted to move back here, but it was actually cantonal government made it difficult for them, a lot of paperwork, they had to pay for it, and people didn't have money and time to do it because for example if the land was to his grandfather I had to translate it to my name, I had to have a proof that it was his own land, so couldn't get the money for the house. A lot of problem, so many people backed out of the moving here, didn't want to deal with papyrology…"* – AB2

Thus, it emerges that the extent of the phenomenon of land abandonment, which can foster the advance of the forest and the brushwood of the polje meadows, is difficult to estimate. It is nevertheless notable that this phenomenon, if it proves to be too important, constitutes a threat for the endemic flora of the meadows (Bonacci, 2013; Sackl *et al.*, 2014; Sackl *et al.*, 2019) and the integrity of the open landscapes drawn by these karst poles. Indeed, some interviewees explained the importance of grazing practices in polje.

"*We found the remains of cattle herders that were 4000 years old. All of our biodiversity is connected to agriculture. During the late 80s and 90s, cattle breeding disappeared from Livanjsko polje and there was a reduction of diversity of birds. A few species of eagles completely disappeared. 15 or 20 years ago, people started working with cattle again, and these birds started showing up again, birds that were not seen for 30 or 40 years. […] Protecting the area also includes sustainable development of agriculture as far as biodiversity is concerned.*" – TT1

Agricultural water infrastructures

A third important point is agricultural water infrastructure. During the Yugoslav era, may hydraulic developments have taken place as drain or irrigation system in some parts of the poljes, especially the Livanjsko one, in order to dry them for cultivation during the winter (which is usually flooded during this season) and keep them moist during the summer. Even though the municipality of Livno mentions the usefulness of further draining arable land to expand cultivation in its strategy, this has not been done so far on a large scale (Općina Livno, 2021). However, some parts of Livanjsko polje are irrigated and drained and there are still many small agricultural dams that are no longer used. This type of infrastructure can have an impact on the amount of water in the lowest areas.

Tourism

Fourthly, tourism around agricultural practices is also seen by many interviewees in the sector as a potential economic and development boon for the territory. If the traditional Livanjski cheese remains in the shadow of the industrial Livanjski cheese, the big producers of this industrial cheese recognize the opportunity.

"*We note that there is a great interest for this product from the touristic activity in the last few years. […] easily we are connected with tourism agencies, and they bring groups of tourists here. We are on the map for visits, and we can receive here maybe 20 persons. You know for the customers to try cheese we can offer other local delicacies, juices, wine, jams … you know whatever is produced, so they can try. They can see the production, talk a little*

bit about history. […] This is pictures when everything started. We have interest to participate in touristic potential." – AL1

Moreover, cultural centre, which are organized by municipalities, are often linked to traditional and cultural food producers. They sometimes have shops to sell these traditional products such as heather honey from Duvanjsko polje, rakija, or typical clothes made from local sheep wool (TT2, AT3). In Kupres, the traditional grass-cutting festival, even though the practice has become a kind of sport and is no longer used in large-scale agriculture, provides a cover for other traditional activities such as singing, dress-making, food, wool, etc. (TK4, TK3).

It can also be mentioned that a traditional practice is the collection of plants specifically present in these poljes. This is for example the case of mushrooms, but also of plants used by the local traditional medicine and which can be threatened to disappear because of the various pollutions or transformation of the use of the grounds related to the anthropic activities (Sackl *et al.*, 2014).

Hunting

Finally, the links between farmers and hunters are plural and depend on the territories. The hunting societies are organized by municipality and sub-section that cover the municipality (cf Annexe 7). In theory they must compensate farmers when they suffer damage from predators or crop ravagers (RT1).

"*The main problem is wild animals: wolves and bears that attack the cows and sheep and boars (wild pig) that destroy the plantations. […] If a farmer has some damages, inspectors will come and control them and then the hunting association will give him some money as a compensation*." – EK1

However, some shepherds have little loss on their herd because they have enough large shepherd dogs (AL5). It's more complicated for the damage of wild pigs which are concentrated on cultivated and ploughed lands. "[Farmers in Glamoč] *don't have any help or compensation. Hunter are hunting wild pig but not enough for helping farmers*" (AG3).

It should be added that many farmers do not claim compensation because the damage is often too complicated and difficult to prove (AL5). Hunters therefore have a significant role in regulating wild fauna to preserve the profitability of agricultural holdings. There are more widely described in the section **Error! Reference source not found.**.

In summary, the agriculture sector is altering four of the five environmental stakes:

- Water quality, as the intensification of livestock and conventional farming can lead to more pollution in natural waters.
- Water continuity can be affected by small dams and drains put in place for agriculture but not always used nowadays.
- The integrity of the landscape can be affected by the afforestation of pastures due to the phenomenon of land abandonment.
- The endemic flora characteristic of the polje pastures could also be negatively impacted by a too strong land abandonment phenomenon as well as an overly intensive grazing activity (Bonacci, 2013 ; Sackl *et al.*, 2014 ; Sackl *et al.*, 2019).

c. Forestry

Forests are one of the most significant hallmarks landscape-wise of the study area. Mainly found on slopes and Karst plateaus, they occupy the space between the poljes. The observed forest in the area could be categorized in 2 types: wild-grown and human-grown.

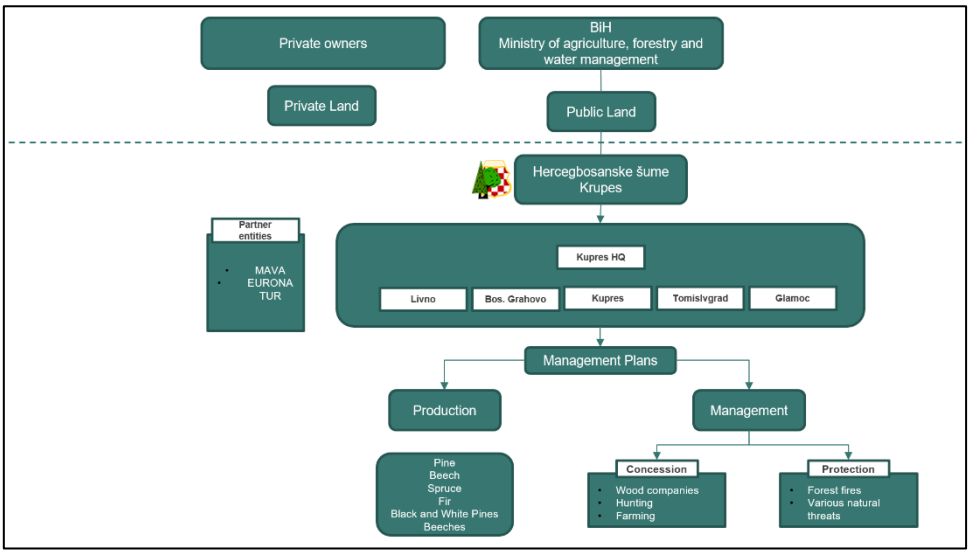

Figure 38: Forestry Management in the Study Area (Source: FNS-MI 2023)

The forest management illustrated in the diagram above, will be detailed in the following lines.

The forests in BIH are either public or private; with private forests being forests existing on privately-owned lands and public forests being grown on public lands. The public land is owned by the State. The head of the cadastral office of one of the municipalities had this to say "*Owner of the forests are the country, not Federation, the national country. Forests are managed by Šumarija*." *(EK2)* On the study area the proportion of both types of forest – private and public - stands at less than 10% of private forests and the rest belonging to the public domain (PT1).

The management of the private forests is exclusive to their owners. The massive depopulation in the area leading to the absence of some owners leaves some of these forests unmanaged.

When it comes to the management of the public forests in the study area, it is done operationally at a municipal level with a common command center. Šumarija, the main entity responsible for public forests in the study area, has thus companies in each of the visited municipalities (Livno, Kupres, Glamoč, Tomislavgrad, Bosansko Grahovo) with the headquarters located in Kupres. The company is public and as mentioned before, manages exclusively public lands "*It is government company. This is the big difference. And the government land is what they are managing*" (PT1).

That government land can be a mix of forest and non-forest. For example, the land managed by the office of Šumarija in Kupres was proportioned as follow: 30% of primary forest (« karst wood »), 30% pine wood forests (planted forest), and 40% of non-forest land for future tree planting and various concessions (PT1).

The company autonomously designs policies and management plans regarding the controlled forest and seeks the approbation of the Cantonal Ministry and municipalities before implementation. A dive within forest management across the study area will look at forest production and management.

Forest Production

In terms of forest production, Šumarija is responsible for taking care of the existing forest and expanding it. To this end, they proceed to tree-planting on unused public lands allocated to them.

The main species grown are:

- Pine (*pinus*), beech (*fagus sylvatica*), spruce (*picea*) and fir in Glamoč (PG1)
- Black and white pines (*pinus nigra* and *pinus strobus*) in Tomislavgrad (PT1)
- Silver fir (*abies alba*), pine (*pinus*) and beech (*fagus sylvatica*) in Kupres (PK1)

Also some monospecific forests – mostly made of pine-trees- are also grown as reported in the aforementioned Tomislavgrad's Šumarija's land use.

The entities follow a forest management system – namely Bavarian system that relies on selective cutting forestry and that allows forests to grow naturally and to be multiage through careful and selective exploitation.

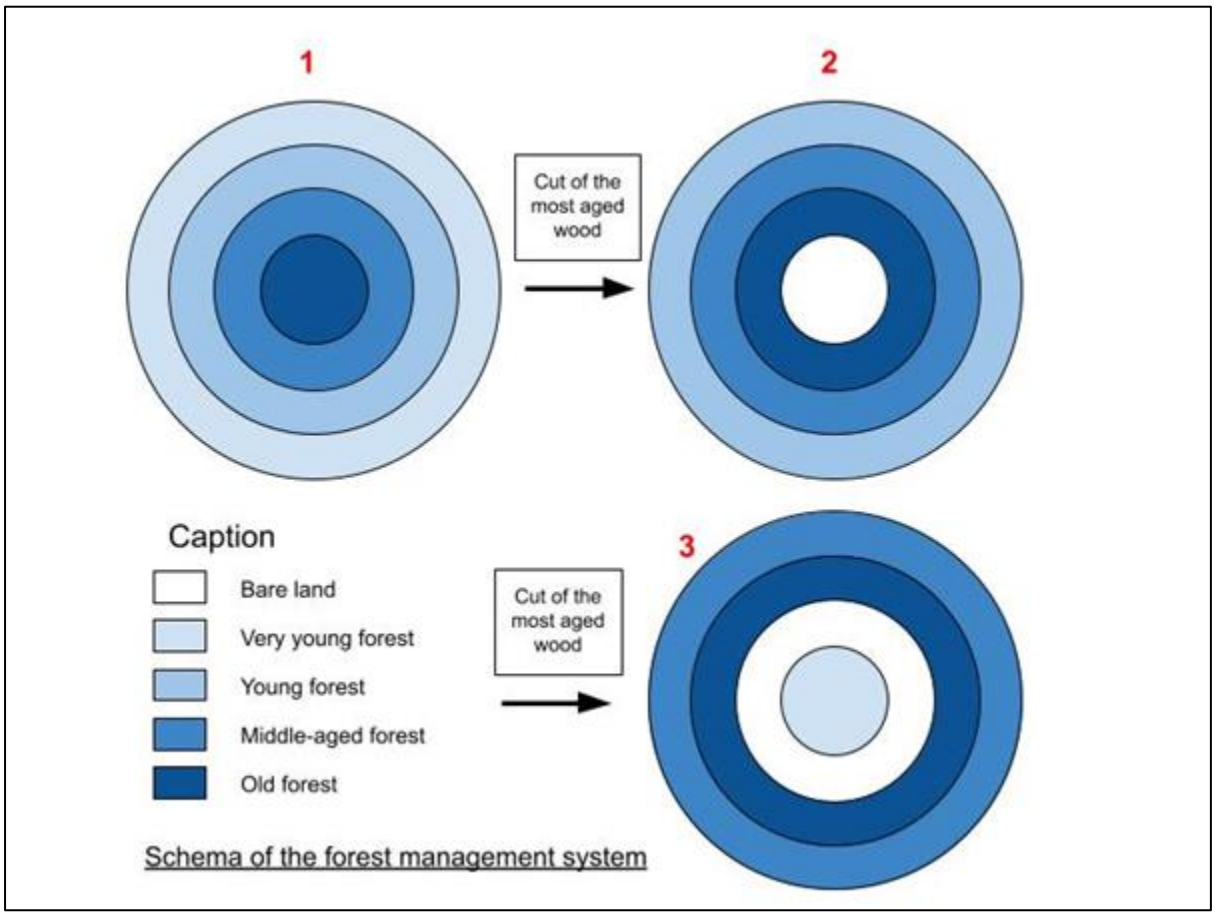

Figure 39: Forest Management System in the study area – Wood selection method (Source: FNS-MI 2023; based on PK1)

Through this management system, only some trees that have reached a certain age can be cut to allow young trees to grow and maintain an age variety between trees.

Forest Management

The management of the forest follows a 10-year plan that is declined in short-term plans of 3 years (PT1). The plans are publicly available on the websites of the different offices of Šumarija.

Apart from providing the number and type of trees to be planted, the plans mainly aim to keep the forests' management sustainable. As such, all forests managed by Šumarija are FSC certified and are regularly audited.

Concessions

- Logging concessions

The number of trees to be cut or planted by year is defined. The trees to be cut are subject to concessions acquired by private actors who then pay for the conceded trees by cubic meter cut. Clear cuts are completely avoided, and trees are selected based on the defined management system to make the forest keep its diverse and multiage attributes.

And although some clear-cuts have been observed on the study area, they are believed to have been executed on private forests as these practices clash with the inhouse selective cutting of Šumarija.

- Hunting

Fishing and hunting practices are organized and regulated quite similarly. It is necessary to pay to have a license to hunt or to fish. The quantity that can be harvested, the species, the places and the seasons are for both practices legally established by the respective associations and validated by the local authorities (cf Annexe 7).

Hunting practices can pose a threat to birds when not legally regulated and it seems that there is also a poaching practice, especially for quail bird (RT1, TL1 and TL3).

> "*There all a lot of Italian people killing the birds and transporting them. It is forbidden but many people organize that kind tourism tour. There are policemen but they cannot do. […] We call the police sometimes but when they arrive, they run away"* (TL1 and TL3)

For fisheries activities, unregulated practices can also foster environmental degradation. It seems that there is introduction of invasive species in some place and that could impact actual water ecosystems including endemic species (RL1, PM1).

Hence, for both practices, if the means to regulate exist, they sometimes seem insufficient. Although "*There is a good law for hunting*" it is "*very hard to control all this*" (TT2) because of the size of areas and the number of game keepers in relation to it (RT1). Also "*sometimes people do fish more than the number allowed but there is no control*" (RL1).

The forests in the study area house various wild animals: deer, wolves, foxes, wild pigs (boars) etc... The richness of the area allows hunting activities to be popular; thus, the need for the activity to be regulated by the forest management entity. This is done by issuance of concessions and permits allowing hunters to have access to the recreational/sports hunting

areas and professional hunting areas (PB1). Hunting associations pay a certain fee to Šumarija to have access to the said hunting areas.

- Farming concessions

Specific concessions are given to shepherds to allow their herds to graze on often yet-to-be-used lands owned by Šumarija, and also as Šumarija often manages Karst plateaus and other areas with mixed or herbaceous vegetation. "*For example, farmers are asking the Šumarija company for a license. They approved for feeding the animals. They have good connections. Because there are no farmers who have their own land*" (PT1).

Protection

The management activities of Šumarija also involve forests protection. The interviews conducted have reported that the forests in the study area are well-managed and observe little to no threats. The residual threats vary from one municipality to another with different levels of intensity.

- Forest fires

Forest fires are the principal identified threats for forests across the study area.

"*In mixed forests you don't have spread of diseases as you can have in Slovenia for example where there is only one species. Our natural mixed forest is healthy. But we have problem with forest fires because you have a lot of karst areas with no trees and people burn them because they think it is good to kill bacteria. This is a huge problem*" (PK1).

Happening when unattended fires lit up by farmers inside the poljes - as clearing practices as explain below - spread out to the neighbouring forests, these forest fires are numerous in areas with important agricultural activities (ie Tomislavgrad registering nearly 30 forest fires each year) (PT1).

About fire, another issue is the fire set directly on the fields of the poljes:

"*The other problem is the fire, it is a huge problem here. Because the people here have this idea that if they put the grass on fire in spring or in fall the better grass will grow out you know in green. Of course, it is a mistake, but you know you cannot explain that to the people. So people just go out and put the field on fire. […] people do, put fire the dries grass, because after it grows some grass. So, it is just for cleaning*" (TL1 and TL3).

This traditional way of cleaning the grass, even if it's not used for agriculture or cattle, is problematic as it destroys the local flora of the polje. Also, the fires can spread and burn the forest.

Yet, it is very difficult to change this practice and to know who sets fire to the pastures, "*The police do come when there is that kind of situation. But if the fire has not burnt someone's property or inflicted some major damage to someone, they can't do anything*" (PB1). To try to prevent that, the municipalities use concessions for public lands to know who uses the land: "*You have to ask municipalities for the soil, fees for the land, for Šumarija you need to ask if you are doing it in a commercial way. This is to prevent from fires*" (WL1).

If these fires are also a way of maintaining the landscape and the vast pastures of the polje by preventing afforestation, agropastoralism or traditional grass cutting as in Kupres (protected by UNESCO) remain the safer options for cutting the grasslands.

Internal teams within Šumarija split between office work and field work have a history of successfully putting out these fires with the cooperation of local firefighters (PT1).

Also, with the support of some civil society organizations (i.e. MAVA & EuroNatur) certain municipal Šumarija offices develop grassroots activities led in cooperation with farmers and populations living around the forests to easily report and handle forest fires (PB1).

And although residual minefields across the forests often prevent full interventions to put out fires, the overall comments gathered on forest fire management by the actual Šumarija employees do not list forest fires as a significant threat.

- Natural threats

Natural threats to forests are less numerous and are handled by Šumarija employees. They are mainly parasite species (mistletoe, *viscum* in Kupres). There are apparently no major health issues with the local trees. And the ones that are spotted are quickly taken care of and their spreading is regularly halted (PB1).

Overall, the forests in the study area are well-managed and rely on a solid inter-municipal organization that facilitates and homogenize norming when it comes to forest management. Some identified threats on them are worth keeping in mind as they have some negative impacts on our environmental stakes, namely forest fires on landscape deterioration and flora degradation.

d. Energy management

One of the activities that is changing the most the landscape and the dynamic of the territory is the energy industry. As said before, the study area is very rich in natural resources useful for energy production: wood, wind, solar and water. "*Some old study about wind in Livno says that Borova Glava is the best place for windfarm in southeast Europe* "(EnL2). Therefore, in the context of a growing demand for clean energy worldwide, the study area is of huge interest for both public and private energy companies.

To understand better how this sector works and its consequences, it is interesting to have a closer look at the different actors of this sector.

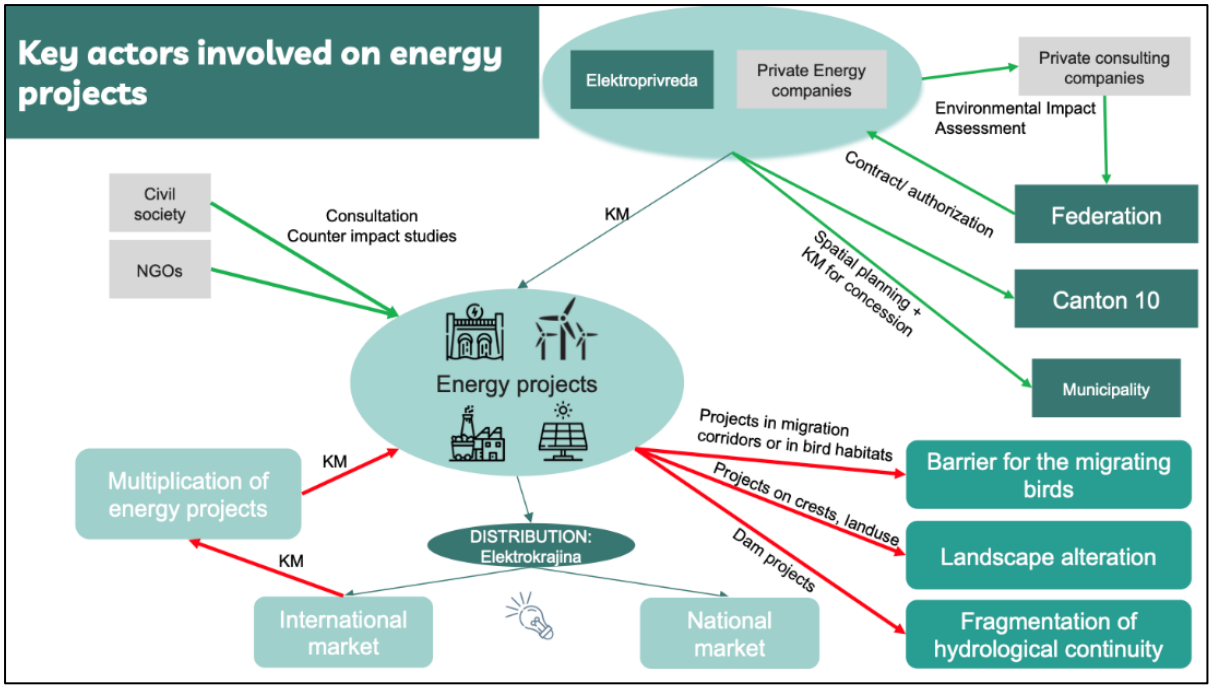

Figure 40: Scheme of the key actors involved on energy projects (Source: FNS-MI 2023)

(KM= Konvertible Mark; green arrows for the legal procedure, red arrows for the pressure on the environment)

This scheme shows the process of approval for an energy project in Canton 10. The initiative of new projects comes from both public and private energy companies (cf Annexe 5).

Public projects

It is possible to focus on the public energy sector operating in the study area. Electric production for the region is controlled at 90% by one of the three main public companies of Bosnia and Herzegovina, Elektroprivreda, that only operates in the Federation (EnL2). If it is a public company, they are mainly financed by their own earnings and international banks and are independent in the choice of the projects conducted. The federal law makes them responsible for public supply. The headquarters are in Mostar, controlling 7 hydropower plants, that are not in Canton 10, and one windfarm in Duvanjsko polje called *Mesihovina*. This last project was financed by the German Bank of development (71 M€) and Elektroprivreda. It is the biggest of the two operational windfarms in the study area, with 22 turbines with a total capacity of 50,6 MW. The windfarm started production in 2018 as the first wind farm project in the whole country. A second public windfarm project is called *Borova Glava* with "*15 turbines of 6 MW each. Starts in 2026.*" (EnL2)

Then, Elektroprivreda is planning two reversible hydropower plants in the study area. The first one called *Vrilo*, is between Livno and Tomislavgrad connecting the two poljes at the level of the Buško Lake. The second one is *Kablići*, in the north of Livanjsko polje, connecting Glamoč and Livanjsko poljes. These two projects are old ones that have been delayed because of NGOs' opposition to them. Also, it is important to note that the only form of energy that is produced is electricity. In Canton 10 there is no heating network, neither gas nor incinerators, everyone using wood, coal or electricity to heat their homes (EnL2).

Private projects

Concerning the private energy sector, two main projects are to be noted both in wind energy. The first one is *Jelovaca*, developed by FL Wind based in Tomislavgrad. This windfarm of 18 turbines and a total capacity of 36 MW, is producing since 2019. The second important project is called *Ivovik* and is developed by a Chinese company named PowerChina. The project is still under construction with an objective of 20 turbines and a total capacity of 84 MW. Also, a small solar farm is active in Canton 10 but only represents 2 or 3 MW (EnL2).

Two things are important to note concerning these private projects. First, there is no interaction between Elektroprivreda and the private sector for the construction of new projects as explained a worker of Elektropriveda: "*We have nothing to do with private projects. It's small projects and amounts of energy*" (EnL2). The only relationship they have concerns the energy produced, as Elektroprivreda has the obligation to buy energy from small producers. Second, there is a difference of scale between existing private and public infrastructures. As said before, 90% of the energy used in Canton 10 is produced by Elektroprivreda. There is then no real competition between them.

Nevertheless, 12 new private projects of windfarms are planned in the study zone, from which 6 have been allowed a concession between Livno and Tomislavgrad (cf Annexe 5). Most of these projects are financed by foreign companies, as the German company WPD who received concessions for the development of the *Čadilj* and *Marino Brdo* projects with a total capacity of 264 MW in Glamoč and Bosansko Grahovo (Schnibbe, 2022). Most of these projects are financed by foreign companies, as the German company WPD who received concessions for the development of the *Čadilj* and *Marino Brdo* projects with a total capacity of 264 MW in Glamoč and Bosansko Grahovo (Schnibbe, 2022).

Approval and concessions

Moreover, when the public or private companies come with a project, they must seek approval from the public authorities. The level of authority concerned depends on the size of the project. "*It depends on the capacity in Megawatts. A small project, it's us (the canton), less than 1 MW. If you want to build a windfarm below 1 Mega Watt it's our job. Above, it's the federation*" (EL6). Most often, as the projects are above 1 MW, it's the Federation of Bosnia and Herzegovina who gives the approval for the construction of a project. At this stage, international agreements can have a role in the approval or not of the projects. For instance, two old projects of coal thermal power plants (*Kongora* and *Celebic*) in the study area have not been approved as Bosnia and Herzegovina has signed the Paris Agreement and is trying to align to EU policies (EL2).

Once it is given, the companies must get the land and include the project in the spatial planning of the municipality and the canton. Almost all the projects are on public land, owned by the state, the canton or the municipalities. For the project to continue, they need to get a concession signed by the Canton's ministry of Economy and the Municipality:

> "*They don't buy land. They are getting concessions for 10-20-30 years. It's with the federation. They are giving them allowance and permission to build. Our ministry here (economy), is making the contract about the concession. They sign the contract with the investors about this concession*" (EL6).

WPD for instance signed two concessions with the Prime Minister of the Canton, the Minister of Economy of the Canton and the municipalities concerned (Schnibbe, 2022). As an important part of the public land is managed by Šumarija, they are also consulted when the project is on their land. For instance, "*the Forest Company in Tomislavgrad is making control of 57% of complete area of Tomislavgrad*" (PT1) including the area on which *Mesihovina* windfarm is installed. "*Because they are managing the area, they're asking the Forest company the approval for putting those things*" (PT1).

Then, the project must be included in the spatial planning of the municipality. "*It's made for 10 years. It's not approved today. This document is made ten years in advance but still not approved. Now it is maybe an older one that works. There is no spatial planning approved so it can change anytime*" (EnL2). This stage is a critical one, as the project can be blocked by the municipality or any other protection in place for the area. For instance, the Ramsar convention in Livanjsko polje blocked a project of solar panels on the polje: "*Solar power plants must be on this document. So, government needs to approve the document. So, it will block*" (EnL2). It is also decisive as it is difficult to change once it is approved and can be misused. That is the case with the *Ivovik* project. "*Ivovik is an old project, so it is here (in the spatial planning) but with very different numbers. In beginning, 6 or 7 turbines only were planned, with each 2 MW of power. Now, it's 20 turbines of 6 MW*" (EnL2).

Overall, the procedure to get all the approvals is very long and can take several years. Yet, some private projects seem to take shortcuts:

> "*In here, we at Elektroprivreda respect procedure, and it takes long to build projects. For Mesihovina for example. But Ivovik, it happened so so fast…. But Ivovik is old project from another company, that the Chinese bought and made happen very quickly.*" (EnL2).

