PROFOUNDAL ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR THE CONSTRUCTION OF HPP POÇEM

Republic of Albania		
The Construction of HPP Poçem		
Ordered by	Çinar-San sh.p.k	
Data prepared	GR ALBANIA Planning & Environmental Consulting Company	
March 2015		

Profound Environmental Impact Assessment Report

Project Title: The construction of HPP Poçem

Location: In Poçem Village, Kutç Commune, The District of Mallakastër, The Region of Fier.

Pursuant to law No. 10440 dated 07. 07. 2011 "On Environmental Impact assessment", annex 1, point 15 "Dams and other installations designed to keep water from flowing out or to keep water deposited permanently, in which new or additional amounts of water trapped or deposited is above 10 million m^3".

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2 Introduction

The EIA report was designed based on the requirements of the legislation in force. The goal of the report is to identify environmental and social impacts resulting from the construction of the HPP. The environmental impacts of the projects are going to be assessed in relation to the status of the environment in the territory where the project is going to be implemented. Besides the identification of resultant impacts, the report aims to present the measures and recommendations with the purpose of avoiding or reducing the impacts.

The main goal of the preparation of this Environmental Impact Assessment Report is the identification of potential combinations between the project and the social and physical environment and with environmental protection policies in the areas where the project will be implemented. More specifically, the document aims to:

- Minimize stress on environment and people and first