Environmental impact assessment

The last key step of the procedure is the environmental impact assessment. This document is made at the same level than the approval (If the project exceeds 1 MW, it is discussed and agreed at federal level) (EL6). In fact, this document is not independently produced, but is made by the company launching the project and given to the competent authority, most often the Federation. Energy companies often rely on private consulting companies to produce impact studies. The project doesn't happen "*if we don't have them. We outsource them. For Windfarm is Ecoplan in Mostar*" (EnL2). This document leads to a public discussion at the local level including the local authorities and the civil society: "*Our obligation is to have public discussion with municipality. NGOs come and say, 'sorry you cannot build this because of impact'*" (EnL2).

Yet, this procedure is deeply criticized by NGOs:

> "*They are legally obliged to report finding speleological objects while working […] There are currently 2 wind farms in the area of Tomislavgrad, and no one reported finding a single speleological object while building these wind farms which is impossible*." (TT 1)

According to them, the main issue is that the study is not supervised by an independent institution:

"*They have to make an environmental impact study, and these studies are made by companies that are owned either by politicians or by someone very well connected, they make their studies without even going to the sites or by falsifying reports*" (TT1).

Then, the impact studies are not well done and do not answer to the environmental stakes of the area "*I had the chance to read one of the impact studies regarding the windmills project and it's just copy pasting from other projects even from other country*" (WL1). To try to avoid that, they send petitions to the ministry of the Environment of the Canton. If they manage to delay the construction of the projects, especially the hydropower plant of *Vrilo*, it is difficult to cancel it completely. The issue according to them is not only on the effects on the environment, but also on the benefits from these projects "*neither the canton, nor municipality, nor the state, will get richer… so people do not benefit from that. Only investors and politics*" (TL3).

International energy demand

The question of benefits links with the reasons behind the multiplication of the projects. Currently, the population in Canton 10 is decreasing, just as the demand in energy: "*This area here has big depopulation. Industry is down here. 90% here is household, industry is very low*"(EnL2). Then, most of the new projects are launched to meet the demand in the rest of Europe. In fact, this is not seen as an issue but even as an opportunity for electric companies, as the price is fixed in Bosnia.

"*We cannot give someone higher price without the permission from Sarajevo. We have a unique price for all our customers in households (0,10 €/KWh). We can give them lower or higher price depending on the time of the day: cheaper in the night and higher during the day. It is the only difference that we can make. The price is unique in BiH*" (EnL1).

Energy companies work with Elektrokrajina, a public company based in Banja Luka in charge of distributing the energy both in Bosnia and Herzegovina and connecting to European electric network. Selling internationally is then a way to increase revenues easily, especially by selling coupons of renewable energy:

"*Companies can buy certificates from us. We are also buying and selling electric energy to other companies, other governments, other national companies all the time. On daily basis, we are buying and selling. Some of the companies use the certificate that our energy is only renewable*" (EnL1).

The international feature is then double: not only are most of the energy projects developed by foreign companies, but they develop these projects to respond to foreign increase in energy demand and not local one. In fact, this paradox can be seen in the electric energy mix of Bosnia and Herzegovina. Today, electricity is already 100% decarbonized in Canton 10 according to Elektroprivreda (EnL2), mainly due to hydropower plants. Yet, it is not the case for Bosnia and Herzegovina as a country, that not only produces 70% of its electricity with coal thermopower plants (IEA, 2023) but doesn't plan yet to close them (Beyond Fossil Fuels, 2023). Then, these new projects do not seem to replace local electricity production but are rather destined to exportation. Actually, this is already the case as the country exports electricity, especially to Croatia, despite the large share of coal in Bosnia and Herzegovina's electricity mix and its engagements to reduce it (Electricity Maps, 2023).

This international relationship can be seen also in the Buško Lake. This artificial lake is inherited from the Yugoslavian times, as the water retention is in Bosnia and Herzegovina, but the hydropower plant Orlovac is on the other side of the border, in Croatia.

> "*This is a long story. It was flooded by 3 small rivers and all the people were moved from this part of our municipalities, Tomislavgrad and Livno. Right now, this Croatian electrical company [Orlovac] is paying every year 1 million marks to Livno and 2 million marks to Tomislavgrad, something like that. I am not sure, it depends on the production of electrical energy. They are producing this electric energy on the Croatian side. But the lake is on the BiH side*." (EnL1)

This contract with the Croatian electric company is seen as particularly unfair as the amount of money given is very low compared to other contracts of this type:

> "*This water is the property of our country. And they are using our rivers to produce electric energy on the republic of Croatia side. So they are paying for this produced electric energy. But we think that this money is very insufficient*" (EnL1).

In comparison, Elektroprivreda pays for the water in Rama Lake to produce hydropower energy about 14 million marks every year.

Links with environmental stakes

Finally, all this actual management of energy production in the study area has major consequences on the previously identified environmental stakes.

First, the multiplication of energy projects and especially windfarms, are creating a "barrier" on the crests. If the importance of renewable energy is not questioned, the densification of the projects between Tomislavgrad and Livno could be a threat for migrating birds that rest in the Livanjsko polje. As seen in the table of energy projects (cf Annexe 5), about 110 wind turbines are working or being built in a small area, surrounding the Buško Lake that is one of the main hotspots for birds (TL3). Incidents have already been recorded by NGOs and tensions appear with the electric companies: "*At first, problem with Mesihovina, with WWF and Ramsar. Because some birds were killed by windfarms*" (EnL2). In fact, NGOs have been warning from the consequences: "*The bird watchers are loudly saying the impact of those wind park in the bird migration*" (WL1). If the Ramsar zone seems to block energy projects on the wetlands where the birds nest, it doesn't protect the migrating corridors that follow the wind... just as windfarms. Another important issue according to some locals is noise: "*Birds are disoriented by wind farm. The biggest threat is for birds and wild horses*" (TL5).

Then, these projects also have consequences on the landscape. If most of the projects are still not constructed, the existing ones are visible from the whole area, as they are on the crests of the mountains. The landscape has not yet changed that much, but the number of windfarms is expected to at least double if not triple in the next years. For the moment local tourism is not really affected, but the area where most of the windfarms are planned, between Livno and Tomislavgrad, is also the area where you can see feral horses. Many tourist activities rely on the wild animals and the landscape to attract tourists. "*I don't know what will happen in the future, because I heard that they want to build many windmills*" (TL2).

Also, these wind power projects can pressurize a landscape unit that has a unique biodiversity: sinkholes. "*This is called prehistoric forest in karst. That thing underneath is an isolated ecosystem in the plateau, it is like a rainforest inside*" (TT1). The multiplication of projects can

destroy these endemic habitats and the unique flora that grows there, "*because they are planning to build them next to the sink holes and since this implies mining [construction of large concrete plot], there will be damages to the sinkholes*" (TT1).

Last but not least link between energy project and environmental stake (defined above), water continuity is also affected by the dams projects. Indeed, if water quality should not be endangered as the coal mines are not approved, the hydrological continuity is deeply affected by the existing dam that creates Buško Lake but could also be even more fragmented with the two hydropower plants planned in *Kablić* and *Vrilo*.

e. Peat extraction

All four of these main management stakeholder systems described above affect environmental issues in different ways. However, there is a last activity, peat extraction more localized that also put pressure, on environmental issuesThis activity that has an important influence in both the landscape and the bird habitat is peat extraction. Only one area is concerned nowadays by this activity in the north of Livanjsko polje, in the municipality of Bosansko Grahovo next to Crni Lug. The peat is extracted by a private company named Ekoterra, owned by an investor in London. Just as an energy project, they had to pass all the levels of approvals: "*It's a 30-year concession for 770 ha surface. We got the approval from the Federal Ministry of Economy, then the approval from the Canton's ministry of Economy. We have regular inspection from the canton"* (IB1). According to the company, 97% of the peat, or turba, is exported to the EU through one client in Croatia as fertilizers: "*We only have black peat here. There are two types of peat that exist: white and black. Black peat is used for fertilizing soil and gardening*" (IB1). White peat is used as a fuel to produce heat.

If the company assures that they respect the European norms and that they put an "ecoprotection" after extracting (IB1), the local population is critical about it, especially for its consequences on birds that nest there: "*It is a problem. It happens in Zdralovac, it is the main place for cranes*" (TT1). In fact, the peat extraction activity is precisely at the heart of the protected area planned in the Protected Landscape project of 2021 (CENER21, 2021). Yet, the company explains that they don't have impact on birds: "*No. They don't nest here, they nest around*" (IB1) and that they collaborate with Naše ptice, the ornithologist association, to report birds coming to the area. Nevertheless, this activity has at least an impact on the landscape, as their activity is in the middle of the wetland of Livanjsko polje.

Finally, an interesting thing about this activity was the lack of knowledge about the status of this activity in the common population. Most of the actors interviewed actually believed that peat extraction was not working anymore: "*as far as I know the company is closed. I believe it is not working, maybe some private company is doing it. But it did destroy the wetland* "(TL3).

f. links between activities and environmental stake

To conclude, here is the repartition of pressure resulting of management systems according to each environmental stake (Table 5). Indeed, each activity described above have specifical impact on environment. It's important to understand and describe deeply the management of each activity to analyse the best practises and possibilities to take action to protect the environment. …

Environmental Stake	*Negative impact*	*Positive impact*
Water quality and quantity	- **Livestock intensification & use of chemical fertilizers** (linked to targeted subsidies and public administration development strategies) (Polje and Bench Land) - **Lack of water treatment and filtration system** (Polje; Bench Land; Underground cave) - **Under-organized waste collection and recycling channel** (Polje; Bench Land; Karst Plateau; Underground cave). - **Seasonal population increase** (all landscape units) - **Hydropower plant** (polje and underground caves)	- Small local NGOs (tourism & fishing) organizing **waste collection and river cleaning** - **Monitor and analysis on waters** - Public and international development **funds for water treatment infrastructure** - Small local NGOs (tourism & fishing) **sensibilizing locals and tourists** - **Well managed forest land cover** for water filtration role (slopes)
Fragmentation of bird habitats	- **Windfarms** and windfarm projects (mountain crests) - **Peat extraction** (polje) - **Fire** (polje) - llegal and **unregulated hunting** (polje; bench land)	- **Well managed forest land cover** (slopes) - **Hunting association regulating hunting practices** - Small local NGOs (tourism) **sensibilizing locals and tourists** - **Traditional grazing** (polje; bench land)
Landscape alteration	- **Windfarms** and windfarm projects (mountain crests; undergroung caves) - **Peat extraction** (polje) - **Fire** (polje) - **Land abandonment** (polje; bench land)	- **Well managed forest land cover** (slopes) - **Traditional grazing** (polje; bench land)
Hydrological continuity	- **Windfarms** and windfarm projects (mountain crests) - Small agricultural **dams and drains** (polje) - **Hydropower plant** (polje and underground caves)	- OpenRiversProgram : **Dams removal** (polje)
Degradation of flora	- **Land abandonment** (polje; bench land) - **Peat extraction** (polje) - **Fire** (polje) - **Livestock intensification & use of chemical fertilizers** (linked to targeted subsidies and public administration development strategies) (Polje;Bench Land)	- **Well managed forest land cover** (slopes) - **Traditional beekeeping, grazing and culture** (polje; bench land)

Table 5: Distribution of pressure from management systems on each environmental issue (Source: FNS-MI March 2023)

IV. Discussion

The overview of actual management systems gives a broad understanding as to how the activities of the territory are linked to the previously identified environmental stakes. These systems of actors also allow to identify the different key organizations and the strategic actions that could reduce the pressures on those environmental stakes.

The diagnosis proposed above is an initial study of the area, and several elements need to be clarified and better defined by further studies. For this reason, the strategic actions outlined below should be seen as a basis for discussion with all the stakeholders in the territory, based on their other knowledge.

1. Actions on the actual management

This report has identified several strategic action tracks based on the described actual management system.

a. The water sector

Following the management systems description in part III.5.a, three strategic courses of action were identified towards solving the water pollution issue: (i) investment in water management infrastructure, (ii) cooperation between the different Komunalnos, and (iii) changing agricultural practices.

To answer the first following question: regarding open air landfills and non-treated sewage water, how could the water and waste treatment facilities be improved to block direct waste emissions? Increased funding for Komunalnos to improve waste collection and disposal as well as wastewater treatment could be a first course of action.

The analysis shows two possible ways to increase funding for Komunalnos: the renegotiation of the water contract with the Croatian hydropower company, and the increase and redirection of public and international funding towards needed renovation and works.

Can the contract with the hydropower company in Croatia be renegotiated to secure more funds to this end? Indeed, as seen in part III.5.a and III.5.d, Croatia's hydropower dam depends on the availability of Canton 10 water. The environmental health of Croatia's Cetina water basin also depends on the quality of Canton 10 water. It is therefore in Croatia's best interest to enable local Komunalnos of Canton 10 to manage their water in a sustainable way. Currently, it looks like the price for water paid by Croatia to Tomislavgrad and Livno is undervalued and not distributed in a fair way. Undervalued because it is much less than the price of a cubic Liter used within the FBiH (cf. III.5.d, PK2), and not distributed in a fair way because the municipalities of Glamoč and Kupres who are indirect water distributers are not currently remunerated (cf.III.5.a, PK2).

The surplus money generated by a higher price of water could be used to develop water and waste management infrastructures (e.g. to build water filtration systems)

Concerning the impact of dams on water continuity and pollution, more information needs to be collected on the matter. This is an important point to consider and investigate in future territorial studies as it is essential to ensure the relevance of the water-related actions implemented.

Similarly, can institutional and international actors (municipalities, Canton 10, FBiH, and international development banks) direct their funds and projects to address the issue of water pollution? In this regard, it would be beneficial that the Adriatic Sea Agency's (ASA) water management plan highlights this issue and include solution pathways to tackle it. It would contribute to the growing awareness of the water pollution environmental stake and could ultimately influence institutions to fund appropriate projects. Increasing the water quality monitoring and reporting to raise awareness about this environmental issue and its main sources would enable local actors to act upon it. Eventually, efficient water management will inevitably require increased subsidies to wastewater management actors.

Komunalnos and municipalities work independently on their territory (cf.III.5.a, PK2). As all waters are linked, would it be beneficial to improve coordination between each Komunalno as well as between Komunalnos and ASA. Given the interconnectedness of the waters between the different poljes, an integrated water management involving more collaboration between the agencies of Canton 10 is most likely to improve the quality of water on the whole territory. More precisely, this research shows that the communication can be improved at two levels: (i) between each Komunalnos, and (ii) between Komunalnos and the ASA. On the one hand, more communication between Komunalnos could encourage the sharing of best practices on water management. It would also enable Komunalnos to share their issues and speak in a collective way to the ASA and other national institutions. On the other hand, an increased communication between ASA and each Komunalno would enable to better target local issues to be included in the water management plan every five years (including water pollution). All in all, a more unified and collaborative way to manage the Canton 10 water seems to be a good way forward towards tackling water pollution. One reason behind the lack of communication between water management actors can be the default of financial and human means. Our interviewee at the ASA reports that the agency would need double their employees to be able to properly carry their prerogatives (PM1). The fact that Komunalnos are bankrupt in two of the five municipalities in the study area is also a blocking factor to tackle the environmental stake of water pollution. It is therefore necessary to increase financial and human means of water management actors before redirecting national and international subsidies towards projects related to water pollution.

Regarding the pollution from agriculture, it seems difficult to act at the direct level. However, can the requirements for national subsidies or the PGI of the *Livanjski Sir* evolve in a way to boost more sustainable agriculture practices? This topic will be tackled in the upcoming part.

b. The agricultural sector

In regards of the agricultural sector, our analysis of the actor system highlights a twofold trend: a decline in the number of small farmers and an increase in the number of large livestock farms which could be based on intensification. Indeed, large scale cattle breeding, and pesticide/herbicide used increase pressure on the water pollution environmental stake. Simultaneously, abandoned land and the resulting afforestation phenomenon increase pressure on landscape alteration and flora degradation environmental stakes. Two strategic action tracks could help improve the study area's environmental management systems: (i) the promotion of environmental standards in the cheese fabrication process and (ii) the revision of the agricultural subsidy attribution system.

As detailed in section III.5.b, it is necessary to clarify that the current *Livanjski Sir* under the PGI is very different from the one initially envisioned during its creation over 10 years ago. Initially, this PGI was focused on traditional cheese production practices. The PGI aimed to strictly regulate its fabrication process through rigorous Product Specifications (PS) that would impose namely the presence of a minimum proportion of unpasteurized sheep milk coming from a determined territorial surface in Livno and Glamoč municipalities. It would seem however that, nowadays, the officially adopted *Livanjski Sir* PGI's PS are much more flexible than that. This PS have fewer production requirements. For instance, the actual PGI does not impose a minimum proportion of sheep milk in the cheese production process. It is produced with a majority of cow milk and is sold in European markets with the *Livanjski Sir* name. Moreover, it does not impose a territorial delimitation for the milk's origin. One large-scale cheese producer affirmed their milk supply came from as far as 100 kilometres from Livno, out of the traditional *Livanjski Sir* cheese perimeter of milk production (AL1).

Most importantly, the PS steps and formalities do not include environmental criteria in the cheese fabrication process. In order to preserve the study area's environmental attributes, it seems crucial to exert control systems on these large-scale cattle-breeding structures. Therefore, it could be highly beneficial for the study area's environmental stakes to modify the *Livanjski Sir* PGI's PS to include environmental criteria such as ensuring that the milk production respects environmental standards that protect the study area's environmental attributes.

This would require bringing modifications to a document that was officially adopted as the result of a long-winded, institutional process in which actors from the study area have different levels of influence. The definition of a PGI in BiH follows a top-down logic in which State institutions determine much of the content and the format of the PGI proposal, excluding consumers and producers from the decision-making process (Bernardoni *and al.*, 2008). Consequently, any modification to *Livanjski Sir* PGI's PS would require substantial efforts by several if not all actors in the cheese production sector (actors that might not agree with such modifications) to influence national administration representatives and national public agencies such as the Food and Safety Agency. Having little to no knowledge on relationships between this national-level actors, this study cannot propose any meaningful strategic action track to improve the environmental management system around the *Livanjski Sir* PGI's PS.

Other strategic action tracks on agricultural subsidies seem particularly appropriate for the study area. The analysis of the agricultural management systems reveals a widely diffused objective from public authorities on municipal, cantonal and federation levels, to increase cattle breeding figures during the next few years. This objective is implemented through a subsidies system that encourages certain practices over others.

As detailed in the actual management for the agricultural sector section, the largest farms and industrial Livanjsko cheese producers are systematically targeted by the federal and cantonal subsidies, with criteria based on the number of heads and hectares per farm. For instance, the subsidies are attributed only to farmers that possess at least 50 heads of cattle. For smaller farms, subsidies will be attributed either by the municipality or by the Canton. As one dairy producer put it:

> "*If you are a small (farm), it is the municipality that helps you, because you are there, you participate at the local level. The bigger you are, the more aid you can get from the canton and the federal level. It depends on the number of animals. 50 is the minimum, if you want*

help at the federal level, you must be at least 50. But it depends on how many males, females, they (the public authorities) count everything: the young sheep, the old ones, those who do a lot of milk." (AL5)

The review of Canton 10's development strategy plans, as well as that of several municipalities in the study area confirms this type of field findings. The case of Tomislavgrad is particularly interesting in this regard, as it is the municipality where there is the strongest will to increase the number of large-scale farms and to reduce the number of small farms. The following excerpt from the municipality's development strategy for 2017-2026 states:

"*Peasant farms must be taken out of the natural circle and directed directly to the market, which is the most important problem for peasant production in modern agriculture. These family farms must be subject to a control system in accordance with all legal provisions relating to the production and trade of food products. This path will lead to an increase in the number of cows on family farms, as well as in milk production per cow, which will only be sustainable under free market conditions. This will reduce the number of small owners with fewer cows.*" (Općina Tomislavgrad, 2017)

Two things come out of this excerpt. First, that there is an officially stated municipal policy to promote large-scale farming practices. In the process to reach this goal, the disappearance of small farmers is a positive, necessary transformation to reach the desired economic development objectives. Second, that the main tool to implement the municipality's endeavour is a control system based on subsidies.

The reviewed strategic development plans assume that the economic development of the five municipal territories in our study area is not compatible with the presence of small farmers. However, as discussed, this subsidy strategy encourages large-scale farmers to further increase their large-scale cattle breeding activities and industrial Livanjsko cheese production. The resulting increase in intensive agricultural practices has a substantial impact on this study's environmental stakes.

Therefore, one of this report's key action track proposals is the repurposing of public fundings to retarget subsistence agriculture farmers and small farmers, whose production could be switched to organic and agroecological sustainable practices. By targeting farmers under a certain number of cattle heads or hectares, this measure would improve the living conditions of rural dwellers and encourage the use of traditional agricultural practices. This in turn would reduce afforestation, thus relieving pressure on landscape integrity. It would also foster the emergence of agricultural tourism by directing public expenditure on organic farming practices that attract food and agriculture tourism industries. This sector is yet to be developed in the study area, and it could subsequently reduce negative impacts from intensive agriculture on natural habitats, while also contributing to the economic development of the concerned territories.

Such a reframing on agricultural subsidy policy would have to be implemented with regards to the different scales of public administration. While municipal authorities are already responsible of the subsidies for the smaller farmers, cantonal and federal level administrations are directed to larger farms and industrial Livanjsko cheese producers. Taping into higher administrative levels could allow not only to unblock public expenditure for small farmers, but also for a larger and more systematic coverage of Canton 10's territory, increasing the impact of this scheme.

This small farmer scheme could take many other forms, with a different set of criteria depending on the public policy's focus. For instance, instead of subsidizing small farmers under a certain number of cattle heads or hectares of land, subsidies could be targeted depending on the farmer's adoption of traditional and agroecological practices such as crop rotation, diversification of cultivated species or a minimum quantity of open-field cattle grazing days per year. This in turn would dynamize the agricultural sector in rural areas where subsistence farming is dominant. Traditional products such as the traditional *Livanjski Sir* would indirectly benefit from such policy. This would also be the case for other agricultural commodities that generate secondary income: honey, wool and fungus/herbal species to name just a few. Developing the agricultural tourism industry could moreover reduce municipalities' economic dependency on large-scale agricultural production and exports to reach their development goals.

The proposed action track assumes that public authorities are not committed to follow their strategic development plans word for word. Instead, there is room for manoeuvre to adapt the implementation of these plans in accordance with the circumstances. Once again, these strategic development plans are projections for the future of the study area. These projections are hypothetical, and therefore can be changed depending on the social, economic, and environmental circumstances. Municipalities seem the best suited scale to operate this type of changes in subsidy policies, as they have enough autonomy to shape their territorial funding systems. Perhaps a trial-and-error strategy could be the best approach to build a robust small farmer scheme that addresses the environmental stakes defined for this analysis.

Agriculture contributes to transforming the landscapes and consumes a large part of the land. These practices can have a positive impact on the study area. But other sectors of activity may have opposite effects on the defined environmental stakes. The following section delves into the numerous energy projects underway in the study area, and the increased pressure they exert on it.

c. The energy sector

Based on the intentional management of the energy sector detailed previously, it is possible to suggest some actions to solve, or at least, reduce some of the identified pressures linked to this activity.

First, the Spatial Plan is a key element to build any new energy project. The development of such projects must be planned in this document in order to be approved: "*For instance for a windfarm, is it compatible with the Spatial Plan? If not, it won't pass"* (EL6). The main impact of the energy projects (wind farms, solar plants, or hydro-electric dams) is the disturbance of the birds and their habitats. If those environmental stakes are considered in the Spatial Plan then the pressures from such projects could be greatly reduced.

Second, the decision to change the Spatial Plan to allow industrial energy projects above 1 MW is made by another administration than the local one. This means that the local actors, which have the best knowledge concerning the environmental specificities of the area, have very few impacts on the development of such projects. *"It's funny because the one part from all the wind parks is 5 MW [so] it's a federal job*" (EL6). However, it seems possible to counterbalance it by the fact that the municipalities must give a concession for the use of the land. "*These projects are big so the permissions are at the federal level for paperwork, in Sarajevo. […] The municipalities give concessions*" (EL1). In order to ensure the protection of

the local environmental stakes, local actors like the municipalities, the civil society or environmental NGOs should be more involved. Indeed, those actors see the state of the environment in the study area and some have the scientific knowledge and the local experience necessary to define the solutions to the identified pressures.

Third, as seen in the section III.5.d, the environmental impact assessments required for each energy project are done by experts selected and appointed by the developers of the projects. This may create a conflict of interests, leading to biased results: "*The consultant* [producing the impact studies] *writes what the investors wants. And also they get subsidies because they still consider it as a green energy*" (WL1). The solution may be to entrust these studies to a third party with scientific knowledge and experience in the environmental impacts, like the NGOs. To complete this academic knowledge, the field experience of the civil society could be used via public consultation.

Fourth, as also seen in the section III.5.d, some private companies seem to be allowed not to follow the rules defined above. More research should be done on this topic to understand how it happens. However, it seems that a better follow-up of the rules could reduce the number of projects which can damage the environment of the study area.

To go further, it seems relevant to use the criteria used in France by the NGO France Nature Environnement (FNE, 2020) as an exemplary tool used to reduce the pressures from the wind farm energy. The Canton 10 has a great wind energy potential which opens the possibility of more intensive development. As mentioned before, the number of windfarm projects is growing and can impact irreversibly the bird's migration among other environmental stakes. In front of the intensification, the FNE criteria can be used to have an opinion and to evaluate any new sustainable wind project. The development of wind energy must therefore be done in a way that has the least possible impact. Considering these following criteria from FNE, it becomes possible to assess whether several wind farm projects in the Canton 10 are sustainable or not.

More precisely, FNE criteria are indicators of good practices and points to watch out (FNE, 2020). The FNE criteria are divided into 6 themes (Planning, Environment, Biodiversity, Description, Governance & Renewal). Here, the focus is made on four "biodiversity" criteria, which are considered relevant in the evaluation of wind farm project in a sustainable way for biodiversity and environment:

1. Avoid Special Protected Areas (SPAs) and wetlands: SPAs as Important Birds Areas (IBA) and wetlands are important areas for the conservation of threatened bird species. IBA aims to maintain the bird populations concerned and to reduce the pressures on them. FNE suggests that wind farm projects should therefore be avoided in these areas. In the study area, the wind farms are located on the karst plateau or in the crests, so not directly in the IBA. However, the proximity to these areas can be a point of vigilance for the future.

2. Choose a low-stakes location: the second criteria concerns the geographical position of the project. Wind farm projects should not be implemented in areas with strong biodiversity risks even if it is not in wetlands or in special protected area. FNE recommends staying away from them and avoiding the areas such as Natura 2000 sites and SPAs designated for birds and their surroundings. A judicious choice of the siting area makes it possible to avoid a maximum of impacts. The project "working

together for Natura" is looking for potential Natura 2000 sites in Bosnia & Herzegovina and more particularly on the Canton 10 (Laner et Favilli, 2022). So, to respect this second criteria, it would be wise not to place wind turbines near these potential future protected areas.

3. Avoiding biological corridors & impact on birds: biological corridors should be avoided by wind projects, with priority given to those concerning wind-sensitive species. As mentioned before, karst poljes are precious bird areas and crucial migrating places for birds. In this sense, energy projects should be attentive to the position and the height of their blades. One by one, wind projects do not have a significant impact on biodiversity. However, it is the intensification of these projects, in a specific area between Šuica and Livno, which can constitute a migratory barrier for birds. All these projects surround on the biggest bird spot: the Buško Lake. Some NGOs as WWF Adria and Naše Ptice have already reported damage on biodiversity because of these turbines. This is therefore a crucial point of vigilance.

4. Layout of machines on site and their characteristics: the choice of the wind turbines' dimensions and theirs positions on site are crucial parameters for birds' protection. It should be made according to the landscape, acoustic, environmental and economic issues. For instance, it is important not to have a too high density of turbines. The greater the number and rows of turbines, the greater the risks of impact.

These four criteria are part of a set of other criteria that will give a theoretical score for a wind project on the environment. It is not an environmental study assessment, but it is a tool for local stakeholders to evaluate a wind project, especially if the technical characteristics are missing.

All these proposals, extracted from the territory analysis and the territory's stakeholder's system, cover a non-exhaustive set of heterogeneous courses of actions, more or less easy to implement and involving multiple levels of decision-making. These courses of action aim to highlight the specificities that emerge from the functioning of the actors in the territory in order to identify what can be done based on the current management. However, in order to deepen and formalize the environmental protection of the karst poljes and inter-poljes, it may be interesting to study which protection systems can be adapted and appropriate to the territory and to the expectations of local actors. Several protection systems have been studied, at different levels (local, national and international) and at various stages of implementation (implemented, already studied or suggested after this study).

2. Overview of potential protection systems

Several protection systems will be presented in the following paragraphs. To clarify the supposed impacts of each one of them on the study area, the table below state the different labels, networks, status of protection and environmental project and their actions on the identified pressures, grouped by environmental stakes. An "X" means that the certificate could solve, or at least reduce, the considered pressure.

It is interesting to note that the pressure from the sewage waters, from the cities, cannot be tackled by environmental protection systems compared in the table below. Indeed, this

pressure is a production of the cities themselves and does not come from a use of the natural resources.

The two lines called “addressed stakes” show the stakes which are protected by the label, network, status or project defined by the column. Two methods have been used:

- Light method: a stake is considered addressed if at least half of the pressures are solved or reduced.
- Strict method: a stake is considered addressed if all the pressures are solved or reduced.

The line called “current obstacle to feasibility” is used to present the status and requirement of each system, to highlight that its efficiency also depends on some administrative and sociological aspects.

The Protected Geographical Identification, *Livanjski Sir* has not been represented in this table because it does not impact any of the pressures.

Pressures	Ramsar	FBiH Law II	FBiH Law Va	FBiH Law VI	Open Rivers	Glamočki Krompir	Emerald Network	GIAHS	Cultural Landscape	Geopark	Biosphere Reserve
1 – Water pollution											
Large scale cattle breeding	X	X	X	X			X	X	X		X
Polluted waters (city sewage)											
Urbanization	X	X	X				X	X	X		X
Fertilizers and pesticides	X	X	X	X		X	X	X	X		X
Polluted waters (agriculture)	X	X	X	X		X	X	X	X		X
Wastes	X	X	X	X			X		X	X	X
2 – Fragmentation bird habitat											
Polluted waters (agriculture)	X	X	X	X		X	X	X	X		X
Wastes	X	X	X	X			X		X	X	X
Wind farm	X	X	X	X			X		X	X	X
Solar farm	X	X	X	X			X	X	X		X
Afforestation	X	X	X	X			X	X	X		X
Peat extraction	X	X	X	X			X				X
Poaching	X	X	X	X			X				X
3 – Landscape alteration											
Urbanization	X	X	X				X	X	X		X
Wastes	X	X	X	X			X		X	X	X
Wind farm	X	X	X	X			X		X	X	X
Solar farm	X	X	X	X			X	X	X		X
Dam (energy)	X	X	X				X	X	X	X	X
Afforestation	X	X	X	X			X	X	X		X
4 – Frag. hydrological continuity											
Dam (energy)	X	X	X				X	X	X	X	X
Water retention	X	X	X		X		X	X	X		X
Dam (agriculture)	X	X	X	X	X		X	X	X		X
5 – Degradation of flora											

Solar farm	X	X	X	X			X	X	X		X
Afforestation	X	X	X	X			X	X	X		X
Fertilizers and pesticides	X	X	X	X		X	X	X	X		X
Addressed stakes (light method)	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 5	4	-	1, 2, 3, 4, 5	1, 3, 4, 5	1, 2, 3, 4, 5	3	1, 2, 3, 4, 5
Addressed stakes (strict method)	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 3, 4, 5	1, 2, 5	-	-	1, 2, 3, 4, 5	4, 5	1, 3, 4, 5	-	1, 2, 3, 4, 5
Current obstacle to feasibility	Local support	National and local support	Local support	-	Legal framework	Local support	Local support	National and local support	National and local support	National support	National and local support

Table 6: Summary of the protection systems' impacts (Source: FNS-MI March 2023)

First, the protection systems that are already implemented or discussed in the study area will be presented in the following paragraphs.

3. Protection systems implemented or under discussion

a. Emerald Network

The Emerald Network has been created to ensure the protection of European protected sites. The aim is to have a long-term survival of the species and habitats of the Bern Convention requiring specific protection measures (European Environment Agency, 2022). For Non-EU countries, the Emerald Network is an important contribution to the new steps towards European nature conservation streams as it is an excellent and useful preparation for Natura 2000. When a site is included in the Emerald network, a management plan is drawn up which, when implemented, can resolve most of the pressures identified. The Emerald Network has been created to ensure the protection of European protected sites. The aim is to have a long-term survival of the species and habitats of the Bern Convention requiring specific protection measures (European Environment Agency, 2022).

The Emerald Network was launched in 1989 and became fully operational in 2020. The state of Bosnia-Herzegovina ratified the convention in 2008. The Livanjsko polje is selected, in 2022, as one of the 29 potential Emerald site in Bosnia and Herzegovina, as shown by the map below.

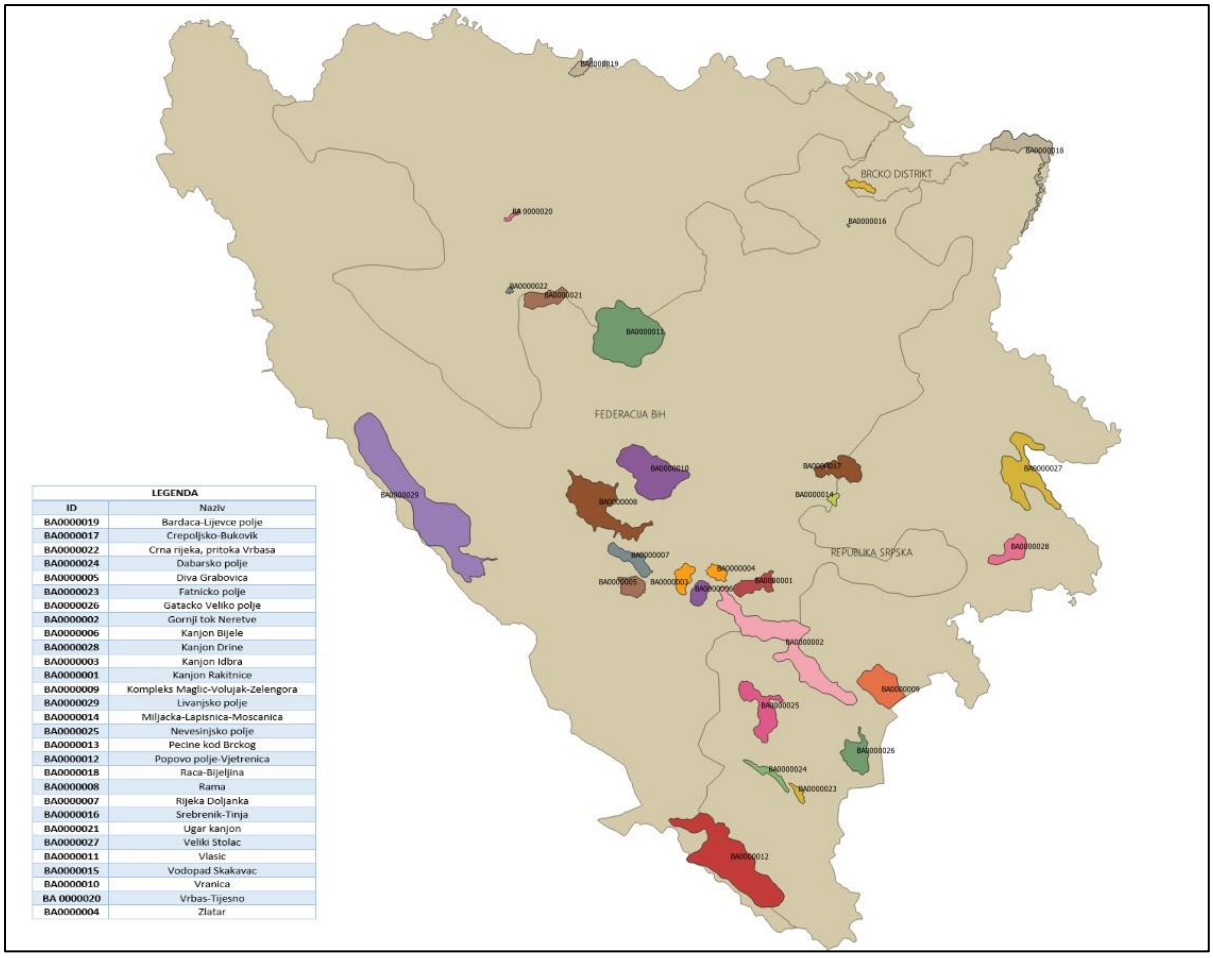

Figure 41 : Potential Emerald areas in Bosnia-Herzegovina (Federation of Bosnia and Herzegovina, 2023)

This list of candidate Emerald site has been submitted in December 2022 to the Standing Committee of the Bern Convention by the government who is also responsible for the surveillance of the status of the protected species.

However, similarly for Ramsar, a non-implication of the local level could lead to a protection in name only, without any real improvement on the territory. It could then be interesting to study other solutions allowing a stronger local involvement.

b. Ramsar

The List of Wetlands of International Importance, also known as the Ramsar List, refers to Sites containing representative, rare or unique wetland types. The Ramsar List is the world's largest network of protected areas. There are over 2,400 Ramsar Sites on the territories of 172 Convention Contracting Parties across the world.

The Livanjsko polje has been added to the Ramsar list in 2008 under 7 out of 8 criteria used to define Wetlands of International Importance (Ramsar, 1999):

1. It contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.
2. It supports vulnerable, endangered, or critically endangered species or threatened ecological communities.

3. It supports populations of plant and/or animal species, important for maintaining the biological diversity of a particular biogeographic region.
4. It supports plant and/or animal species at a critical stage in their life cycles or provides refuge during adverse conditions.
5. It regularly supports 20,000 or more waterbirds.
6. It regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.
7. It supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.

It consists of 458.68 km² on the territory of three municipalities: Livno, Bosansko Grahovo and Tomislavgrad (Stumberger & Gotovac, 2008) and is the only existing protection in the study area.

Despite the significant potential for the protection of the birds and their habitats, this system did not receive the political nor the financial support to implement any action to solve the pressures on the environment, as illustrated by an elected representative: "*It's a piece of paper to me*" (EL5). As a result, there is no clear operational strategy in place: there is no representative nor manager of the area and the essential management documents; like the management plan, are missing. This protection has then no real effect on the activities impacting the wetlands and their biodiversity: "*Ramsar forbids hunting in the area and everyone is hunting with illegal traps and stuff like that"* (TT1). Only once, Ramsar has been mentioned as a potential protection for supervising the development of energy projects: "*Solar power plant in Livanjsko, for instance, cannot go because of Ramsar*" (IL1). There is an action on-going to instore another system in order to re-enforce the Ramsar protection: "*The Protected Landscape national legislation project would constitute a management plan as part of Ramsar's management obligations*" (WL3). This other system will be detailed in the following paragraph.

c. Protected landscape

The Federal law on nature protection (2013) introduced establishes a framework of different protection tools that can be used to preserve the environment. Article 134 introduces the following different types:

- Category Ia: Strict Nature Reserve
- Category Ib: Wilderness Area
- Category II: National Park
- Category IIIa: Nature Park
- Category IIIb: Monument of Nature and nature characteristics
- Category IV: Area of habitat/species management
- Category Va: Protected Landscapes
- Category Vb: Regional Park
- Category VI: Protected Area with Sustainable Use of Nature Resources

These different types of protected areas (PAs) are ranked according to their level of protection based on the IUCN framework (IUCN, 2008). The smaller the number of the protection (on a scale of I to VI), the stricter the protection (including less human access to the area). As it was seen in IV.3.c. the environmental diagnosis of the Livanjsko polje and the consultation of local

municipalities, have landed on the designation of a Protected Landscape (Category Va) which now seems difficult to implement. In-depth analysis of the different protection tools allows to widen the number of options to protect the territory.

One of the most promising current actions is the enforcement of the Protected Landscape law project that is currently being submitted for approval. It is the result of the UNEP & GEF project "*Achieving Biodiversity conservation through creation, effective management and spatial designation of Protected Areas and Capacity Building in Bosnia and Herzegovina*". It started in 2016 and is still ongoing. Its main aim is to define protected areas in the country. Among other worth-protecting areas in BiH, the Livanjsko polje was identified as one main target area to protect within this project. CENER21, an environmental consultancy firm in the Balkans, was mandated to produce a scientific justification report and law proposal to establish the protected area. It is a mandatory step towards the designation of a protected area according to the Federation Law on Nature Protection of BiH (Official Gazette 66/13). It aims at (i) referencing the most exceptional environmental attributes of the site, and (ii) proposing an appropriate protection tool as per the Federation Law on Nature Protection (Official Gazette 66/13).

CENER21 sent approximately 20 experts on the field over the course of 12 months to study the main environmental attributes of the Livanjsko polje covering the four seasons. These included a botanist, fauna experts, ornithologists and herpetologists among others. Field work was not continuous, it was rather sporadic and included travels back and forth between Sarajevo and the Livanjsko polje (WS1). CENER21 consultants also liaised with local municipalities involved in the project, i.e., Livno, Bosansko Grahovo and Tomislavgrad. Most communication was done via the sending of enquiries and consultative meetings to establish a zoning that would meet the protection objectives as well as being compatible with local use of the territory and its resources.

The means of protection that was deemed appropriate by the scientific report was the "Protected Landscape", corresponding to the UICN level of protection Va.

According to Article 140 of the Federal Law of BiH (Official gazette 66/13), Protected Landscape corresponds to:

> *"A protected area that occur(s) through the interaction of humans and nature, and is characterized by its significant ecological, biological, cultural and aesthetic values. Maintenance of the humans and nature interaction is of vital importance to the protection and sustainability of the area along with natural and other values."*

Its primary objective is the *"protection and maintenance of important (…) nature parks with the values that occurred through the interaction of humans and traditional management practice"*. This specific protection measure would enable to preserve the link between traditional pastoralism, agriculture, and the biodiverse wetland within the polje.

The zones of the Protected Landscape area were defined as follows:

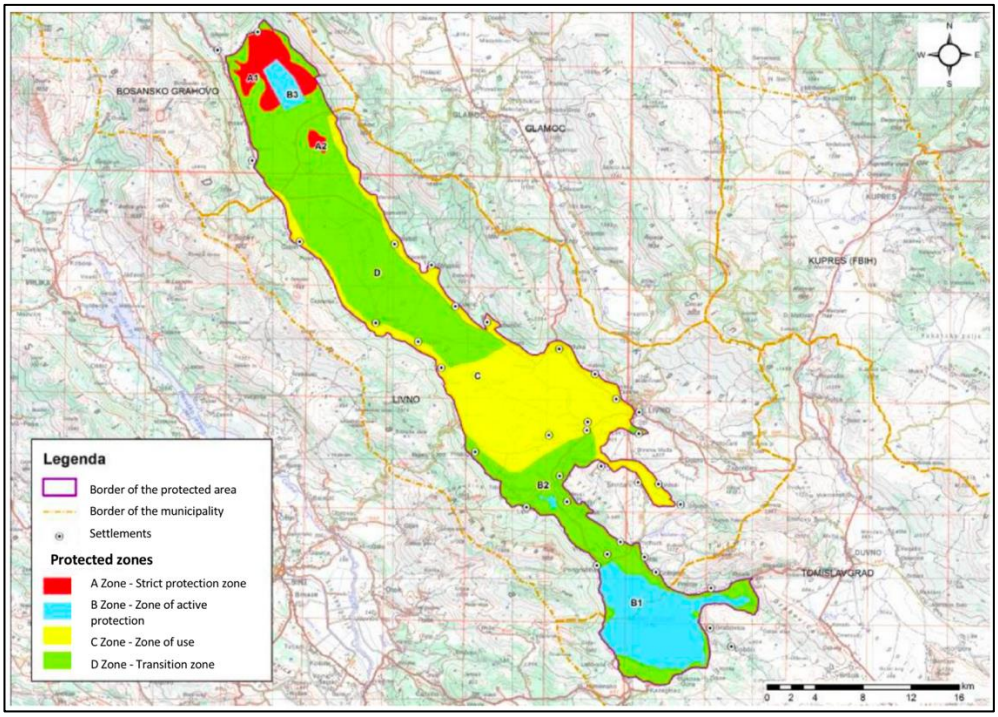

Figure 42: Protected Landscape Final Zoning Proposal, (Source: Cener21 report, 2021)

In each zone, some activities are allowed and prohibited:

A Zone – Strict Protection	Prohibition of felling or altering trees except for sanitary purposes Prohibition on disturbing the hydrological regime of water resources and peatlands Prohibition of collection of medicinal plants Prohibition on the collection of fauna and flora specimens Prohibition of disturbing birds or moving nests Prohibition of disposal of any type of waste Prohibition of hunting and fishing Prohibition of construction
B Zone – Active Protection	Prohibition on draining aquatic habitats Prohibition on the exploitation of mineral resources Ban on hunting and fishing Prohibition of collection of endemic, threatened or protected fauna and flora specimens Prohibition of agricultural activities Prohibition of construction Prohibition on lighting fires Prohibition of littering
C Zone - Use	Prohibition of felling of trees that do not conform to the "anthropo-economic" basis Prohibition of introduction of invasive alien species Prohibition of construction activities in water source areas Lighting of fires to control weeds Ban on the use of chemical agents in agriculture
D Zone - Transition	Ban on cutting "that does not conform to the economic base Prohibition of hunting "that is not in accordance with the economic basis". Lighting fires to control weeds Prohibition to build without conformity with the land use plan

Table 7 : Summary of the activities in the Protected Landscape according to the defined zoning (Source: Cener21 report, 2021)

Despite its benefits for the environment, the current Protected Landscape law project faces many obstacles.

The Protected Landscape law project is an initiative to use federal protection to protect the territory (albeit international development agencies being at its source). On paper, the initiative seems to be addressing all environmental issues that have been identified on the territory and allows for most territorial practices to last over time (including traditional grazing). NGOs also agree with this project, which they deem "*sufficiently ambitious*" (WL3). However, in practice, CENER21 reports that municipalities are reluctant to approve it: *"We faced obstacles with institutions. Here people are not used to the protection of areas. Especially municipalities. They didn't accept the proposal. They postponed it"* (WS1). The expert further added that municipalities did not mention the reason for their reluctance to accept the project. Without their feedback, it is impossible for the agency to modify the law proposal. "*We finish our part of our assignment (the law proposal), we will not do more. Next thing is either agree or make alternate proposal from the canton. Without this, we can't go further"* (WS1).

The territorial analysis shows that such a protection measure would tackle all five of the environmental stakes that have been identified within this research study:

1. **Water Pollution:** by prohibiting the use of chemical products in agriculture, closely monitoring industrial and waste management practices.
2. **Fragmentation of Bird Habitats:** by prohibiting the development of industrial, exploitative, construction and hunting activities in the most sensitive zones were most important birds are.
3. **Landscape alteration:** by coordinating and managing the burning of land in the wetland to avoid afforestation.
4. **Fragmentation of hydrological continuity:** by prohibiting the drying of the land or the diversion of the water in the wetland.
5. **Degradation of flora:** by prohibiting wild flora harvesting and fighting against afforestation and chemical use in agriculture.

According to Articles 151 and 152 of the federal law on Nature Protection (Gazette 13/66), "*protected areas (…) shall be managed by public companies and public institutions*". They "*shall perform activities pertaining to protection, maintenance and promotion of a protected area*". The creation of such an institution, bearing in mind the management system's room of action described above in parts IV.1.a and IV.1.c for water pollution and wind projects, could be a great solution. Indeed, it establishes a public actor with the legitimacy and the funds to undertake all necessary activities to protect local environmental attributes. Regarding water for instance, the public company would be able to direct funds and coordinate water management infrastructures renovations. It would also be able to prohibit wind farms on bird migration corridors within the PA (Protected Area) based on accurate environmental impact assessments and spatial plan. However, as most windfarm projects are located outside of the karst polje per say, in the inter-polje zone between Livanjsko and Duvanjsko on crests and karst plateaus (see Figure 42) it would not cancel the entire wind turbines pressure on the avifauna.

Several reasons were identified to explain why this measure was blocked. A first key learning from this project lies in the methodology used to determine the protected area. Locals stakeholders (as municipalities) are not at the initiative of this project, which comes from international development bodies and the Federation level. They said they have not been

consulted during the diagnosis phase, and are yet to be informed about clear repercussions of the law on their land and activities. In consequence, most of the local population carries misconceptions about the reality of the protection, and finds itself in a defensive position. "*If they want to do something with the polje, they need the approval of the locals. It should come from them, not from an NGO far away"* (EB1). A common belief is that farmers would not be able to carry on pastoralism activities: "*our land is used for food production. Protecting it will interfere with that"* (EB1). In fact, this is an authorized and encouraged activity in the largest part of the Protected Landscape, i.e. Zones C & D (green and yellow, see Table 7). In terms of lack of awareness, the population (including municipal officials) doesn't have sufficient knowledge to present the defined zoning and what it entails to the locals. Apart from NGOs, there is no public body that has the capacity to educate and raise awareness on the matter *"now they expect of the local community to explain to people what these areas mean. And we do not. We do not have the capacity and knowledge for this explaining. We need a supervision"* (EL2). At this point, the only legitimate opposing parties identified are fishermen and hunters, as the law prevents them from carrying on their activities in the richest and most biodiverse zones of the Livanjsko polje (zones A and B, Table 7). Finally, complex politics between the municipalities can also be at the source of the blockage. "*There is political interference in the development of this project, and (the interviewee) doesn't know much more about the issues at stake"* (WL3).

Ways forward identified include the clear identification of a party to manage the implementation of the project and align stakeholders. Public engagement and awareness-raising also seems necessary to defuse local tensions due to misconceptions and consider the voice of locals.

Other smaller environmental protection programs which tackle rather specific issues, such as the Open Rivers Program, could be easier to implement since they are of smaller size, yet face similar challenges in public consultation phase.

d. Open Rivers Program

The Open Rivers Program is an international multi-stakeholder initiative that strives to support the removal of small dams to foster river restoration and ecosystem recovery in European rivers. WWF Adria have partnered with the Open Rivers Program for the creation of a dam removal project in Livanjsko polje. The project is called "*Ahead of the first removal of dams and barriers on rivers in BiH: Livanjsko karst polje case study*".

Historically, dams where massively built in the study area's freshwater networks to direct water from rivers to countless watermills. This traditional infrastructure forms barriers for fish migration from surface waters to ground waters. In Livanjsko polje, many watermills, irrigation facilities and channels that have a large impact on the water regime are nowadays unused or abandoned. Removing these dams offers a good opportunity to improve the habitat for several migratory species, threatened aquatic bird species and other economically important species. The dam removal projects will be implemented in collaboration with key stakeholders including relevant ministries, municipalities, water management and development agencies, scientists and NGOs.

The objective of the Open Rivers Program is therefore to introduce dam removal as a nature restoration measure in Livanjsko karst polje. These are the first dam removal projects of their kind in the country. Through the project "*Ahead of the first removal of dams and barriers on rivers in BiH: Livanjsko karst polje case study*", Open Rivers Program is currently in an initial phase focused on research around topics of spatial planning and technical feasibility. One of the key challenges in this phase is the need to include Livanjsko's population in the dam removal planning and implementation process. This is partly because of the atomised structure of land tenure in the polje. Watermills, irrigation facilities and channels spread across numerous private parcels of land. Dam removal necessarily implies strong concertation practices with all concerned landowners. Therefore, adopting as most as possible a participative approach could contribute to a far-reaching project. One keyway to do this is through local population consultation actions and through awareness raising campaigns on the hydrological benefits of dam removal.

Once the project delivers its first results, dam removal will be effectively launched in the karst polje. While this endeavour is highly important to improve aquatic habitats, it is necessary to stress that this project will have an exclusive impact on hydrological continuity of the study area, leaving other environmental stakes such as water pollution or bird habitat fragmentation untouched.

The present panel of protection systems has covered action tracks that are already in place and others that are currently being implemented. Further inputs on action tracks that have not yet been conceived and implemented can bring valuable insights on how to improve the quality of the environmental attributes of the study area.

e. *Glamočki Krompir* PGI

Beyond the protection systems that are already implemented and those that are currently being deployed, other regional, national and international protection systems have been identified as appropriate action tracks to reinforce environmental protection in the study area.

The first protection system that has not yet been undertaken explicitly is a potential PGI (Protected Geographical Indications) on one variety of potato that is exclusively cultivated in Glamočko karst polje. Called *Glamočki Krompir*, this potato presents unique features due to the mineral and dry composition of the soil in the high karst polje of Glamoč, as well as the particular climatic conditions of the considered area (Općina Canton10, 2021).

As detailed earlier, this type of protection system is particularly useful for the economic development of the agricultural sector, both in terms of added value for local products that benefit traditional producers, and in terms of emerging opportunities for the development of agrotourism. Coupled with a strong potential for environmental protection, PGIs can constitute a tool of choice for the purposes of this study.

In regards of the *Glamočki Krompir*, the possibility of creating a PGI that takes into consideration good environmental practices is highly interesting. On the one hand, it could improve the living conditions of small farmers in Glamoč, which remains the least developed of all considered karst poljes; on the other: it could contribute to the preservation of this study's environmental stakes. This is particularly the case for the first environmental stake on water pollution, as traditional potato production with high environmental standards could prevent large scale agricultural practices such as the use of chemical inputs. This action track also

improves the third environmental stake on landscape degradation, as it promotes the traditional agricultural practices that have shaped local landscapes, therefore contributing to the reduction of afforestation trends in karst poljes.

As discussed in section 1.b, all of the five municipalities in the study area have produced strategic development plans which have an important agricultural axis. Overall, Canton 10 wants to increase its agricultural value chain and to encourage working age population to work in the agricultural sector. However, there is no mention of the potential contribution of a PGI to reach these objectives (Općina Canton10, 2021). These municipal strategic development plans could be revised to include key projects for the creation of a *Glamočki Krompir* PGI.

But in order to do this properly, any PGI project for the *Glamočki Krompir* must learn from the *Livanjski Sir*'s lessons, both positive and negative. First and foremost, any PGI project around the *Glamočki Krompir* that aims to improve environmental protection measures must include environmental standards in its PS. The *Livanjski Sir*'s PS has no environmental criteria, stripping away from it any environmental potential. This is all the more difficult to change as it would require substantial efforts to influence an administrative procedure that is dominated by statal actors.

On a more positive ground, in the case of the *Livanjski Sir* PGI, one crucial step in the efforts to create the PGI was the creation of producer cooperatives like Cincar, which not only attracted attention on the value of local products, but also facilitated interactions between producers and local public authorities. This experience demonstrates that intermediary bodies between farmers and public authorities are a key factor in the PGI adoption process.

Currently, there are no NGOs or other actors that are supporting the creation of a PGI for the *Glamočki Krompir*. This represents an obstacle for any PGI project, as there is a severe lack of communication and even strong defiance from farmers towards public authorities. As a farmer puts it: "*There is no NGO here to promote the PGI project. This is mostly a farmer's initiative. It is the role of the municipality to push forward for that kind of initiative, but they don't approve it*" (AG3). As explained earlier, the priority should remain the inclusion of environmental criteria in the *Glamočki Krompir* PGI's PS. Depending on the actor consortium that pushes for the recognition of the PGI, these environmental criteria will be expressed differently, if at all, in the PS. Put differently, if there are only potato producers and municipalities with the overall objective of flooding the market with these potatoes, there will unsurprisingly be no mention of environmental standards in the PS. But if an environmental actor such as an NGO or other environmentally concerned stakeholders structure a consortium that federates producers around environmental preservation goals, then the PS will most certainly include robust environmental standards.

Special attention must be given to the collaboration of environmental actors and agricultural producers to increase the likelihood of an *Glamočki Krompir* PGI project that preserves the environment in the next few years. Regional measures such as this one have the advantage of involving local actors. However, they cannot substitute efforts on a wider, federal level.

4. Federal protection systems

The Federal law on nature protection (2013) introduced in part IV.3.c. establishes a framework of different protection tools that can be used to preserve the environment.

Based on their pertinence for the study area and the identified environmental stakes, National Park (cat. II), and Protected Area with Sustainable Use of Nature Resources (Cat. VI) have been studied as potential protection routes. It should be noted here that due to time constraints, all federal protection tools have not been investigated thoroughly. Further investigation crossing the data of this report and the implementation of different types of federal protected areas would help clarify protection options for the study zone.

a. National Park

According to article 157 of the law on Nature Protection (Official Gazette 66/13), a **National Park** is a:

"*Vast natural or almost natural areas, separated for the protection of wide-range ecological processes, and relevant species and ecosystems characteristic for the area, which constitute ground for spiritual, scientific, educational, recreational and touristic purpose compatible with the protection of cultural and natural heritage*."

Its primary objective is the "*protection of natural diversity together with ecological structures and accompanying ecological processes with the promotion of education and recreation*."

These study's five environmental stakes could be addressed within a national park. Indeed, it aims to protect:

- Wide-range ecological processes, which can be associated to the continuity of the underground hydrological system, but also water quality
- Relevant species, which addresses the stake around bird habitat fragmentation and endemic flora and fauna
- Ecosystem characteristics, which rely in the richness of the biodiversity thanks to the wetland and semi-annual flooding of the zone, the presence of peat and the non-altered landscape for migration corridors.

Regarding the size of such protected area, the term "vast" is vague. The only existing point of comparison is the Una Federal National Park of 350 km^2. The surface of each of the four karst poljes of the study zone is comparable, ranging from 62 km^2 for Glamočko polje to 408 km^2 for Livanjsko polje (cf. Figure 11: Map of the study area, QGIS). All poljes together seem to be too large a surface for such a protection, however, the protection of one specific karst polje seems to be realistic.

Therefore, for a National park to be created, a specific zone within each polje should be identified. It is important to note that the larger the PA, the more difficult it will be to protect it. Indeed, as National Parks are one of the strictest level of protection (II) it is likely that the pursuit of many activities on the territory will be prohibited. Although the law provides that the protection will be "*compatible with the protection of cultural (…) heritage*", it is not one of its key or secondary objective and therefore it is likely that most industrial, construction and energy works will be forbidden, as well as large scale agriculture (as it is not a cultural activity). Purely looking from a feasibility point of view rather than pertinence, and taking into account the different territorial pressures (cf. Figure 34) identified, this study shows that Glamočko polje seems to be the polje most likely to be successfully defined as a National Park. Indeed, peat exploitation and large-scale agriculture activities rule out the protection of the Northern and Southern parts of Livanjsko polje, as well as the Duvanjsko and Kupreško poljes. In the end, Glamočko polje has the least territorial pressures (cf. Figure 34) which means that

implementing a National Park would not largely disturb territorial activities. The one condition for this would be to reduce or ban the use of pesticides and fertilizers in agriculture in the centre of the polje. For this, one key lever would be the increase in revenues, whether from an increase in subsidies or an increase in sales. An increase in subsidies could be complicated for political matters, a farmer in Glamoč reports:

> "*Due to politics, sometimes canton does not agree with the municipality's approval, so it is hard for farmers to have access to subsidies. Sometimes, there are not the same political parties in the municipality than in the canton. They can block subsidies at any level"*(AG3).

An increase in revenues could come from the valorisation of the Glamoč potato through the creation of an PGI (cf.IV.3.e).

Once the water pollution issue is solved, this study reports additional barriers and enablers. Concerning blocking factors, this study highlights the lack of environmental knowledge (cf. IV.3.c for Protected Landscape challenges), lack of social and economic dynamism of the zone (cf. Figure 20) and heterogeneity of political parties at all federation levels. Canton 10 also faces challenges due to the exodus of knowledgeable people in the field of environmental protection "*We have a brain drain in medicine, construction and environmental protection."* (EL6), but also to work in agriculture "*now nobody wants to work on fields*" (EG1). It means that even if political approval and financial means are found to create this protected area, a difficulty will remain in the ability to (i) find people that know the territory and are skilled for environmental protection and management, and (ii) perpetuate traditional practices, as farmers stop working and larger industrial farms take their place (EG1).

In a certain way, the exodus of people can also be seen as an enabler for the protection of the zone: the less activities and people there are, the easier it is to protect it in a strict way. In the long run, if the management of the protected area goes as planned and that nature flourishes, the economic dynamism brought in by a growing touristic activity might help the remaining farmers and traditional activities sustain, as well as become an example of the positive outcomes that can arise from the protection of the land for other municipalities within Canton 10. These perspectives are based on a number of assumptions: (i) that local people will more easily accept the protection of the land if it is not currently used or if they do not depend on it for their activities, (ii) that the establishment of a National Park would allow for the improvement of the ecological state of the environment as a whole (e.g. in terms of biodiversity, water quality, soil quality, …), (iii) that the tourism that is being developed in the zone mainly depends on the exceptional quality of nature, landscapes, and traditional activities, and (iv) that the economic dynamism brought in by the development of tourism appeals to surrounding municipalities.

These assumptions can be challenged, and a different course of action can eventually happen, but this is a first step towards developing an action plan to effectively protect the land.

All in all, the creation of a National Park seems really ambitious as it would require the coordinated work of the federation, the Canton, municipalities, Šumarija, local industries and farmers and tourism professionals, but it also seems like a promising opportunity to give a second breath to the Glamočko karst polje.

b. Protected Area with Sustainable Use of Resources

Another type of protection identified in the Law on Nature Protection (Official Gazette 66/13), refers to article 141. A Protected Area with Sustainable Use of Resources (PAwSUR):

> "*Shall conserve ecosystems and habitats along with cultural values and the system of traditional management of natural resources. Generally, those are wide areas with majority of the territory under natural conditions parts of which are the subject of sustainable management. A sustainable use of natural resources of non-industrial type is one of the main objectives of management.*" Its primary objective is that the "*protection of natural ecosystems and sustainable use of natural resources complement each other to the benefit of both*".

This protection type is relatively less strict than all protection laws seen previously. It corresponds to IUCN's category VI, which is less strict than Protected Landscapes (cat. Va) and National Parks (cat. II). It means that more human activities will be allowed in the Protected Areas. It also means that Canton 10 and not the Federation will be at the initiative of the law.

According to the 2016 report on Bosnia and Herzegovina's Strategy and Action Plan for the protection of biological diversity (Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina, 2016: 73-74), there are no PAwSUR currently existing in BiH. The reality of such a protection tool is yet to be determined. The law explains that a sustainable use of biodiversity and natural resources is sought to boost social and economic gains for the local community. As it is a smaller protection than other tools discussed above, it would be better not to opt for it. However, in case the project of the Protected Landscape bill does not pass because it is too strict, this level of protection might be considered for the Livanjsko polje. Indeed, even though it allows for the free development of the economy, it still prohibits industrial scale projects.

In terms of the environmental stakes it tackles, this analysis shows that it is likely that environmental pressures such as urbanisation, non-treatment of city sewage water, the construction of dams and water retention will not be addressed. Therefore, the third and fourth environmental stakes would not be tackled by the PAwSUR protection (cf. Table 6). Nonetheless, it would still be a step in the right direction.

A more in-depth analysis of FBiH protection tools is yet to be performed, but as such, the Protected Landscape law seems to be ambitious enough in terms of environmental stakes, and already quite advanced in its approval process. More needs to be done at the level of municipalities and the local population to make sure that all stakeholders are heard and that the protection measure is understood. If no common ground is found, the PAwSUR could be a good alternative as it is less strict. In the longer run, the protection of the Glamočko polje with the designation of a National Park (cat. II) and the protection of the sustainable harvesting of *Glamočki Krompir* could be a great way to boost the dynamism of the zone and protect the local untouched nature.

In addition to the national protections systems, some international systems seem to be able to address the identified environmental issues but not all the pressures and seem far from the concerns of local populations.

5. International protection systems

There are several types of international protections focusing on various aspects of the territory.

a. GIAHS

Proposed by the FAO, the Globally Important Agricultural Heritage Systems (GIAHS) protects areas of global importance, defined by five concepts (Fernandez, 2023):

1. Food and livelihood security
2. Agrobiodiversity
3. Local and traditional knowledge systems
4. Cultures, value systems and social organizations
5. Landscapes and seascapes features

The protection of such areas aims to preserve the traditional food production practice and knowledge. The evolution of such practices is allowed to ensure the food supply of the local people and their socio-economic development as long as the biodiversity is not deteriorated.

According to our analysis, if implemented in the study area, this protection could:

- prevent the development of intensive agriculture
- contain the extension of the urbanization
- maintain the traditional agropastoralism and avoid the karst poljes' afforestation
- prevent the development of big solar farms and dams

This will allow to tackle four or the five identified stakes. As shown in Table 6, the third stake is not solved due to the lack of actions concerning the wind farms and peat extraction projects, as well as the waste and the poaching.

The ensure the best support to this protection system, the GIAHS Programme requires strategies on three levels (FAO, 2016):

1. The Global level: the international promotion and network is improving the recognition and then the efficiency of the protection, as well as the knowledge learned from each site.
2. The National level: the government must carry and submit the proposal to FAO, instore legal measures (regulation and incentives) and supervise the implementation and follow-up of the planned activities.
3. The Local level: the local communities are involved and supported in the actions taken to sustainably use the natural resources.

This multi-level process can be an obstacle to the creation of the protected area. However, this system is also a good protection for the traditional agricultural sector. This could be an alternative to the intensive agriculture without reducing the number of farms, which is a concern that has been expressed by some actors.

b. Cultural Landscapes

This category is part of the World Heritage system of UNESCO. The karst poljes could be under the Cultural Landscape, which is focused on lands that are modified by humankind in response to the environmental constraints and specificities. Due to their evolving economic

and social aspects, they could use the “organically evolved landscape” category and “continuing landscape” sub-category.

To be added to the list, the study area must fulfil at least one criterion out of the ten mentioned in the guidelines (UNESCO World Heritage Center, 2008). The studied karst poljes can be submitted under three criteria (the roman numbers represent the number associated to each criterion in the UNESCO guidelines):

- (v) an outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change
- (viii) outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features
- (x) contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of Outstanding Universal Value from the point of view of science or conservation.

The UNESCO requires that the World Heritage sites have a long-term protection and management by any kind of adequate authority (law, administration, custom, …). The status of the site and of the actions taken for its protection is investigated every six years by UNESCO’s Secretariat based on reports submitted by the State (UNESCO World Heritage Center, 2008).

c. Global Geopark

This protection tool has been mentioned by a local farmer as a solution to the environmental pressures: “*first we need the municipality to protect the area and make a Geopark at a national level to go further*” (AT1).

This protection system is different from the World Heritage and is managed by the Global Geopark Network included in the International Geoscience and Geopark Programme (IGGP) by UNESCO. It encourages “international cooperation between areas with geological heritage of international value, through a bottom-up approach to conservation, local community support, promotion of heritage and sustainable development of the area” (UNESCO, 2015). Global Geopark focuses on the protection of unique geological heritage as well as the communities linked to it and their sustainable use of the natural resources. In addition, this system requires the development of scientific research and public awareness, using tourism for example.

It could be used to protect karst plateaus, the underground water system, the caves and the karst poljes. Moreover, some local people “*found fossils at Buško Lake*” (AT1) which is another heritage worth protecting. The implementation of a Global Geopark could reduce the pressure from wastes, dams wind and solar farms on the study area. As shown in Table 6, this would allow to tackle only the third environmental stake as it would solve very few of the identified pressures.

The application procedure requires that “*the area has already been functioning as a de facto Global Geopark for at least one year*” (UNESCO, 2015) meaning that the site is protected and that scientific research are already in place before having the certification. The National

Commission for UNESCO must be involved in the creation and the choice of the park's missions. However, the project will be managed by regional or local authorities.

The protected area is inspected every four years and could lose its certificate if the effort in terms of protection or scientific research are not met.

There are less levels of authorization that the international protection systems presented previously, but the creation and the management of such area must be a teamwork between the national and the local level. It could be an obstacle, as observed for the energy projects where the environment seems under-considered. One of the solutions could be to involve more the NGO's and/or the actors in favour of a friendly environmental tourism, especially because the tourism seems to be a stake for many interviewed people, included the elected representatives, and is especially encouraged in the Geopark system.

d. Biosphere reserve

This protection system is not part of the World Heritage and is managed by UNESCO's Man and Biosphere Programme. It is used for areas with a high biodiversity level which can be used for scientific research to "*promote and demonstrate a balanced relationship between humans and the biosphere*" (UNESCO, 2020). The type of human activities allowed differs depending on the three zones which form the protected area (UNESCO, 2019b):

- Core Areas: it comprises a strictly protected zone that contributes to the conservation of landscapes, ecosystems, species and genetic variation
- Buffer Zones: it surrounds or adjoins the core area(s) and is used for activities compatible with sound ecological practices that can reinforce scientific research, monitoring, training and education
- Transition Area: the transition area is where communities foster socio-culturally and ecologically sustainable economic and human activities. There is no protection in this area but the sustainable activities are promoted and encouraged.

This mosaic of protection levels will make it easier to implement, considering the various human activities spread all over the study area. This type of protection should allow to protect the birds and their habitats as well as the traditional agropastoralism. As shown in Table 6, this system could tackle all the environmental stakes because it will solve or reduce all the identified pressures.

The nomination of Biosphere Reserve is done by the national government. No local nor regional authority is necessary for the official implementation of such area (UNESCO, 2019a). This particularity must make its application easier than for the other protection systems presented above. However, based on the Ramsar experience, the local's support seems an indispensable condition for an effective environmental protection.

The protected area is reviewed every ten years. The management, zoning and local involvement are examined to check that the area is sustainably used and studied.

6. To go further with the protection systems

Considering Table 6, five protection systems do not seem pertinent to tackle the five environmental stakes of the study zone: the level IV (Protected area with sustainable use of

natural resources) of the Federal law, the Open Rivers Program, the *Glamočki Krompir*, the GIAHS and Geopark. Keeping a strict selection method, Ramsar, the level II (National Park) and the level Va (Protected landscape) of the Federal Law, Emerald Network and Biosphere Reserve are the most pertinent tools. With the light method, UNESCO Cultural Landscape can be added to this list.

One must bear in mind that the results of this analysis should not be considered as certain. Indeed, the extent to which each pressure would be tackled has not been considered. Additionally, the pressures can also be ranked according to their level of importance and results could be a weighted average rather than an average of all pressures tackled. Finally, as detailed in the whole analysis part, it is important to bear in mind the creation and management systems that go with each protection system. These will greatly impact their feasibility. More work needs to be done to deepen the analysis of the feasibility and relevance of these solutions. The time allowed for this current study did not allow to know the national and cantonal actors who are essential to the implementation of those presented protection systems. Another study could be necessary to understand the actors at a federal and cantonal levels and better apprehend the necessary actions to involve them in the environmental protection of the study area.

V. Conclusion

Bosnia and Herzegovina is a country remarkable for its hospitality, its nature, its people, its culture and its history. Conducting a project with such high stakes in such a short period of time was a challenge that the authors made a point of taking up. This field study, with more than 59 interviews achieved, strived to be close to the territorial stakeholders in order to depict the local reality of activities and use of the land as accurately as possible.

The qualitative data collected via the interview series enabled to define the numerous existing interactions between all types of territorial stakeholders. Starting from the inhabitants' activities, looking at agriculture and the production of cheese, discovering fishing and hunting practices, understanding water and waste management… the goal was to understand the nature of the different activities shaping the territory. This, in turn, allowed to produce a territorial diagnosis which combined with landscape and mapping analyses, provided a substantial database to exploit.

The cartographic work and our field observations enabled us to identify five landscape units: karstic poljes, flat areas, slopes, karstic plateaus, ridges. Each of these units has geomorphological and environmental particularities. The threats to each are different. Moreover, by identifying these five units, it is possible to show the dynamics that exist between the different spaces (for example water flows, seasonal uses or corridors for biodiversity) and to understand the importance of repositioning the poljes within their environment. These five units and the dynamics that exist deserve to be better identified and described in order to fully highlight the importance of considering the poljes as part of a larger and more complex territory in the management plans.Thanks to a triangulation between all data sources, main environmental pressures were identified, leading to the spatialization and prioritization of **five main environmental stakes** on the study area, namely; (i) water pollution, (ii) the fragmentation of birds' habitats, (iii) landscape alteration, (iv) hydrological discontinuity and (v) the degradation of flora.

Managing these environmental stakes implies to reduce the amount of territorial pressures exerted. Following an analysis of sectorial management systems, several rooms for improvement and action have been identified in agriculture, water and waste management and energy production.

In addition, existing and promising protection systems have been studied in the last part (IV Discussion). Two criteria were used to understand whether they could be a solution: (i) first their ability to reduce the identified environmental pressures and (ii) second the feasibility of their implementation, knowing the nature of territorial management dynamics. No clear-cut conclusion can be drawn from this analysis. More so, it draws a comprehensive vision of the protection systems that exist, their pertinence towards the management of an environmental stake, and the different implementation considerations to bear in mind whilst activating them. Some systems appear to be more promising than others, tackling all five environmental pressures at once, but seem extremely difficult to put implement as it would need the alignment of all stakeholders and the involvement of all public administration's levels. A combination of several protection tools could also be a way to achieve the environmental protection of the territory. It is important to note that the feasibility analysis of the protection tools is only superficial at this stage, and further research is needed to cross the data collected by this report and the official implementation process of such tools.

All in all, this work aims to give a first understanding of the different environmental protection paths that exist for the four karst poljes of the study zone. Further research is needed to

explore the feasibility of protection paths and build a protection programme that enables to safeguard traditional activities, natural landscapes, a rich biodiversity, and the fulfillment of the population of the territory.

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VII. Annexes

1. List of interviews conducted and their coding in the report, FNS-MI

Domain/type/activity	Municipality	Coding within the report
Agriculture	Bosansko Grahovo	AB1
Agriculture	Livno	AL7
Agriculture	Glamoč	AG1
Agriculture	Glamoč	AG2
Agriculture	Glamoč	AG3
Agriculture	Kupres	AK1
Agriculture	Kupres	AK2
Agriculture	Livno	AL1
Agriculture	Livno	AL2
Agriculture	Livno	AL3
Agriculture	Livno	AL4
Agriculture	Livno	AL5
Agriculture	Livno	AL5
Agriculture	Livno	AL6
Agriculture	Tomislavgrad	AT1
Agriculture	Tomislavgrad	AT1
Agriculture	Tomislavgrad	AT2
Agriculture	Tomislavgrad	AT3
Elected representatives (Canton 10/municipality)	Bosansko Grahovo	EB1
Elected representative	Bosansko Grahovo	EB2
Elected representative	Bosansko Grahovo	EB3
Elected representatives (Canton 10/municipality)	Glamoč	EG1
Elected representatives (Canton 10/municipality)	Kupres	EK1
Elected representatives (Canton 10/municipality)	Kupres	EK2
Elected representatives (Canton 10/municipality)	Livno	EL1
Elected representatives (Canton 10/municipality)	Livno	EL2
Elected representatives (Canton 10/municipality)	Livno	EL3
Elected representatives (Canton 10/municipality)	Livno	EL4
Elected representatives (Canton 10/municipality)	Livno	EL5
Elected representatives (Canton 10/municipality)	Livno	EL6
Elected representatives (Canton 10/municipality)	Livno	EL7
Energy	Livno	EnL1
Energy	Livno	EnL2
Elected representatives (Canton 10/municipality)	Tomislavgrad	ET1
Elected representatives (Canton 10/municipality)	Tomislavgrad	ET2

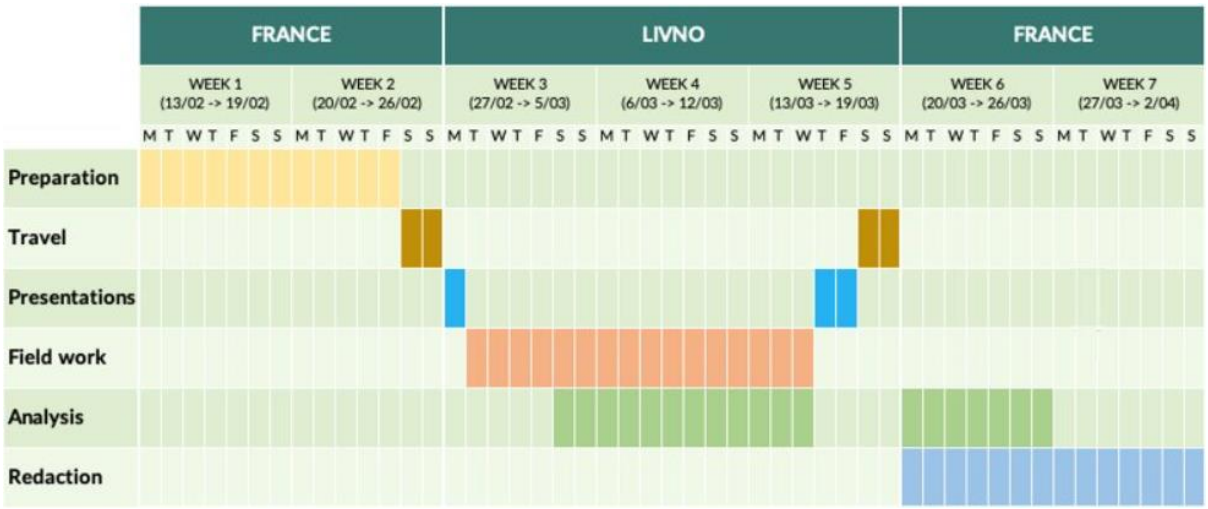
Industry	Bosansko Grahovo	IB1
Industry	Livno	IL1
Industry	Livno	IL2
Public management agencies (water and waste/forest)	Livno	IL3
Public management agencies (water and waste/forest)	Bosansko Grahovo	PB1
Public management agencies (water and waste/forest)	Glamoč	PG1
Public management agencies (water and waste/forest)	Glamoč	PG2
Public management agencies (water and waste/forest)	Kupres	PK1
Public management agencies (water and waste/forest)	Kupres	PK2
Public management agencies (water and waste/forest)	Livno	PL1
Public management agencies (water and waste/forest)	Mostar	PM1
Public management agencies (water and waste/forest)	Tomislavgrad	PT1
Public management agencies (water and waste/forest)	Tomislavgrad	PT2
Public management agencies (water and waste/forest)	Tomislavgrad	PT3
Recreational activities (hunt/fishing/wild picking)	Livno	RL1
Recreational activities (hunt/fishing/wild picking)	Tomislavgrad	RT1
Tourism/cultural activities	Bosansko Grahovo	TB1
Tourism/cultural activities	Bosansko Grahovo	TB2
Tourism/cultural activities	Kupres	TK1
Tourism/cultural activities	Kupres	TK2
Tourism/cultural activities	Kupres	TK3
Tourism/cultural activities	Kupres	TK4
Tourism/cultural activities	Livno	TL1
Tourism/cultural activities	Livno	TL2
Tourism/cultural activities	Livno	TL3
Tourism/cultural activities	Livno	TL4
Tourism/cultural activities	Livno	TL5
Tourism/cultural activities	Tomislavgrad	TT1
Tourism/cultural activities	Tomislavgrad	TT2
Tourism/cultural activities	Tomislavgrad	TT3
Tourism/cultural activities	Tomislavgrad	TT4
Tourism/cultural activities	Tomislavgrad	TT5
Water and biodiversity experts/NGOs	Banja-Luka	WB1
Water and biodiversity experts/NGOs	Livno	WL1
Water and biodiversity experts/NGOs	Livno	WL3
Water and biodiversity experts/NGOs	Livno	WL4
Water and biodiversity experts/NGOs	Sarajevo	WS1

Domain/type/activity	**Code letter**

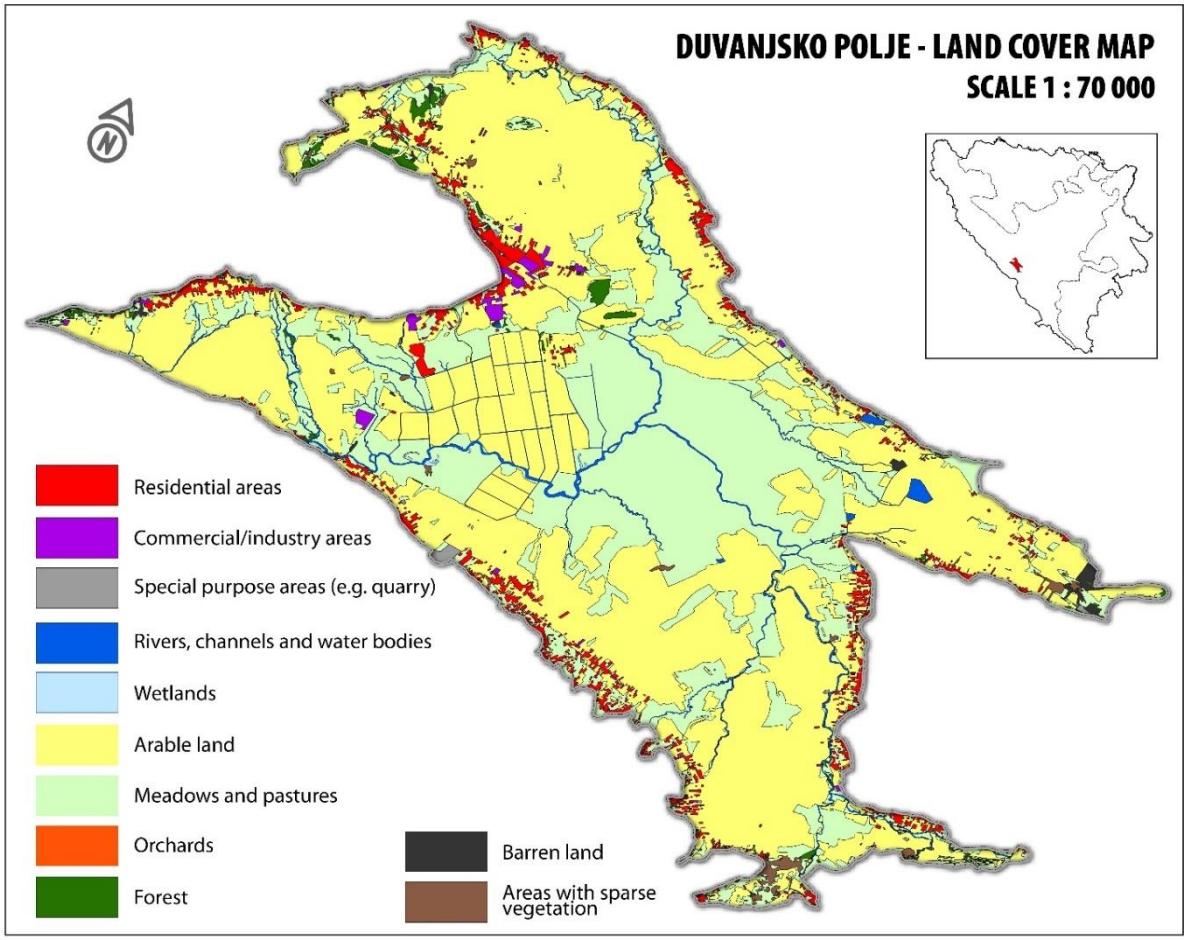
Agriculture	A
Elected representatives (Canton 10/municipality)	E
Energy	En
Industry	I
Public management agencies (water and waste/forest)	P
Recreational activities (hunt/fishing/wild picking)	R
Tourism/cultural activities	T
Water and biodiversity experts/NGOs	W

Municipality	Code letter
Bosansko Grahovo	B
Livno	L
Glamoč	G
Kupres	K
Tomislavgrad	T
Mostar	M
Banja-Luka	BL
Sarajevo	S

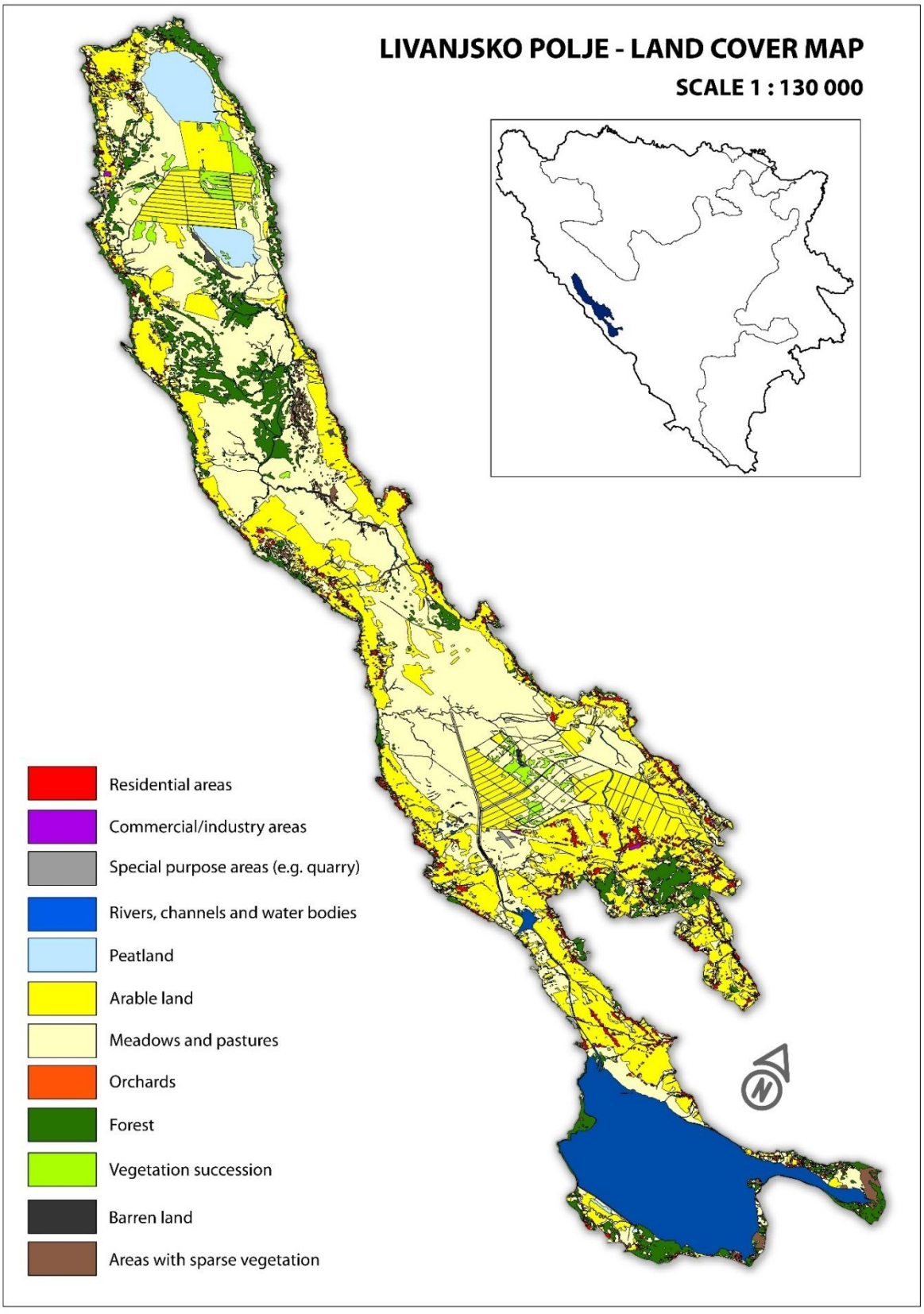
2. The planning of the study, FNS-MI :



3. Duvanjsko polje land cover map (Source: “Land cover map” EuroNatur, Date between 2010 and 2020)



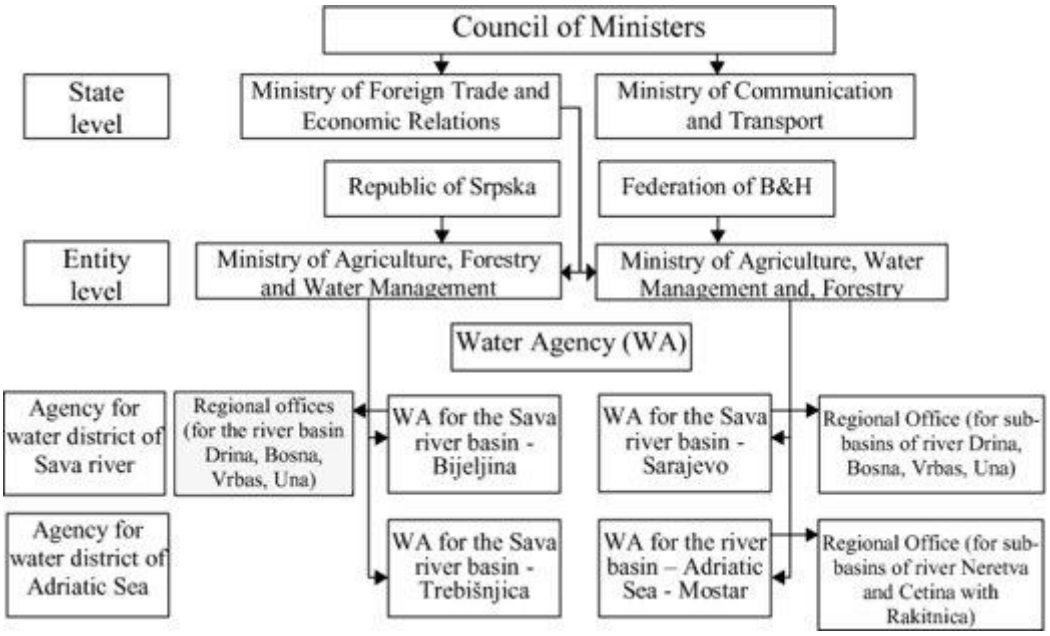
4. Livanjsko polje Land cover mapSource: “Land cover map” EuroNatur, Date between 2010 and 2020



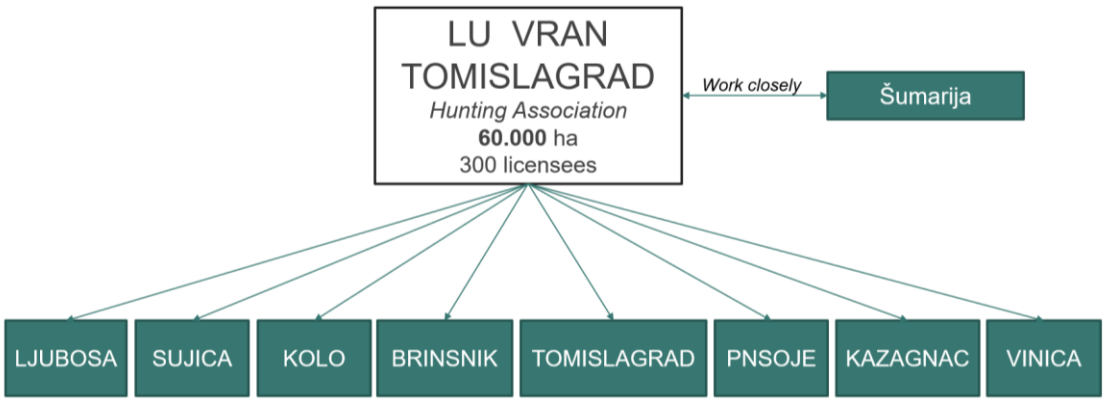
5. Energy projects in the study area, sources: FNS-MI 2023, Balkan Green Energy News, EnL2

Energy Type	Project name	Municipality	Number of turbines	Capacity (MW)	Status (expected delivery)	Owner (Company-Country)
Windfarm	Mesihovina	Tomislavgrad	22	50,6	Operational	Public
Windfarm	Jelovača	Tomislavgrad	18	36	Operational	Private (FL Wind-BiH)
Windfarm	Ivovik	Tomislavgrad and Livno	42	84	In construction (2023)	Private (Power China and Ivovik Wind power)
Windfarm	Borova Glava	Livno	26	52	In construction (2026)	Public
Windfarm	Tušnica	Tomislavgrad	-	72,6	In construction (2023)	Private (FL Wind-BiH)
Solar power	Zvizdan	Tomislavgrad	NA	23	In construction (2023)	Private (FL Wind-BiH)
Windfarm	Bundina Kosa	Glamoč	12	80	Environmental Impact assessment	Private (Wild Wind-BiH)
Windfarm	Gradina	Tomislavgrad	11	73	Environmental Impact assessment	Private (Lager-Croatia)
Windfarm	Slovinj	Glamoč	49	130	Waiting for environmental approval since 2013	Private (Vjetroelektrane)
Hydropower plant	Vrilo	Tomislavgrad (Šuica river)	NA	66	Concession signed	Public
Windfarm	Čadilj	Glamoč	-	138	Concession signed	Private (WPD-Germany)
Windfarm	Marino Brdo	Bosansko Grahovo	-	126	Concession signed	Private (WPD-Germany)
Windfarm	Galečić	Tomislavgrad	-	30	Concession signed	Private (Concordia-BiH)
Windfarm	Ljubuša	Tomislavgrad	-	80	Seeking concession	Private (Kamen-Dent)
Windfarm	Orlokuk	Tomislavgrad	-	90	Seeking concession	Private
Hydropower plant	Kablić	Between Glamočko polje and Livanjsko polje	NA	56	Federal approval	Public
Windfarm	Baljci	Tomislavgrad	-	48	Federal approval	Private (Tomkup)
Windfarm	Oštrc	South of Duvanjsko polje (not in Canton 10)	-	30	Federal approval	Private (Relaks)
Windfarm	Široka Draga	Tomislavgrad and Livno	19	125,4	Federal approval	Private (Imres)
Windfarm	Dževa	Glamoč	23	46	Federal approval (initial project from 2016)	Private (Vjetroelektrane)

6. Water management organisation at State level, Source : (Negm et al., 2020)



7. Organization by sub-section of the Hunting Association of Tomislavgrad: FNS-MI 2023, RT1



8. Non exhaustive description of the formal legal management of Hunting and Fishing: FNS-MI 2023, RT1, RL1

	Hunting (RT1)	*Fishing (RL1)*
License	Membership registration is charged : special license to wear an arm 1 member can bring one person (non member, foreigner) to hunt with him. No additional charge for harvested animals Licensing process : young hunter must choose a mentor, during one year he can not hunt, but only observing, learning. After that he pass an exam and then got a license.	Registration to be a member is paid once a year
Invasive species	wild pigs, boar, wolf	Zanders, Catfish
Authorised species	Wolf, fox, chacal wild pigs,boar, bear, quail	Trouts and greylings
Protected or endemic Species	Wild horses are protected and can not be killed. **There is protected bird species but no endemic bird species.**	**Endemic species have to be released.** **Endemic Species** : Dalmatian barbelgudgear, chub (squalius cephalus), telestes turskyi, seardinisus dergle, and phoxinellus alepidotus
Geographical and temporal extent of right and harvested quantity allowed	Each municipality corresponds to a large association, which is organized into smaller sections responsible for a delimited fraction of the territory. Wolf, fox, chacal can be hunt all year. Others species are limited to a certain quantity and period.	3 rivers (Bristice, Sturba, Jabdjak), 2 lakes and 1 canal system. There is an area where there hasn't been any fishing for 7 years because this is a part of a spring which is protected. The fishing season is from March 1st to October 1st. During this time, 40 days of fishing are allowed and everyone can bring back 3 fish maximum/day. Sometimes people do fish more than the number allowed but there is no control. In some protected areas, fishing is allowed all the year but fish must be released.
Additional effective	If there is damage made from these predators hunter must pay.	The fishing activity is mostly for personal consumption when fish

practices and rules	~50% are professional and other are just for hobby for hunting wolves for example. They don't have right to sell catches. They are trying to keep and protect animals. People that are hunting [...]mostly like nature they really like animal and want to protect them.	are not released. The main mission of this association is to protect fishes. Trouts can be sent to restaurants.
Interactions with local authorities for the Management Plan	10 years plan with Ministry approval Municipality Same Cantonnal instruction to hunt. They are working very closely with Šumarija, the forest company.	A document from the faculty of Sarajevo defines the quantity of fish allowed to take. It is reviewed every 5 years. Agricultural ministry of the canton : if approval --> federal level : need approval. Fishing law = same in the whole Canton
Regulating means	Hunterkeeper. 10 hunter keepers for 270 hunters in one Tomislavgrad section.	Fishing gard (a policeman) is in charge of keeping the rivers safe. He has the authority to check people's activities around the waters and to stop them if anything is illegal.

9. Interview guides

INTERVIEW GUIDE

List of all guides by actor:

1. General presentation
2. Farmers
3. Hunters / Fishers
4. Dairy / Cheese Factories
5. Mayor, ministries (Elected People)
6. Administration/ Project Manager / Technical skills (Water, Forest, Energy)
7. NGOs
8. Enterprises
9. Citizens/ Local Population
10. Researchers

1. General Presentation

Hello, we are French & Bosnian students in environmental management. Bosnia-Herzegovina is an amazing territory and we are very interested in understanding it better. Today, our interest focuses on wetlands and poljes. In this context, we are meeting the different territorial stakeholders in order to understand their practices and the nature of their links to the land. (Si contexte favorable : This project is conducted in partnership with two local environmental NGOs : AIDA and CZZS, and should help design a relevant conservation & development policy locally). This is why we would like to ask you a few questions, understand how you work and what matters to you here. Would you be ok with this ? We'd need approximately two hours for the interview.

Wait to be well installed to ask: *Would it be possible for us to record our conversation ? This will make it easier for us to take notes. We guarantee that this data and recording will stay completely confidential and we will anonymize names and places in the final report.*

Open question about the person's profile-

Presentation of the contact person and his/her background:

Can you introduce yourself, and what are your main activities ? You can also include your side activities.
How did you get here ? What are the main steps of your journey to get to where you are today ?

Present our research themes :

We are working on the importance of poljés and their specific environmental value. We are here to understand the territorial value of poljés, and relationship between them.

We wish to understand the different dynamics that shape the territory.
We want to understand if the environment you live in is adapted to your activity. Do you benefit from living in the poljés ?
What value do you perceive from living and working in the poljés.
To what extent does the polje territory/environment contribute to or hinder your activities?

Understand the differences in activities practiced :

Let's start by your daily activities *(repeat the different activities listed by the person one by one)*
Can you describe a typical day ?
What are your main sources of income ?

End of the interview

Take up the issues raised and dig deeper
Bring up issues not raised and dig deeper
End the interview - let the person ask questions or add anything
Inform about the feedback

2. FARMERS

Link to family and the place of leisure in life :

Are you several people working on the farm ? (Is your family working with you ? Can you tell us a bit more about your family ?)

Water management

How do you access water?
Do you notice any changes related to global warming?
Do you have problems with your water supply (drought, lack of water, too much water?) Have you developed practices to adapt to changing climatic conditions?

inter actors dynamics -> land sharing and use, cooperatives, potential conflict of use

Inter-agri relations
What informal organisation? e.g. Lending equipment to each other? → *Are there any synergies?*
Land management: do you own your land? Are you registered in the register?
Relationship with other actors in the value chain (suppliers and customers) → *understand the power relations in the value chain*
Relations with all other actors in the territory: forest, water and electricity supplier (hydroelectricity...) peat... development of renewable energies -> installation of wind turbines in the polje landscape...
Institutional relations / State / ministries / administration

Agricultural practices

Can you describe a bit more your agricultural practice ?
What does a typical day looks like ?
(en off) Are there any factors that you cannot replace for the sustainability of your business? What are you dependent on to sustain your activity? Could it be economic, environmental, contextual, family, biodiversity factors?
(en off) How do you deal with the inputs you depend on for your practices?

How do you adapt your practices according to the seasons → transition towards the inclusion of the activity in the environment
What is your perception of the impact of agriculture and pastoralism on the environment? Positive or negative? Willingness to use ecological practices or not? Why or why not? If they use pesticides, what do they use? Is organic interesting/implemented?
How did you learn your practice? Evolution of know-how?
In terms of soil fertility/quality, do you see an evolution over time?
Are the characteristics of the polje (wetlands, peat bogs...) beneficial to you?
Do you practice slash-and-burn farming?
Ask about the impact of residual mines on your activity
Can you describe how your activity evolves with changing seasons and hydrologic cycles?

Tourism

Do you interact with tourists ? if yes, how ? Are you comfortable with receiving tourists in your home ?
How does tourism impacts your activity ?

Economy

Who do you sell your products to ?
Do you wish to grow you sales ? Which markets to you wish to reach ?
Are you favorable to the idea of PGI locally ? On your products maybe ?

Territorial value

Willingness to preserve an aspect of the territory? At what cost?
What is the perceived value of the territory?
What is the link with Ramsar?

Future prospects / developments -> recovery of activity, seen in 50 years time

What utopian vision of poljes in 50 years
What is the vision of poljes in 50 years if we continue in the same direction as today?

3. **HUNTERS / FISHERS**

Hunting and fishing practices:

What animals / fish can be hunted / fished in Bosnia? small (birds - PETIT GIBIER / big animals, GROS GIBIER sanglier / chevreuil ?)
Are there any factors that you cannot replace for the sustainability of your activity? (breeding, influx of migratory birds, state subsidy...) This can be economic, environmental, contextual, family, biodiversity factors?
How do you adapt your practices according to the seasons → transition towards the inscription of the activity in the environment
How did you learn your practice? Evolution of know-how?
In terms of soil quality, and animal reproduction, do you see an evolution over time?
Are the characteristics of the polje (wetlands, peat bogs, etc.) beneficial to you?
What is your relationship to your polje?
Ask about the impact of residual mines on your activity, can you hunt anywhere?
For hunters: Have you noticed any changes in wildlife (quantity/type of animals) since you started hunting? What do you think about reforestation?
For fisherman: Have you noticed an evolution in the quantity of fish since you have been fishing? What do you think about the quality of the water? (Does he notice any pollution of the water or not?)

Water management

Hunter: Do you use the water bodies for hunting?
Do you notice any changes related to global warming (game population...)

Inter-actor dynamics -> sharing and use of the territory, potential conflict of use

Is hunting/fishing practiced as a tradition or as a source of income?
What is the informal organization? . Lending of land? Public / private owners and hunting and fishing rights
Land management: is it a communal hunting association or do you rent or own the land?
Relationship with other hunters / fishermen, are you the only ones on the territory?
Relations with the other actors of the territory: forest (forestry agency), water and farmers, do you meet conflicts or on the contrary do you develop partnerships?
Institutional relations / State / ministries / administration, are you rather encouraged or restricted to hunt ? Do you have subsidies to hunt harmful animals if there are any?

Tourism

What is your relationship with tourists?
What is the impact of tourism on your business?

Economy

Are you doing commercial activities?
If yes, in which direction would you like to develop your practices?

Relationship to the territory

Is there a desire to preserve an aspect of the territory? Is it important to hunt and fish in the polje territory to maintain a stable population?

Perspectives / future developments

What utopian vision of poljes in 50 years
What vision of the polje in 50 years if we continue in the same direction as today?
Do you think that there would be axes of improvement to study to preserve these activities?

4. **DAIRY / CHEESE FACTORY**

Water management

Do you notice any changes in production that could be linked to global warming? (+ or - milk yield, water supply difficulties, product quality)

Inter-actor dynamics -> sharing and use of the territory, potential conflict of use

Is the pooling of products rather implemented by tradition or by economic optimization?
What is the informal organization ? regularity of the productions ? contractualization ? obligation of yield ?
Relationship with other producers, valorisation of products, quality mix ? farmers in poljés VS farmers in other regions
Institutional relations / State / ministries / administration, are you rather encouraged to pool the harvests? (Do you have a network of actors dynamic enough to organize yourselves in this way?)
In terms of sanitary standards, are you subject to strict regulations? (Non-pasteurization of cheese: tradition or facility?)
What is your relationship with the farmers of the poljés?

Organizational practices

Are there any factors that you cannot replace for the sustainability of your activity (is this the best way to generate profit?) This can be economic, environmental, contextual, family factors?
How do you adapt your practices according to the seasons, off season?
How did you learn your practice? Evolution of know-how? What were your motivations for pooling your harvests?

Tourism

What is your relationship with tourists? Are they beneficial to you? Potential of tourism reputation...
What is the impact of tourism on your activity ?

Economy

How are the supply and consumption of your products organized? To whom do you sell your products?
In which direction do you wish to develop your practices ? As far as the number of your members is concerned, what evolution do you notice ? concerns, growing numbers ?
What are your plans for the future of your activities ?

Relationship to the territory

Do you want to preserve traditions?
Nature conservation, a theme that concerns you?

Perspectives / future developments

What utopian vision of poljés in 50 years
What is the vision of the artisanal activities of the poljés in 50 years if we continue in the same direction as today?
Do you think that there would be axes of improvement to study to preserve these activities?

5. **ELECTED / STATE Mayor, ministries**

Water management

How are the exchanges between the municipality and the water agency organized? What is the water policy? How do you judge the water supply in your municipality (good/not well served for the stakeholders)

Do you know if the actors of the territory (water agency/farmer/population) have encountered problems (drought, lack of water, too much water?) Have you adopted new practices to adapt to changing climatic conditions?

(At your level, do you notice changes related to global warming?)

How are relations with neighboring countries regarding water management?

Dynamics of the territory:

Do you know how the farmers/breeders market their products?

Do you feel that there are tensions or on the contrary, are there cooperatives of actors on the territory? Do you know of any informal forms of organization? → Are there any synergies?

Relations with all the other actors of the territory: forest, water and electricity supplier (hydroelectricity...) peat... development of renewable energies -> installation of wind turbines in the landscape of poljés...)

Agricultural practices

How do you see the development of agriculture? Is there a subsidy system? How does it work? Will it evolve?

What is your perception of agro-pastoralism? Does agriculture and pastoralism have an impact on the environment? Positive or negative?

Ecological practices: agricultural development policy? Why? If they use pesticides, what do they use? Is organic interesting/implemented (background idea: how is it perceived by citizens?)

Economy/Tourism

(The territory is facing a phenomenon of rural exodus). How do you respond to the issues of attractiveness of the territory?

Are there policies to develop the tourist attractiveness of the territory?

Which economic sectors will serve as a lever to develop the territory (and, conversely, which ones seem to be neglected)

Are your decisions/recommendations understood and implemented effectively by local actors?

How do you respond to the issue of attractiveness of the territory?

To what extent are your policies impregnated with the protection of biodiversity?

Protection/Label: RAMSAR protection? Do you see an interest in it?

Perspectives / future developments -> recovery of the activity, seen in 50 years

Public perception of poljes?

What utopian vision of poljes in 50 years

6. Administration/ Project Manager

Technical skills (Water, Forest, Energy)

1/Water Management

Water management

Do you have a monopoly on water management? What are your relations with the different actors of the water management (hydro power plant? other electricity producers...)
How does the water network work, how is it organized? How far does it extend (retrieve a data map)
What are the pollution thresholds, do you respect particular norms? Which ones?
Have you ever had your water cut off? How do you deal with this? How do you manage to stabilize the distribution?
Do you have memories of floods/droughts, did the water get out of its bed one day, something that affected everyone?
Are you affected by climate change, do you have any related measures in place?
Do you VS give concessions to parties and/or companies? How does it work?

Inter-actor dynamics

How are relations with neighboring countries in terms of water management?
How does it work in other cantons?
What is your relationship with peat harvesting?

Agricultural practices

What is your relationship with the farmers? Have they ever expressed needs

Economy/Tourism

Do you receive subsidies from actors (State, private companies...)?

Perspectives / future developments

How do you see the future, how do you see the future in 50 years?
What are your future development projects?
What are your links with the peat exploitation

2/ Forest management

Forest management

How do you manage the forest? (Forestry method + wood actors)
Main threats for you (see what he answers first: fire / illegal logging / illegal waste...). (What are the impacts of fuelwood cutting in the forests, the illegal part?)
Do you observe any impacts of climate change?
Forest fires: frequency of the phenomenon? Do you have a forest fire management policy? Impact on Poljes (Biodiversity)
How do you deal with the fact that there are mines in the forest?

Inter-actor dynamics

How does the population appropriate the forest? Hiking trails?
How do you coordinate with other public services?

Agricultural practices

What are your links with hunters, farmers, water management?

Perspectives / future developments

What is your point of view on the evolution of poljes? Do you see any reforestation? How do you position yourself in relation to this?
How do you imagine Polje in 50 years?

3/ Energy

Energy management

What is the energy mix (renewable energy/fossil fuel share) in the canton?
Are there any energy industries in our study area (4 poljes)?
What is the evolution of the energy needs of the area? (Hypothesis, rural exodus, decreasing needs or not). (Have you noticed any impacts of consumption related to the demographic decline?)
Is the energy policy discussed with the local population?

Water management

How is the water supply managed for the industries concerned (electro-hydraulic power station, etc.)
Have you noticed any changes that may be related to climate change ?

Inter-actor dynamics

inter- actors relations: What are your links with peat harvesting?
(Conflict of use?)

Perspectives / future developments

What are your current development projects? Have you encountered any difficulties? Tell us how it goes when you create a new project?
Do you do impact studies?
Have you ever stopped projects because of a popular uprising?

7. **NGOs**

General/Practical Issues

Problems of access to the field → To what extent does the field constrain your travel?
Capacity to meet local actors → How much of your activity is dedicated to interactions with actors in the field?
Internal organization → Within the framework of your work areas and with a view to meeting your objectives, how do you allocate roles within your teams?
Action strategy → How do you design the ideal approach to be adopted to meet the (environmental/ecological/dvpt) objective set? How do you adapt to contextual changes and paradigm shifts? What are the priorities for action?
Decision-making processes → How and to what extent do you involve your employees in the organization's decision-making processes (e.g. in matters of internal organization, strategic positioning, etc.)
Image → By what means do you manage to develop your image?

Water management

Do you notice any problems with water supply (drought, lack of water, too much water?) Do you advise any adaptation practices to changing climate conditions? Which ones?
Do you notice any changes related to global warming?

Inter-actor dynamics

Relations with other NGOs :

Inter-NGO collaboration, cooperation programmes → Do NGOs face particular difficulties in federating around their causes? Do they easily join new programmes?
Conflicts related to divergent visions → How do NGOs deal with potential other spheres of influence and development / biodiversity protection visions present in the field (if any)?

Involvement of other stakeholders in the reflection processes

Farmers / Producers / Breeders → Historically, how willing are local stakeholders to change their ways of doing things when you propose areas for improvement?
Administration → How do you evaluate the impregnation of the subjects by the politicians, participation in exchanges? Does the administrative organisation (local/global) favour contact with decision-makers and consideration of NGO interests (lobbying)?
Research organisations → Does the local dynamic facilitate the impulse of new partnerships with researchers? What links exist between the research community, decision support expertise and NGOs?
Public services → Is it possible for existing public services (forestry, water management, energy, etc.) to modify their practices / respond to the issues at stake?

Tourism

Do you intend to include tourism in your recommendations?

Economy

What is your funding (local / international)?

Perspectives / future developments

What utopian vision of the polje in 50 years' time
What potential do you see in the sector (hypothesis: agropastoralism, tourism, etc.)
Relevance of the different labels?

8. **ENTREPRISES** *(energy, eolien, industry, mine…)*

Water management

· How do you get/approvisionate your water ?

· Do you see changements related to climate change ?

· Do you have problems getting your water ? (drought, lack of water, too much water ?) Did you develop practices to adapt yourself to climate change ?

Dynamics inter-actors -> partage and usage of territory, cooperatives, potential conflicts of usage

· Relations inter-entreprises/industries

· Which informal organization ? → *Are there synergies ?*

· Gestion of land : are you the owner of the land?

· Relation with other actors of the value chain (providers, clients…) → *understand the balance of power in the chain (*filière*)*

· Relations with other actors of the territory : farmers, forest, peat (*tourbe* in french)…

· Institutional relations / State / ministries / administration

Industrial practices

· What are you dependent on to sustain your business ? Economical, environmental, contextual, familiar, biodiversity factors ?

· How do you adapt your practices according to seasons → *transition to the inscription of the activity in the environment*

· Which perception of the impact of your activity on the environment ? Willingness to use green or non-ecological practices ? Why ?

· How did you learn your practices ? Which evolution of know-how ?

· Do you observe an evolution concerning the land quality ?

· Are poljés characteristics (humid zones, bog (peat)…) beneficial for your activities?

· Is there an impact of the residual mines on your activities ?

Tourism

· What relation do you have with tourists ?

· What is the impact of tourism on your activity ?

Economy

· In which direction do you want to change your market and sales ?

(Importation/exportations ?)

Relation to the land

· Willingness to preserve an aspect of the land ? For which price ?

· Which value is perceived about the land ?

· Have you ever heard of the Ramsar label ?

Perspectives / future evolutions -> business recovery, in 50 years ?

· Which utopian vision of the poljés in 50 years

· Which vision of poljés in 50 years if we continue in the same direction as today

9. **CITIZENS / LOCAL POPULATION**

Water management

How does the water system work in your home? source/company, city... drinking water?
Do you notice any changes related to global warming? (heat islands in the city, drought -> water restrictions by the city, electricity in winter, firewood?)
Have you developed practices to adapt to climate change conditions?

Inter-actor dynamics -> land sharing and use, cooperatives, potential conflict of use

Relationships with other residents of the city/village
Are you part of a collective? (looking for an informal type of organization? → Do you find synergies? (e.g. Lending equipment to each other if agri/ and or sales network)?
Are you aware of any associations developed in the area? Are there any in the field of environment/police? (birdwatching groups, nature outings, meeting with farmers...)
Land management: do you own your house/apartment/land? (Do you have a concession?)
Relations with all the other actors of the territory: forest, water and electricity supplier (hydroelectricity...) peat... development of renewable energies -> installation of wind turbines in the landscape of poljés...)
Institutional relations / State / ministries / administration, what are the last measures of the State that have impacted you? (Positive/negative> know what is its relationship to the state)

Agricultural practices

What is the perception of the impact of agriculture and pastoralism on the environment? Positive or negative? Willingness to consume local products? What do you think of organic food ?

Tourism

What is your relationship with tourists, to the development of this sector for the country, the region? Are you comfortable receiving tourists?
What is the impact of tourism on your business?
How do you see your own tourism? Where do you travel (inside the territory, outside)?
How do you use the forest? the polje? the mountains?

Economy

How do you rate the job market? easy to find a job? and your family?
What are your sources of income? do you have one or more jobs? main jobs? side jobs? (try to determine if there is a change in purchasing power or not

Relationship to the territory

Willing to preserve an aspect of the territory? Are you ready to invest in the preservation of your territory?
Are you sensitive to the different riches that make up your living environment?
What do you think about the development of tourism in your region?
Are you aware of the protection measures present on your territory? What do you think of them? If we take the example of Ramsar and wetlands?

Perspectives / future developments

What utopian vision of poljes in 50 years
What vision of the polje in 50 years if we continue in the same direction as today?

10. **RESEARCHERS**

Start by presenting the research project - our approach
Ask about the researcher's academic (and non-academic) activities
Dig to understand their speciality(ies) and how they relate to poljés.
Understand why he/she is interested in these particular themes.
Depending on the speciality, select questions as follows.

Information that could be sought from the academic body:

- How does the scientific body work with the managers of the natural environment and/or contribute to the conservation projects of the territory?
- What is/are the exceptional value(s) of the poljes to be preserved?
- From experience, do local people volunteer to preserve poljes? Collectively or individually? What collaboration between science, NGOs, government and local people?
- Does it make sense to consider the 4 poljes as a whole?
- Is it relevant to distinguish the plain from the mountains when dealing with land conservation?
- To what extent is the academy taken into account in the design of public policies for land management and biodiversity conservation?
- Did you participate in the design of the BiH ESAP 2030+ (policy that established environmental policy and goals for BiH up to 2032 - joint initiative with all governments of the country involved)?
- What is the impact of population decline on the ecological quality of the territory in your opinion?
- If forests were to regain their surface area, what impact would this have on biodiversity?
- If grazing land were to expand further, what impact would this have on biodiversity?
- What are the consequences of climate change on the environment today and tomorrow?
- Can tourism and conservation of the territory co-exist in your opinion?

Specialties of interest:

1/ Ecology // Biology

o Understanding the different ecosystem services of polje

o What are the major differences in polje ecosystems?

o What are the conservation needs? Current threats?

o Have you been involved in the establishment and management of the Livanjsko Polje Ramsar site? If yes, how would you characterize the management of this site?

2/ Ornithology

o Know which birds are present? What is their protection status?

Which species are rare / to be protected?

Which species are threatening/invasive?

o What are the population dynamics of the birds? -> More and more individuals... or less?

- o What threats to bird habitats? What threats to birds in general? Understand the destructive dynamics.
- o What is the desire for bird habitat protection tools?
- o What feedback from the management of the RAMSAR site?
- o What other environmental protection labels & networks, to your knowledge, could help conserve polje?
- o What impact does climate change have on bird migration?
- o What is the link between territorial activities and the sustainability of bird populations?

3/ Zoologist

- o Which animals are present on the territory (endemic species to be protected? invasive?)
- o What are the dynamics of population evolution over time?
- o What is the impact of demographic decline on animal habitats?

4/ Mycology

- o Which fungi are present?
- o What functions do mushrooms have for the environment?
- o What link between mushrooms and local activities?
- o What use do local people make of mushrooms (marketing?)

5/ Geographer / Hydrographer

- o More detailed description of the river system
- o Important elements for maintaining the river system
- o Understanding the value behind the river system
- o Dynamics of how the system will evolve over time if things remain as they are today
- o What are the threats to river systems from dam development?
- o How does climate change impact on the ecology and water system of the area?

10. Thematic sheet: hydrogeology, biodiversity, ecosystems

Hydrogeology

The karst polje

Karstic polje are geological formations dating from the Tertiary era, these are

elongated depressions surrounded by mountain slopes closed basin in the Dinaric Alps, with hudge hydrographic networks with ; bottoms covered with arable soils and constant or intermittent water courses : seasonal floods => wetland

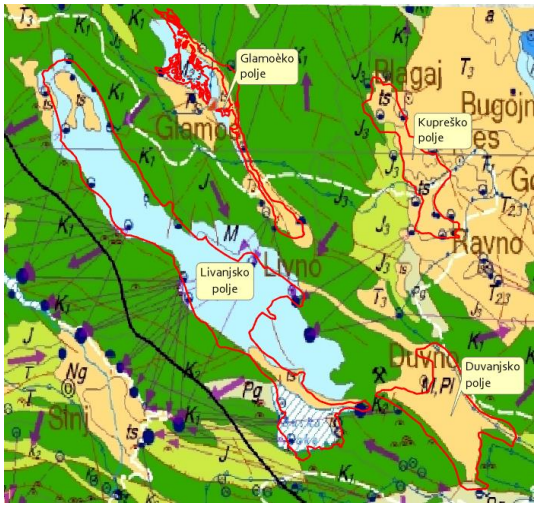
Highest polje are often dry

-> IN : Winter precipitations + heavy hydrostatic pressure

<- OUT : ponor's absorbtion capacity > total polje water mass

- Development of the karst landscape depends on corrosion, (ability of rocks to be dissolved in water)
- Diversity of karst landform features
- Ponors, pit, estavelles

Poljes are still evolving (data from fleeding and/or landform evolutions during time ?)



Biodiversity

The natural heritage

- The only **nesting place** for the Great Egret, the Pomarine Eagle and the European Bittern.
- **Valorization of the cattle** (production of cheese, meat...)

- ❖ Rare **endemic fauna** among the most diverse in the world (endangered species like **newts** etc.)

400 wild horses

250 birds listed

60% of forests

7 plant species are protected, including rhododendros and Edelweiss

Several rare and vulnerable **mushroom** species which testify to the quality of the soil

Biodiversity pressures:

Water extraction and human impacted drought

Introduced species

Agricultural pollution

Wild horses source : https://www.itinari.com/fr/wild-horses-of-livno-

Great egret https://www.notrenature.be

Ecosystems

Ecosystems/Ecology of the poljes

- Poljes are **wetlands** where we can find seasonally flooded agricultural land and alluvial forest, seasonal marshes and pools, permanent streams, karst springs, sinkholes and peatlands.
- Duration of flood events greatly change the size of different wetlands types between years.
- The main ecological process is **flooding of the polje by karst rivers**. Through the annual cycle of flooding, the capacity of sinkholes to drain the polje and evaporation, the ecological value is naturally maintained

We have informations on the ecosystems of Livanjsko Polje, and even a map, but not for the others poljes.

Is there peatland restoration projects and/or development project to simulate natural flood conditions and to make groundwater level higher ?

Pressures on ecosystems:

Construction of canals, water extraction for energy production can be the causes of hazard.

Peat excavation can lead to the destruction of the peatlands.

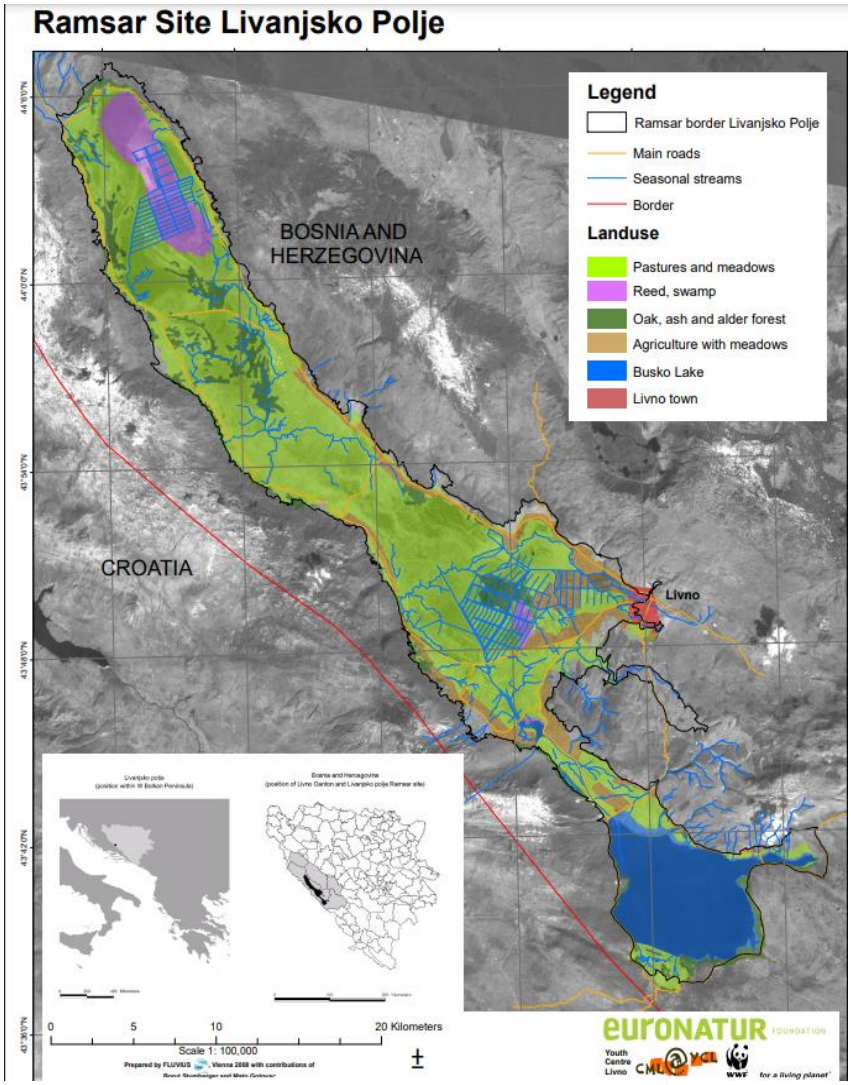
Uncontrolled burning of peat, grassland and scrub areas in the winter and early spring at Livanjsko Polje is a serious problem.

Logging

Land exploitation

Illegal waste dumps

Hydropower plant projects affect also the wetlands.



Sources:

Information Sheet on Ramsar Wetlands (Livanjsko polje): https://rsis.ramsar.org/RISapp/files/RISrep/BA1786RIS.pdf

State of peatland ecosystems in Bosnia and Herzegovina (Senka Barudanović, Ermin Mašić, Armin Macanović, Ena Hatibović)

Blanc André. Poljes karstiques. In: L'information géographique, volume 16, n°2, 1952. pp. 72-75;

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11. Bosnia-Herzegovinia History and Socio-Economic Stakes

1. HISTORY OF THE COUNTRY

Local and recent history of Canton 10:

A majority Croat canton, Herceg-Bosna proclaimed its independence during the Bosnian war (1992-1995). Ruled by the Croat minority, they were at war with both Bosniaks and Serbs from 1992 to 1994. The Serbs invaded the canton from the east and attacked Glamoc, Kupres, Livno. The alliance of Croats and Bosniaks in 1994 enabled the federation to repel the Serbs. After the war, in 1996, the state of Herceg-Bosna was dissolved and became a canton of the federation.

Today, the canton is predominantly Croat. Serbs are mainly living in the north-western part of the Canton.

2. POPULATION

2.1. Demography in Bosnia and Herzegovina

The last census was made in 2013. Since then, only projections have been made. According to the Agency for Statistics of Bosnia and Herzegovina, the population reached **3 453 000 people in 2021**. Nevertheless, the last census showed that projections had been overestimated by 300 000 people. Then, according to the World Bank the total population is around **3 271 000 people in 2021**.

51% of the population are women. Each year there are more deaths than births (especially during the Covid crisis), with **one of the lowest fertility rates in the world** (the average rate of births per woman is 1,3; the average in OECD is 1,7). Life expectancy at birth is 76 years.

Migration represents about 25 800 people per year. Added to the fertility rate, it explains the **degrowth of population of about 1,4% per year**. Approximately **57% of young people in BiH expressed a desire to emigrate**, the highest rate in the region.

2.2. Demography in Kanton 10

Kanton 10's last figures are from 2013. The total population of **Kanton 10 was 84 127 people**. Population density is six times inferior to France's, reaching **17hab/km², less than Lozère.** In 1991, there were 115 692 inhabitants. The two main municipalities are Livno and Tomislavgrad.

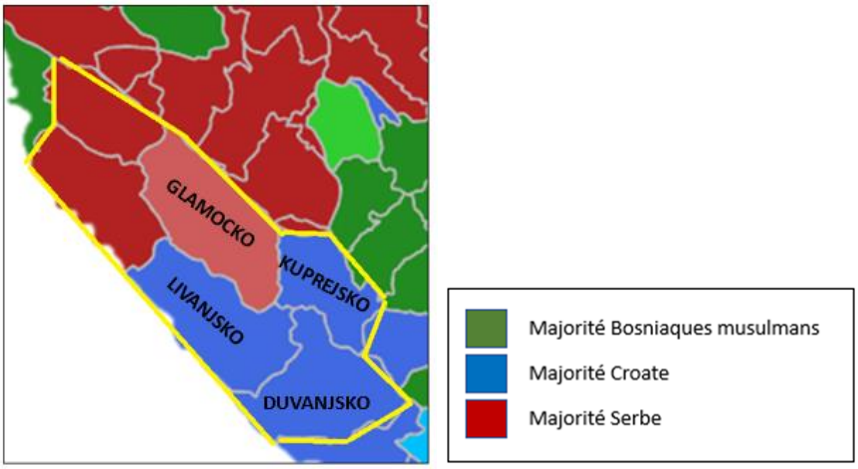
Municipality	**Livno**	**Tomislavgrad**	**Drvar**	**Kupres**	**Glamoc**	**Bosansko Grahovo**
Number of inhabitants	34 133	31 592	7 036	5 057	3 860	2 449
% of the Kanton	41%	38%	8%	6%	5%	3%

The average age of population in 2013 was 41,3 years (43 years average in France)

2.3. Ethnicity and religion

In Kanton 10 there are people from all ethnicities but with a **clear majority of Croats today**. Yet, in 1991 we could find ⅓ of Serbs that seem to have left after the war (only 13% now). In fact, it is a movement seen in the whole BiH, with geographical dispositions of ethnicities. **Kanton 10 is composed of a majority of Croats (76,8%)** while the Federation of BiH is in majority composed of Bosniaks (70,4%).

Concerning religion, we can see that figures are very similar to ethnicity. In fact, most Bosniaks are Muslims, Croats Catholics and Serbs Orthodoxs. In **Kanton 10 there is then a majority of Catholics (76%)**.



3. POLITICAL ORGANIZATION

3.1. The political structure

The political structure of BiH today is the **legacy of the Dayton Agreements (1995)**. These agreements instituted nationalism to restore peace by establishing a collegial presidency, based on the three largest minorities: Serbs, Croats and Bosnians. The presidency is one of the centralized institutions of the state of BiH, along with the central bank and the constitutional court.

In order to take into account the spatial distribution of national minorities caused by the war, the Dayton Agreement defined a very specific geographical decentralization separating BiH into 3 zones:

- The Federation of BiH, that is divided in 10 Cantons, with a majority of Bosnians and Croats, including the capital, Sarajevo. FBiH = 79 municipalities + 51% of the country's total territory. Our study area is almost entirely located in Canton 10, which is the largest by area. Out of 10, 5 cantons have a Croat majority, 5 Bosnian.
- The Republika Srpska has a Serb majority. RS = 64 municipalities + 49% of the country's total territory. A small part of Kupresko Polje is located there.
- Brčko District

3.2. The political landscape

The municipalities are the smallest administrative entities in BiH. The studied poljies are located in 5 municipalities: Bosansko Grahovo, Livno, Tomislavgrad, Kupres, Glamoč. These municipalities are not cities in the strict sense of the word, as they group together settlements which are towns or villages. Thus Livno and Glamoc designate both a municipality and a settlement (city). On the other hand, each municipality elects a Mayor. The mayors of Bosansko Grahovo and Glamoč are from Serbian nationalist parties, while those of Livno, Tomislavgrad and Kupres are from Croatian nationalist parties.

Focus - Canton 10

In the assembly of Canton 10, out of 25 deputies at least 15 are today from 4 different Croatian parties. At least 2 deputies are from a Bosniak party and 2 from a Serb party. 2 other deputies are from a party claiming to be independent and officially multi-ethnic: the Social Democratic Party, supported mostly by Bosniaks.

3.3. EU application

BiH launched its application for official EU membership to the EU in 2016. The Council and Commission declared **BiH an official candidate in December 2022**, and it will have to deploy efforts regarding the rule of law, fundamental rights, democracy and the fight against corruption. The commission recommends, among other things, reforming the constitution resulting from the Dayton Agreement (1995) to ensure political equality for Bosnian citizens without ethnic discrimination.

On the environmental aspects, the EU asks the country to implement and enforce better its commitments. The main recommendations are on protection strategy, harmonization of the measures in the country and formalization of the commitments in the field. The other issue is on energy as the EU asks BiH to adopt an integrated national energy and climate plan.

4. ECONOMY

4.1. At the national level

The currency is the **Convertible Mark (KM)** since 1998. In 2021, the country's GDP stood at **US$7.14 thousand per capita** with an increase since 2020(French GDP was US$43.66 thousand per capita), inflation has also been rising since then. In 2021, **Canton 10 was the poorest canton in the FBiH**.

4.2. Energy and pollution

Bosnians' energy mix is very dependent on fossil fuels, **54% of the energy consumption coming from coal and 21% from oil**. Hydropower represents 5% of the energy mix and 30% of electricity production while renewables only represent 0,4% of the total energy consumption.
This can be explained by the heating directly from coal.

Total CO2 emissions reach 20,5Mt mainly from electricity production and heating.
Emissions per capita are 6,3 tCO2eq (average of 11tCO2eq in Europe).

4.3. Main activities of Canton 10

In terms of municipalities in Canton 10, Kupres is the most developed and Bosansko Grahovo is the poorest.

In 2021, **83% of jobs are located in the areas of Livno (41%), Tomislavgrad (29%) and Kupres (13%)** municipalities. Most of the jobs in the Canton are in:

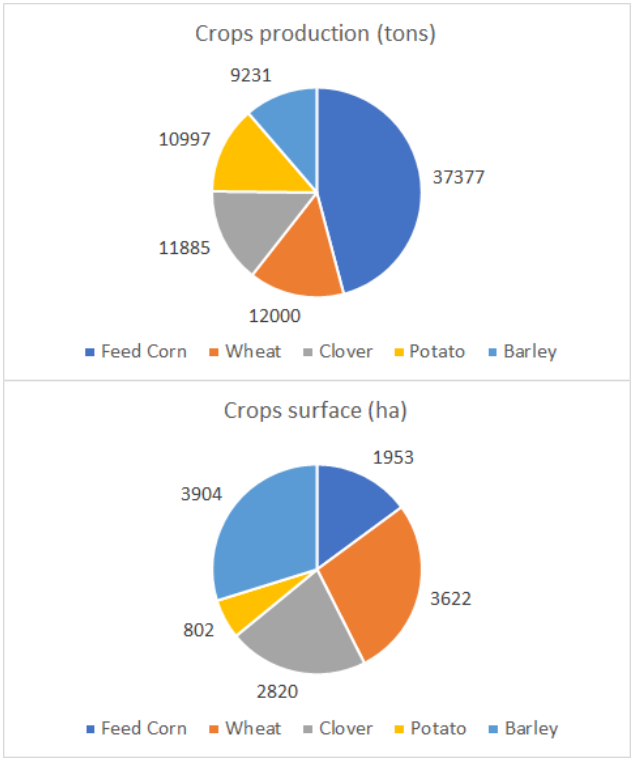
- wholesale and retail trade, automotive and motorcycle (16.7%)
- manufacturing industry (14.4%)
- public administration and defense, compulsory social insurance (13.6%)

- agriculture (12.2%)

In these 4 sectors, **wages are highest in agriculture.**

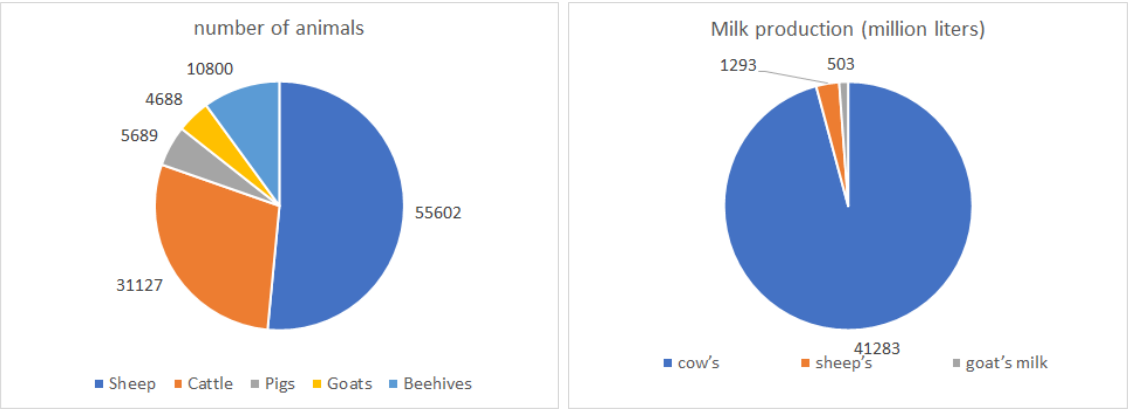
4.4. Activities impacting the polje ecosystem in Canton 10

The polje ecosystem is mostly impacted by agriculture carried out by **small individual farms**. The graphs below show the most important crops in 2021 for Canton 10 by size and weight.



Fruits are also grown (mostly apples, plums and hazelnuts) but the tonnage is much lower than the above crops (142 t of apples in 2021 for Canton 10).

The table below shows the number of **livestock and milk production** in 2021 for Canton 10. We are missing information about meat production: this may represent 80% of the farmers' income but the production is mainly for export.



Canton 10 also produces wood, mostly logs and firewood from resinous wood.

The Canton's **economic balance was positive by 34 million KM in 2021**. **The main trade sector is manufacturing**.

The Canton is **one of the least touristic areas in BiH**. Tourism was very affected by COVID: local tourism recovered well (more tourists in 2021 than in 2019) but there are still less than half of foreign tourists in 2021 compared to 2019.

Year	2019	2020	2021
Total number of tourists	**12 949**	**5 985**	**9 621**
Number of tourists: local	3 730	2 933	4 868
Number of tourists: foreign	9 219	3 041	4 753

4.5. Unemployment

The employment rate is very low, only **39,6% of the population in age to work did in 2021** (57,7% average in the OECD). Women are underrepresented in the labor market (only 35.4% in 2019). **Informal employment rates are estimated at around 23.1% of total employment in 2019**, mostly because of high labor costs (social insurance contributions amount to about 41.5% of the gross wages in the Federation of Bosnia and Herzegovina).

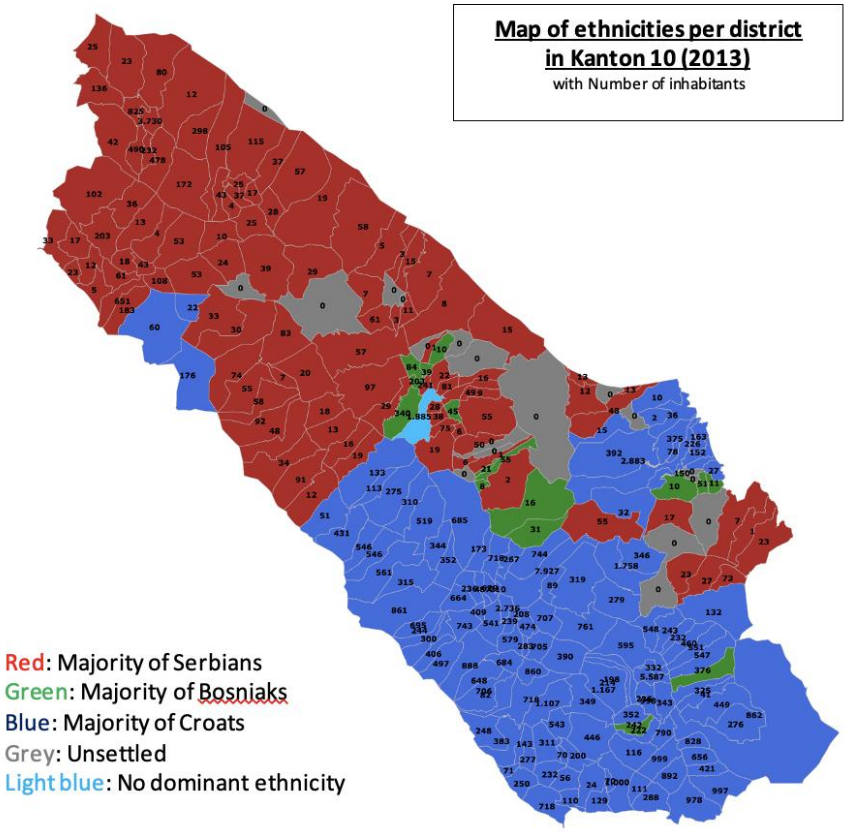
Unemployment has declined since 2015 (27,7% of the labor force was unemployed), reaching in **2021 an unemployment rate of 15,2%**. Yet, it has one of the highest unemployment rates in Europe, only Montenegro (18,49%) and North Macedonia (16,2%) do worse. The average in the EU is 6%. Moreover, **youth unemployment rate is still very high, around 33%** of the economically active population aged 15 to 24 is currently without work and in search of employment.

4.6. Salary and poverty

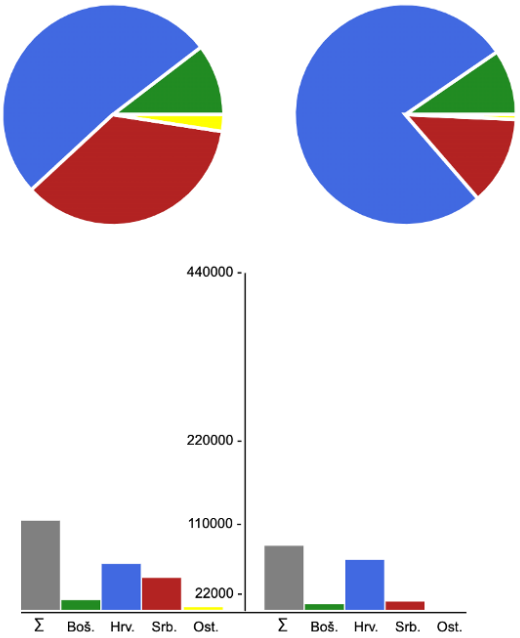
The **mean net salary in Kanton 10 is 942 KM (around 482€)** which is under the average of the country that is 1190 KM (609€).

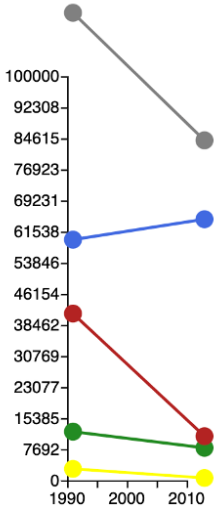
17% of people live in poverty (based on the national poverty line). This figure reaches 19% in rural areas. This is relatively high compared to the OECD average (12%).

5. Annexes



Census 1991			Census 2013		
Bosniaks:	**12.041**	**10,4%**	Bosniaks:	**8.037**	**9,6%**
Croats:	**59.553**	**51,5%**	Croats:	**64.604**	**76,8%**
Serbs:	**41.265**	**35,7%**	Serbs:	**10.905**	**13,0%**
Others:	**2.833**	**2,4%**	Others:	**581**	**0,7%**
∑:	**115.692**		∑:	**84.127**	

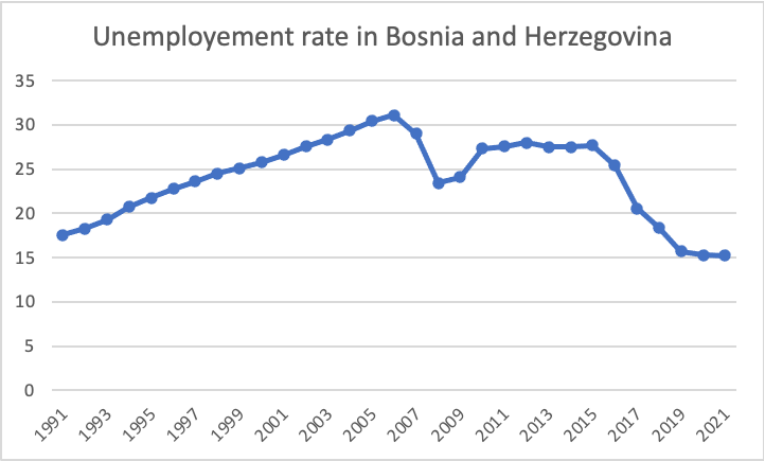




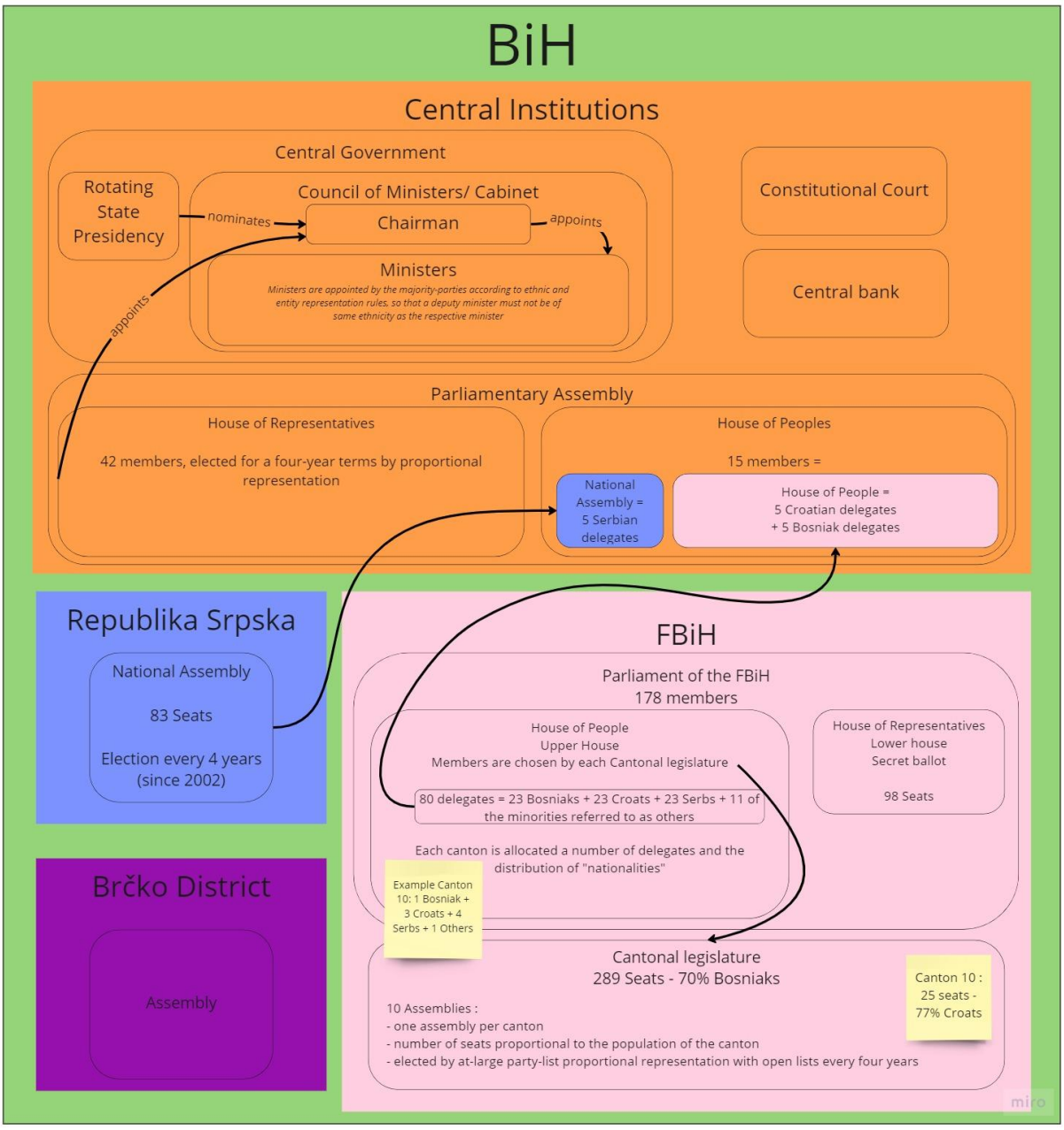
(Source : http://www.statistika.ba/?show=12&id=19300)

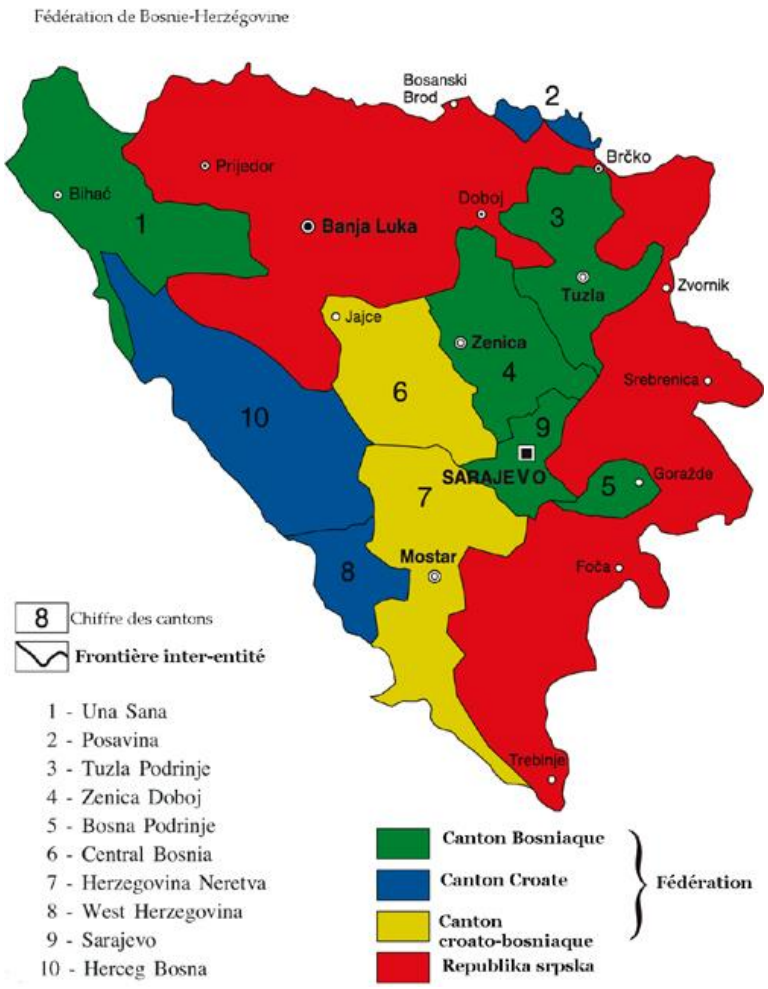
Ethnicity	Bosniak	Croat	Serb	Not declared/other/no answer
% Kanton 10 in 1991	10,4%	51,5%	35,7%	2,4%
Kanton 10 in 2013	8 037	64 604	10 905	581
% Kanton 10 in 2013	9,6%	76,8%	13%	0,7%
% BiH in 2013	50,1%	15,4%	30,8%	3,7%
% FBiH in 2013	70,4%	22,4%	2,6%	4,6%

Religion (2013)	Islamic	Catholic	Orthodox	Other
Number in Kanton 10	7 904	63 990	10 873	1 360
% Kanton 10	9%	76%	13%	2%
% BiH	51%	15%	31%	3%
% FBiH	71%	22%	3%	4%



Source : World Bank


BiH
Central Institutions
Central Government
Rotating State Presidency
nominates
Council of Ministers/ Cabinet
Chairman
appoints
Ministers
Ministers are appointed by the majority-parties according to ethnic and entity representation rules, so that a deputy minister must not be of same ethnicity as the respective minister
appoints
Constitutional Court
Central bank
Parliamentary Assembly
House of Representatives
42 members, elected for a four-year terms by proportional representation
House of Peoples
15 members =
National Assembly = 5 Serbian delegates
House of People = 5 Croatian delegates + 5 Bosniak delegates
Republika Srpska
National Assembly
83 Seats
Election every 4 years (since 2002)
FBiH
Parliament of the FBiH
178 members
House of People
Upper House
Members are chosen by each Cantonal legislature
80 delegates = 23 Bosniaks + 23 Croats + 23 Serbs + 11 of the minorities referred to as others
House of Representatives
Lower house
Secret ballot
98 Seats
Each canton is allocated a number of delegates and the distribution of "nationalities"
Example Canton 10: 1 Bosniak + 3 Croats + 4 Serbs + 1 Others
Cantonal legislature
289 Seats - 70% Bosniaks
Canton 10 : 25 seats - 77% Croats
10 Assemblies :
- one assembly per canton
- number of seats proportional to the population of the canton
- elected by at-large party-list proportional representation with open lists every four years
Brčko District
Assembly
miro



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- State Veterinary Administration of Bosnia and Herzegovina (2003), “Animal genetic resources in Bosnia and Herzegovina”, link
- Statistika (2013), “Population and ethnicity”, link
- World Bank (2020), “BOSNIA AND HERZEGOVINA SYSTEMATIC COUNTRY DIAGNOSTIC UPDATE”, link
- World Bank (2021), “Data on Bosnia and Herzegovina”, link
- It's Complicated: Bosnia's Byzantine System Of Government, RadioFreeEurope, RadioLiberty, infographics, October 11, 2018 : link

7. To go further

Economic articles :

- https://www.emerald.com/insight/content/doi/10.1108/978-1-78973-755-420201003/full/html
- https://link.springer.com/chapter/10.1007/978-3-030-98523-3_14

Demography and landscape : https://link.springer.com/chapter/10.1007/978-3-030-74590-5_24

Older people : http://dostojanstvenostarenje.org/wp-content/uploads/2016/08/Socio-Economic-and-Health-Economic-Living-Conditions-of-OP-in-BIH.pdf

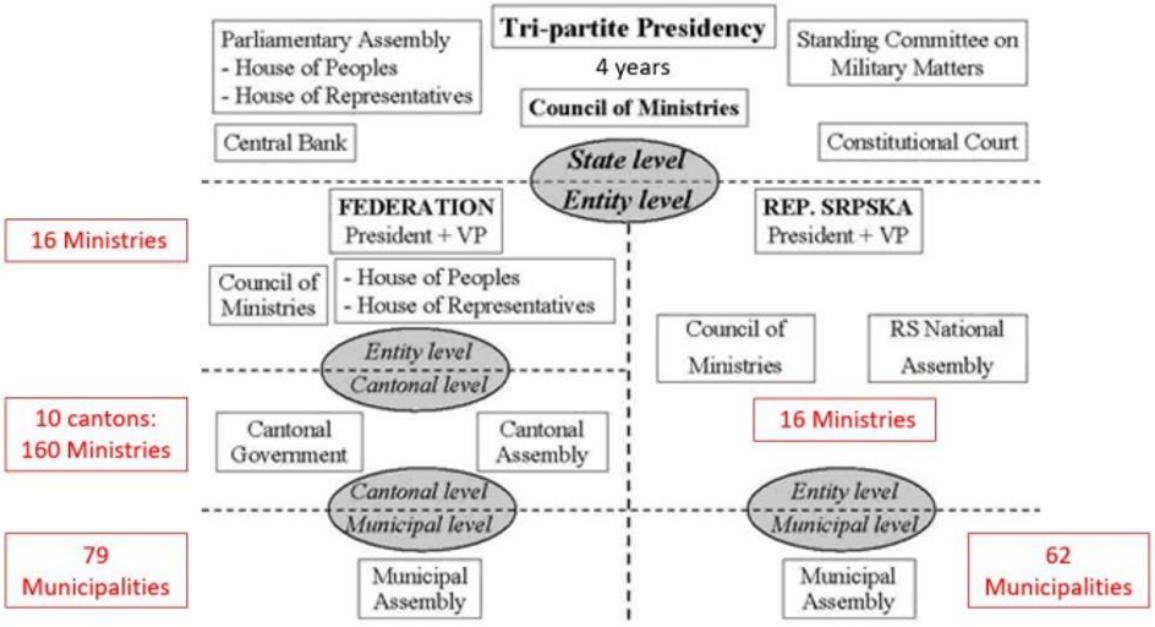
12. Thematic sheet Governance, institutional actors and project leaders

I – Background, governance and administration in Bosnia and Herzegovina and Canton 10

In Bosnia and Herzegovina there are three distinct higher administrative entities:

- Federation of Bosnia and Herzegovina
  - It includes 10 cantons, of which 5 are Bosniak-majority, 3 Croat-majority and 2 mixed.
- Republika Srpska
  - 6 administrative areas
- Brcko's district
  - Independant one, under United Nations mandate

There are three presidents at the head of the federation, one for each ethnic group (Bosnian, Croat, Serb). They take turns every 8 months.



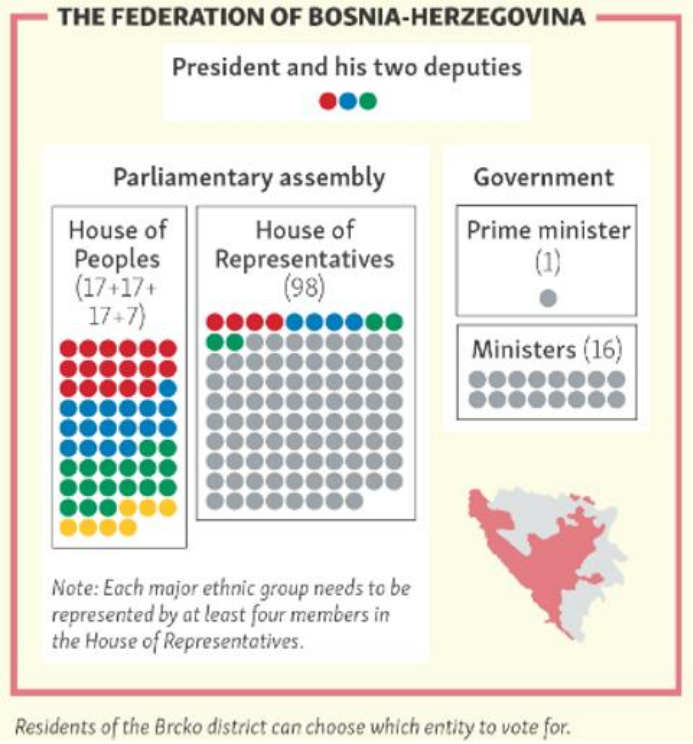
Source : Zoé SIEGEL, Thèse professionnelle – Identification et compréhension des principaux enjeux environnementaux à l'échelle du territoire en Bosnie-Herzégovine

Each canton has its own judicial, executive (Livno, with the prime minister) and legislative (Tomislavgrad, with the assembly) power. It manifests itself with:

- Constitution
- Assembly

- Government
- Symbols
- Exclusive competences

However, there are very different realities depending on which canton you are in. At the level of ministries, for example, only 6 of the 10 cantons have their own ministry of agriculture. Elections are held every four years to appoint the representatives of the assembly at the cantonal and municipal level. In the case of Canton 10, our study area, 25 members are elected. Their responsibilities notably include the management of natural resources.



Source : https://www.rferl.org/a/its-complicated/29538308.html

When we look in more detail at the facts on the ground, the state seems to have a stranglehold on natural resources. It delegates the management of rivers, lakes, forests, ... to private companies. Users can have access to public territories (river for fishermen, forest for hunters, etc.) through concessions.

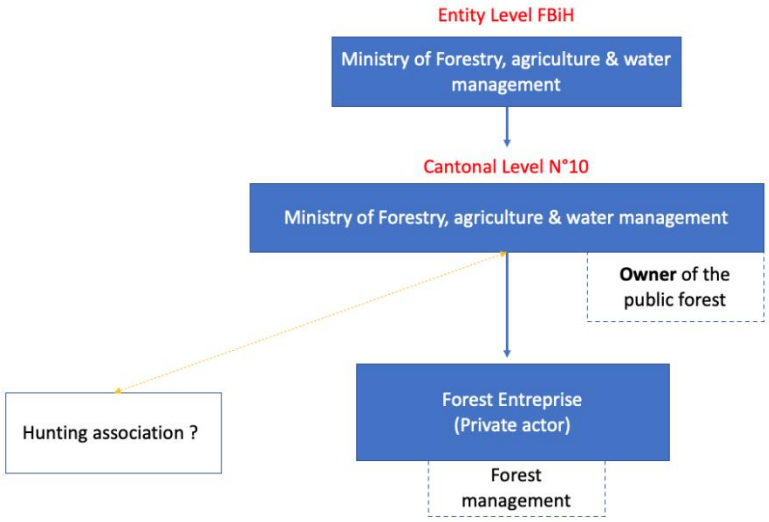
On the other hand, there is an indecent number of concessions delivered to companies for the exploitation of resources (mines, hydroelectric dams, etc.). Despite the competences of the cantons and municipalities that appear on paper, there is overall a big top down in the country with a state that controls everything.

The model seemed to be efficient at the time of Yugoslavia but today it generates many problems such as:

- Underdevelopment of the distribution infrastructure
- Political corruption at national level
- Waves of emigration

Let’s detailed now localy each sector.

II – Forests



Bosnia and Herzegovina is covered by 63% of forests. The management of forest is still influenced by the past socialist system. Most of resources are state-owned (80% of the forest is public VS 20% is private). The Ministry of *Agriculture, Forest and Water Management* is responsible of the organization and control of wood management. It has contracts with one enterprise for the management of forests.

Challenge:

→ **Control fire to keep composition of vegetation:** fire is a big threat for forests, bogs, fens and open grassland. Fire changes the composition of grassland soil and the vegetation it supports. Uncontrolled man-made climate change fires are changing the composition of vegetation leading to desertification in some areas.

→ **Control the increase of the forest to keep composition of vegetation:** Without agricultural use, the poljes would be probably dominated by forests. Such forests still exist in Livanjsko polje but are absent or very repressed in other poljes.

Good to know:

- Almost all the country's public forests are certified FSC.

Questions:

- *What is the name of the forest company in charge in Cantonal 10?*
- *Is there a hunting association? Is there a wide-life’s stock management?*

- *Does the forest company have a fire management process? Do they aware of ecological issues?*
- *Are there some artisanal products made of woods in the region (like: Rakia Bottle incense, loom, painting, clock….)*

III – Water and peat management

The water management structure is similar to forests resources. Republic of Bosnia is the owner of the water components. These latter cannot be sold but can be the subject of a concession (for hydropower plants /fishing: water activities). Water management is regulated by the Law of water (depending on the entities). The Ministry of agriculture, forestry, and water management (entity and cantonal level) is responsible for water. Requests for all types of concession are submitted to this Ministry. It is responsible for: -The preparation of strategies and development policies

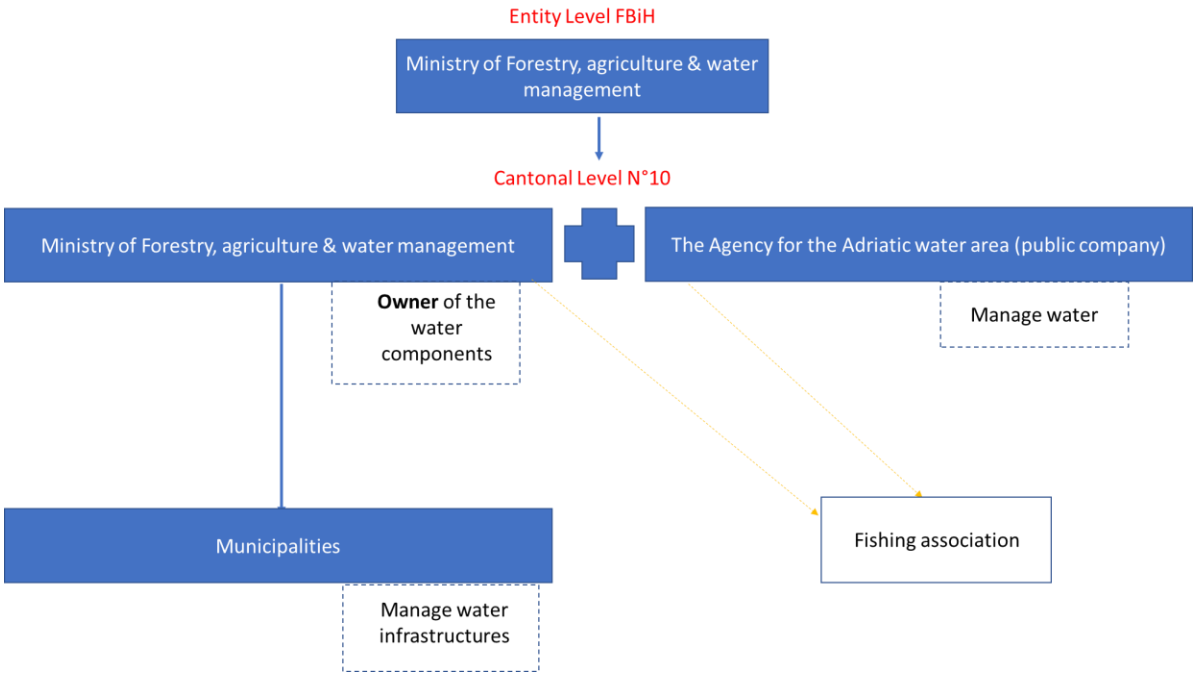
-Water management plans

-Monitoring the state of water resources

-Proposing laws

-The supervision of lower organizational units, etc.

Contrary to the forest sectors, water departments are present in the administrative structure of the Municipalities. It has for role to build and manage infrastructure to assure water supply and quality (collectors for purification) to the population.



- Fishing association

They pay the government to use rivers as concessions. Management plans are done for 5 years in BiH by the Ministry. A yearly plan is also done for each municipality with quotas according to the present population. The principal threats on fish population are the river pollution and the hydroelectric power plants which break rivers.

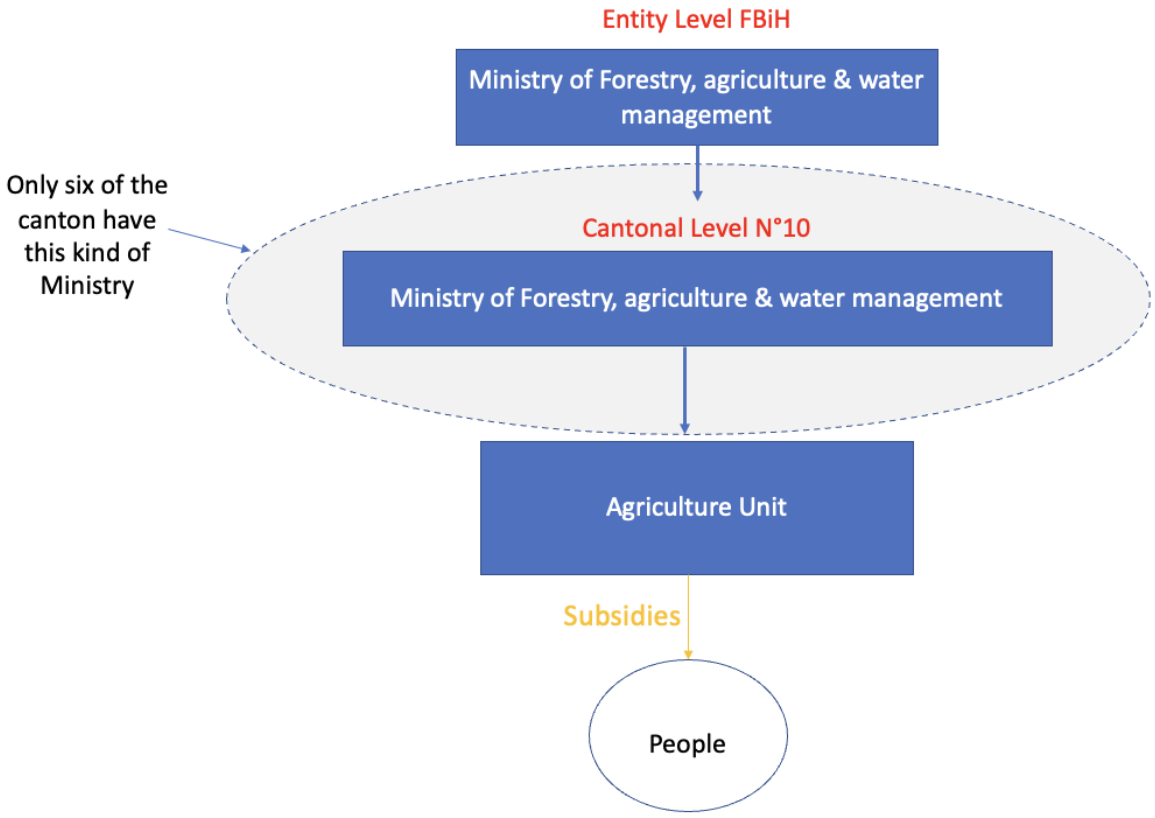
- Threats

Threats on	Who?
Peat (Kupreško & Livanjsko polje)	Researchers from the University of Sarajevo & BL Farmers Private company ?
Waste & pollution water	Association as Dinarica Association Municipalities
Hydropower plants (Duvanjsko & Glamočko)	Two municipalities (Kablic & Vrilo) Elektroprijenos B&H

Questions:

- Is there an industrialization of the peat extraction? A value chain?
- What about the water uses by farmers for their fields?
- Is there a lack of local autonomy to manage water as written in this?
- What is the place of the water in a drought? Is there a strategy plan?

IV – Agriculture



4.1 REGISTERED OR NON-REGISTERED?

Basic form of organization in agriculture seems to be an

- **Agricultural farm**
- **Family agricultural farm** VS a **non-commercial family farm** (is a farm that is not market-oriented and that has not reached the minimum total volume of production)

Types of farms, registered in agriculture register, exercise the right to **get financial helps/incentive**. *Examples of sub subsidies: Milk subsidies, subsidies to support beekeeping production, funds intended for the improvement of agricultural mechanization and facilities in animal husbandry….*

Challenge:

→ **To be registred**. Indeed, Entrepreneurial activities are also hard to develop. When people register to start a commercial production, pre-requirements and controls are strong and people are often discouraged to start something because of that pressure. Moreover, the access to the market is difficult, especially in agriculture where around 60% of the food is imported.

4.2 COMMERCIALIZED CULTIVATION

	Glamočko polje N°12	Kupreško polje N°13	Duvanjsko polje N°15	Livanjsko polje N°16
Potatoes	X		X	
Cereals	X			
Blackberries			X	
cabbage				X
Livestock grazing	X	X	X	X
Milk Production				X
Italian cheese				X 1-Livanjski (GI registered Livanjski sir PGI-BA-2881 - 16/12/2022) 2- Cincar

Non exhaustive list, to be complete on the field during our investigation.

Challenges

→ **A decline in livestock farming for biodiversity:** Traditional extensive agriculture was always compatible with the natural balance of the polje, and livestock grazing helped maintain grassland ecosystems.

→ **Water for farmers**: drought threatens agriculture and it have increased in recent years. In *"People use the water from the municipality to water their productions" in Sanski Most (an.* Drought is the only climate change that people felt these past years.

→ **Price of seed farmers**

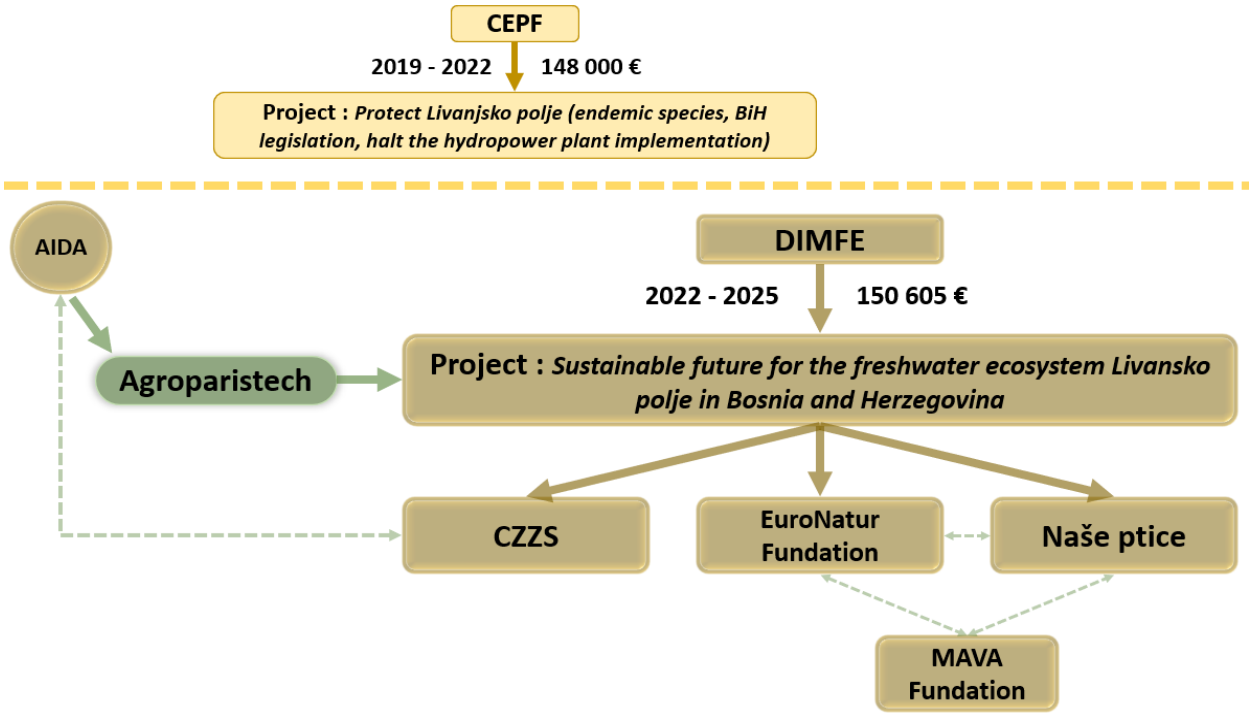
Question:

- *Is there honey production? Wine (as 10 wines are protected under agreement in BH)? Others cultivated fruits and vegetables. …*
- *Is there an agricultural cooperative?* Like "Emina" à Goražde, initiative slow food.

V – NGOs

Political pression of NGOs on government: As a potential member of the EU, Bosnia-Herzegovina will have to establish a network of Natura 2000 areas and has recently started preparations for the

adoption of EU nature conservation policy. EU legislation opens the chance for NGOs to influence the Natura 2000 process. Even if national authorities do not take non-governmental support in account in many cases. In many countries (also in the Western Balkans) NGOs have prepared “shadow lists” of habitats which were not designated by local authorities.



2019-2022	2022-2025
CEPF (Critical Ecosystem Partnership Fund) Project: “Protection of Livanjsko polje”	***Project: “Sustainable Future for the freshwater ecosystem Livanjsko polje in Bosnia and Herzegovina”***
1) Establish the conservation status, research the ecology and management needs for five endangered fish species of Livanjsko poljé and Busko lake 2) Support the sustainable management of water catchments through integrated approaches for the conservation of threatened freshwater biodiversity 3) Advocate for the protection of Livanjsko polje under category V.a. of the BiH legislation Biggest achievement of the project is halting the hydropower project CHE Vrilo in 2021. Hydropower company Elektroprivreda HZHB abandoned the construction of the project once	The project targets 5 main specific goals : 1) Enabling long term sustainable protection of Livanjsko Polje and surrounding karst poljes as an important freshwater ecosystem in BiH; 2) Conservation and restoration of freshwater ecosystems and its biodiversity in Livanjsko Polje through fostering and improving of environmentally beneficial land use practices; 3) Reduction of illegal and harmful activities to the freshwater ecosystem of Livanjsko Polje; 4) Strengthening local initiatives that contribute to nature conservation and sustainable

the German Development Bank KfW halted the financing due to interventions of NGOs and local communities (led by WWF Adria, Udruga Dinarica) The Hydropower project would have irreparably damaged the underground connection from Duvanjsko to Livanjsko polje destroying biodiversity and archeological sites that have still not been fully discovered Linked to Euronatur	management of the freshwater ecosystem of Livanjsko Polje and surrounding karst poljes; 5) Increased awareness and knowledge in the general public about the natural and cultural values of karst poljes.

NGO	Creation date	Country of origin	Objectives	Projects in Bosnia-Herzegovina	Linked to	Capacity (employees, volunteers)	Additionnal comments
AIDA	1988	France	- To carry out actions to promote the agro-environment in all its forms. - Offer technical and scientific expertise, propose mediation and inter-mediation and produce and distribute training, popularisation and communication materials	- Embedded research on agro environnemental issues. -Fieldwork and projects located in the Western Balkans Countries.	Agroparistech CZZS	8	- Since 2018 : active participation - AIDA - CZZS : already partnership on two municipalities of BiH (Sanski Most and Merkonic) goal : to provide complementary elements (contextual and territorial approaches) to the defence of the environment.
CZZS	1999	Bosnia-Herzegovina	Focused on environmental issues with active and proactive actions	**Sustainable Future for the freshwater ecosystem Livansko polje in Bosnia and Herzegovina**	AIDA EuroNatur Naše ptice	20	important influence in BiH 30 various donors, 7 partners & 4 initiatives
EuroNatur Fundation	1987	Germany	- Focused on Europe primary forests, rivers, green belt, migratory birds, bear, wolf, lynx and Conservation policy - Working for official national recognition of livanjsko polje as a fully protected area	- **Sustainable Future for the freshwater ecosystem Livansko polje in Bosnia and Herzegovina** - Ongoing project "Adriatic Flyway" : identifying important breeding habitats and resting sites of migratory birds in the region - Project "Identification of Karst Poljes as Wetlands of National and International Importance" in 2010	CZZS Naše ptice Mava	29	
Naše ptice	2003	Bosnia-Herzegovina	Focused on the field of ornithology, ecology, bird ringing and protection and monitoring of birds and birds' habitats	- **Sustainable Future for the freshwater ecosystem Livansko polje in Bosnia and Herzegovina** - Ongoing project "Adriatic Flyway" : identifying important breeding habitats and resting sites of migratory birds in the region - Project "Identification of Karst Poljes as Wetlands of National and International Importance" in 2010	AIDA EuroNatur Naše ptice Mava	10	- 351 bird species have been registered in BiH to date, including several "new" species which were found in recent years. - NGO traditionally awards small grants : to support the protection and sustainable use of karst poljes. 22 projects from the area of Livanjsko and Duvanjsko polje were supported, with a total amount of 60 000 €. - 3 000 € in 2022 with the DIMFE funds for project proposals aimed at the protection and preservation of Livanjsko polje, as well as projects led by young people (18-25 years of age) and/or women.
Mava Fundation	1994	Suisse	Protecting biodiversity, especially in the Mediterranean region, the coastal zone of West Africa and Switzerland	- Identification of Karst Poljes as Wetlands of National and International Importance - Project "Identification of Karst Poljes as Wetlands of National and International Importance" in 2010	EuroNatur Naše ptice	20	- Helped create DIMFE with Prince Albert II of Monaco Foundation and the Aage V. Hensen Charity Foundation.
Youth Center Livno	2000	Bosnia-Herzegovina	- Gives opportunities to young people to actively participate in the development of social life of the community - Promotion of Aarhus convention in Slovenia, Bosnia and Croatia	Project "Bosnia-Herzegovina Green Belt" around Livno in 2004			
Naša baština	2008	Bosnia-Herzegovina		Implementation of Project "Grabovica trail" at the border of Duvanjsko polje			Some of the old trails on Grabovica plateau wil be reused. Goal : make the karst phenomena of Grabovica plateau accessible for public use with some renovation of old trails + concept of interesting people for nature. Establishing a recreational trail should promote education about natural and historical values and help to preserve the original landscape
Udruga Dinarica Association	2013	Bosnia-Herzegovina	-Strategic partner of WWF, implementation of WWF Adria conservation strategy in BiH -Protect the main natural resources & ecosystems of BiH -> freshwater and forestry	- Implementation project to research endemic fish species in the Livanjsko polje (fish protection measures that should be in line with the EU Water Framework Directive and the European Union Biodiversity Strategy until 2030) - Engages with protected Areas (PA) authorities in order to improve their management in BiH - Promotes transboundary cooperation and integrated river basin management -> WWF Adria Freshwater Programme - Wildlife Program -> The Interreg Adrion DINALPCONNECT Project in BiH	CEPF City of Livno		

Question : What are the links between the 3 NGOs of the project, how are they working together?

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13. Terms of Reference

Comprehensive environmental-territorial diagnosis of polje's watershed systems in Bosnia and Herzegovina (BiH)

Which environmental status or labels for an efficient and relevant protection of poljes in BiH?

Management Plan elements

Framework document &Terms of references

1) Institutional, Educational and Project Context

1.1 International Strategic Environmental Evaluation training module

The "International Strategic Environmental Evaluation" (ISEE) training module is part of the Specialized Master's program (Post MsC) "Forest, Nature, and Society – International Management" (SM FNS-IM). The program is offered by AgroParisTech, the Paris Institute of Technology for Life, Food and the Environment and led by the "Environmental Management" research and training unit (UFR G-ENV).

In response to current and urgent issues affecting the natural environment, the FNS-IM Specialized Master program offers a post-MSc year-long training course to 14 students.

The program: (1) offer a number of key teachings in social sciences (sociology, economics, political, and management sciences) applied to natural resources management; and (2) combine these with courses in the biophysical and scientific aspects of global forest management.

Understanding the relationships between the three main levels of operationalization of action for the environment - local, national and international – is crucial today. Natural ecosystems, and in particular forest ecosystems, present major environmental and social concerns related to sustainable development.

The overall course addresses issues related to the capacity of public authority regulations, good governance and private actions of both NGOs and firms (e.g. certifications, global value chains) to address these pressing environmental challenges. It prepares engineers and Master's students in maintaining and managing the services needed to sustain these threatened areas in a context of global development and changing ecological environmental management.

1.2 Poljes of the Livno areas (Bosnia-and-Herzegovina - BiH)

A "polje" (also "karst polje" or "karst field"), is a large flat plain found in karstic geological regions of the world. Poljes are a specific geologic formation very present in the Dynaric Alps. Poljes are hydrographic systems. Indeed, at the bottom of a watershed, poljes concentrate the water which infiltrate under karst. Most of the polje contains wetlands or lakes and sometimes upsurges (as important spring). Consequently, polje contain high value ecosystem and specific landscapes. BiH counts around 57 poljes covering a total surface of 1,551 km^2.

Livanjsko polje (BiH) is probably the largest polje of the world which spread on 408 km^2. Located on the west of BiH near the boundary with Croatia, the main city of this polje is Livno (located at around 100 km on the north-west of Mostar and around 200 km on the west of Sarajevo). Livanjsko polje is located in the 10^{th} canton (sometimes named "Herzeg-Bosnian canton"), the largest canton of the Federation of BiH, and divided between Bosansko Grahovo, Livno and Tomislavgrad municipalities. It's difficult to estimate the population of the polje because the BiH has a massive emigration and rural areas are the more affected. Last census of Livno indicate 12 000 inhabitants. Rural and mountainous activities as agriculture, pastoralism or accommodation for tourism are historically present in Livanjsko polje.

Livanjsko polje is integrated in a larger watershed containing other poljes as Kupresko polje, Glamocko polje and Duvanjsko polje. These areas are known as really particular migration corridors for birds and specific seasonal wetland.

1.3 The "Sustainable Future for the freshwater ecosystem Livansko polje in Bosnia and Herzegovina" project

The project "Sustainable Future for the freshwater ecosystem Livansko polje in Bosnia and Herzegovina" is supported by the Center for Environment (CZZS), EuroNatur Foundation and the ornithologic association Naše Ptice. The project is funded by the DIMFE (Donors' Initiative for Mediterranean Freshwater Ecosystems) for a 3-year duration and focus on the implementation of restoration measures to improve water management, reduce succession, or restore peat mines. It will support local initiatives, monitor and report illegal activities and influence nature conservation legal framework. By targeting the various actors like police and inspectors, all levels of authorities, farmers and other local actors as well as initiatives, it aims to build a strong network for the conservation and sustainable management of karst poljes in Bosnia and Herzegovina through co-existence between people and nature.

The project targets 6 specific goals as follows:

- SG1: Enabling long term sustainable protection of Livanjsko Polje and surrounding karst poljes as an important freshwater ecosystem in Bosnia and Herzegovina
- SG 2: Conservation and restoration of freshwater ecosystems and its biodiversity in Livanjsko Polje through fostering and improving of environmentally beneficial land use practices
- SG 3: Reduction of illegal and harmful activities to the freshwater ecosystem of Livanjsko Polje
- SG 4: Strengthening local initiatives that contribute to nature conservation and sustainable management of the freshwater ecosystem of Livanjsko Polje and surrounding karst poljes
- SG 5: Increased awareness and knowledge in the general public about the natural and cultural values of karst poljes
- SG 6: Successful management, coordination and project implementation

The project is registered as part of CZZS "Biodiversity and Protected Areas" Program which aims to make its contribution to conservation and adequate management of natural values and protected areas.

By advocating, the program seeks to influence the increase in the number of protected areas and the public involvement in decision-making processes related to the management of natural resources and protected areas. CZZS participate in organizing scientific research and encouraging collaborative research with an aim of creating better quality and giving more

visibility to scientific community. In addition, through the activities they carry out they communicate with all relevant stakeholders and interested parties thus enriching the cross-sectoral cooperation in order to preserve the environment.

The focus of this program at the moment is improving the management of brown bear populations in BiH, combating invasive plant species along the Sava River, advocating for the protection of Sana River and many other freshwater ecosystems, research and protection of Neretva tributaries biodiversity and promotion of karst fields in BiH and their importance as well as advocacy for the karst fields protection. The others objectives of the program are:

- Achieving a higher number of protected areas in Bosnia and Herzegovina;
- Sustainable management of protected areas and natural resources;
- Exploring the biodiversity of Bosnia and Herzegovina with a focus on protected and potentially protected areas;
- Researching and observing infrastructure and development projects in protected and potentially protected areas
- To draw public attention to the need for active participation in decision-making on protection of the nature

1.4 AIDA. The nexus climate-biodiversity-agriculture: a territorial approach

AIDA (Association Internationale pour le Développement de l'AgroEnvironnement) is a French NGO mainly focuses on agri environmental issues, the nexus between climate change, biodiversity loss and agricultural and rural sustainable development and agroecological transition. Fieldwork and projects are located especially in the Western Balkans Countries (WBC – and candidates countries to the European Union).

AIDA is already carrying out a partnership with CZZS on two municipalities of BiH (Sanski Most and Merkonic) which aim is to provide a complementary element of context and a territorial approach to the defence of the environment. This perspective materializes in "learning areas" for researchers, knowledge brokers and local actors. The challenge is to increase the efficiency of the action, knowledge and management in a multi-scale, multi-purpose and multi-actors approach.

2) FIELDWORK PROJECT AND OBJECTIVES

2.1 General objectives of the collective study

The objective of this collective field study is to produce the elements needed to build an accurate and efficient protection strategy that could benefits the polje watershed systems in BiH.

In Mediterranean mountains, uses and practices contribute to the maintenance of landscape and environmental features. Livanjsko polje and the surrounding poljes are areas with remarkable landscapes and different environmental characteristics where conservation measures are to be discussed. In such way, maintenance of the habitats, landscapes, and socio-economic characteristics of polje watershed system are crucial. It is therefore important to build an approach where the involvement of local and related stakeholders is central as well as the specificity of each study site.

This study will be based on the theoretical framework proposed by the Strategic Analysis of Environmental Management (SEMA) (Mermet & al., 2005; Leroy, 2006). The analyses will provide operational and strategical elements for Bosnian environmental actors, inhabitants, local government units and other rural management structures (such as those in charge of forest management).

Precisely, the overall objective of the project is to gather data and produce an accurate territorial diagnosis from which a specific protection strategy will be defined in regards with socio-economic characteristics of the study site.

2.2 Specific objectives

The central objective is decline in three operational specific objectives as follow:

SO1/ Developing a benchmark of different types of status, labels and networks of protection using inventory and comparison methods aiming at biodiversity conservation, landscape protection or sustainable development of the territory. The objective is to build an exhaustive list for comparison of the scales of action, the specific objectives, the rules and constraints, the interests of each status, label, and network and the strategical elements regarding their management. This work will i) guide the partners in the choice, relevance and feasibility of the type of protection status to be developed in the territory of the poljes of the Livno areas ii) provide strategical support for each type and rank the best options in each status, label, and network in a mountainous and Mediterranean candidate country to integrate European Union as Bosnia-and-Herzegovina. The inventory and comparison will be based on macro and local scale scientific bibliography and reports but also using feedbacks and reviews through semi-structured interview from stakeholders involved in the management of these types of status, labels, and networks.

SO2/ Designing a territorial diagnosis based on participatory methodologies of Livanjsko and surrounding poljes. The SEMA theoretical framework and methodology (Mermet *et al.*, 2005) will be used to achieve the territorial diagnosis. Focusing on natural resource management and especially on forest stand and high natural value of agriculture as pastoralism, the application of the framework will guide the diagnosis of complex conservation issues such as territory organisation, natural and socio-economic dynamics, local consequences of biodiversity loss and climate change effect on the environmental baseline and territorial governance. The diagnosis will be draw using an exhaustive international literature review of Livanjsko and surrounding polje, and semi-structured interviews of stakeholders involved in these issues. Data production and analysis such as GIS, hydrographic, biodiversity and natural resources inventory will complete the achievement of the framework.

SO3/ Propose a relevant management strategy for Livansko and surrounding polje's protection of environmental dynamics by overlaying specific objectives 1 and 2 (Benchmark vs Diagnosis). The following questions will guide the proposition:

Under what conditions can the landscape be maintained in its heritage dimension?

What is the most relevant environmental status, label, or network to develop regarding the environmental, socio-economic, and political characteristics and dynamics of the territory and local environmental issues?

What are the measures to be put in place to avoid the degradation of this natural and cultural landscape by maintaining an agri-pastoral activity?

The methodology developed for a relevant management strategy are thus specifically designed with the objective to provide new data (as a baseline) and new analytical results on a specific target landscape in order to support the partner's actions, conservation strategy and research interests.

2.3 Methodology – calendar

The specific orientation of the study as well as the methods used for fieldwork and analysis are adapted to the partners' needs and to the specifics of the context in the target landscape. The module lasts a total of six to seven weeks, between from 13th February 2023 and to 31th March 2023, consisting successively of:

- One or two weeks of preparation, which includes: bibliography research on the specific topic and area where the fieldwork will take place; preparing the analytical framework and key research questions that will be used; sketching the fieldwork and interview planning. In addition, this week will be organized with an alternation of presentations from specialists - the protection of poljes in BiH with regard to the history, socio-economic and ecological issues of the region - and practical work on methodological aspects (existing inventories, cartography), bibliography and surveys (database, statistics, interview questionnaires). As far as possible, this week will associate Bosnian students by videoconference.
- Three weeks stay in the field in Livno areas. Students experience life in study sites. During this fieldwork period, the Bosnian and the FNS-MI students will work closely together;
  - They conduct and transcript interviews with multiple stakeholders and collect other social sciences data, under the close supervision of their professors.
  - Everyday, collective debriefings are organized by the teaching team to help students progress in their understanding and analysis of the context and involved in the management and protection of the territory and biodiversity in BiH, but also on the processing of existing data that can provide information on the various ecological, use and conservation aspects of the area (statistics, inventories, land use maps, aerial photographs, etc.).
  - At this occasion, analytical frameworks from social sciences are used to progress in the analysis (for instance SEMA; socio-anthropology, etc.).
  - At the end of the three weeks, a presentation and discussion of the results with local stakeholders and/or the partner organization is organized.

- Two last week in France is dedicated to writing a collective report which is shared and discussed with the partners.

Logistic (field work, accommodation, translators) and financial support and collaboration have to be discussed with partners interested by the proposal.

13th to 24th of February 2023	5 days in classroom, Montpellier (France): Field preparation, bibliographic synthesis, development of a methodological framework, field action plan and first propositions of protection tools relevant to Dynaric karst polje

27th of February to 17th of March 2023	Three weeks of fieldwork in Bosnia and Herzegovina in the areas of Livno. Preselected areas for the study: Livno areas These areas may change depending on logistical conditions and the evolution of the study. 1. Introduction of the study and the team to all partners: CZZS, local communities, local government unit, other universities... 2. Refining the fieldwork's methodology and delimitation of various objectives. 3. Collecting data: semi-structured interviews, map analyses, biodiversity inventory, transects and field observations etc. 4. Initial data analysis, 2nd wave of targeted data collection and interviews. 5. Pooling of survey results, analysis, drafting, additional ad hoc surveys 6. End-of-field meeting / Study results presentation to all partners and local stakeholders.
20th to 31st of March 2023	2 weeks, Montpellier (France): writing the study report + policy brief supervised by the AgroParisTech teaching team

3) EXPECTED RESULTS

Expected outputs from the project led by the students and AgroParisTech academics include:

- Methodology for the benchmark of environmental status (SO1) and the territorial diagnosis (SO2)
- A presentation of the preliminary results from the analysis to interested local and national stakeholders, and/or to the partner's organization. This can take the form of a power point presentation followed by a collective discussion with stakeholders, or of a specially organized workshop
- Depending on the target landscape and the research orientation given to the study, specific activities can be organized as part of the fieldwork such as workshops and focus-group with local stakeholders.
- The drafting of a study report (around 100 pages in English) detailing the research method, the analytical framework, work hypotheses and field results and analyses. Appendixes containing the datas used, interview transcripts, contact databases, cartography, statistics, etc. will be provided.
- A policy brief addressed to environmental NGOs highlighting the general results and outcomes of the study.

4) PERSONAL SUPPORTS AND CONTACTS

The field stage is jointly supervised by AgroParisTech teach team and the host field partners collaborating in the project.

4.1 Group of students

The team will be composed of 16 interdisciplinary students: 14 from AgroParisTech's Specialised Master's program FNS-IM and 2 from HEC's MSc SASI. All the students who participate in this course have gone through a thorough selection process.

BRICAULT Pauline: holds a Master of Arts with Honors in Economics & Business Management

DARAS SIFFAIT DE MONCOURT Bertille: holds a Master in Rural Law

DHALLUIN Anna: holds a Master AlterEurope in Geopolitics

DURAND Théo: holds an engineering diploma in Applied Sciences

FRESEL Lucie: holds an engineering diploma in Energy and Environment

LEGAY Jean: holds an engineering diploma in Risk Management

FIEVET Augustin: holds an engineering diploma in Telecom Physics

MONTILLOT Gaël: holds an engineering diploma in Energy and Transportation

NAUDIN Adélaïde: holds an engineering diploma in Industrial Risk Management

PIECHON Camille: holds a Master in Urban Policies and Territorial Governance

PIEDIGROSSI Léa: holds an engineering diploma in Agriculture

POUTHE Guillaume: holds a Master in Environmental Management

PRETESACQUE Juliette: holds a Master in Management

SANCHEZ Bernardo: holds a Master in Environmental Policy

DEBONO Santiago and KOUAHO Hermelan: finishing a MSc in Sustainability and Social Innovation in HEC (Paris)

In addition, a group of students from Bosnian University could be involved in this fieldwork according to modalities to be defined.

4.2 Technical and pedagogical support

In the field, the students will be supervised throughout the work by three AgroParistech lecturers, by AIDA director, by a project manager of CZZS and a Bosnian lecturer.

- Dr. Orianne Crouteix (AgroParisTech) – orianne.crouteix@agroparistech.fr ;
- Jérémy Vendé (AgroParisTech) – jeremy.vende@agroparistech.fr ;
- Dr. Coralie Calvet (AgroParisTech) – coralie.calvet@agroparistech.fr
- Dr. François Lerin (AIDA) francois.lerin@posteo.net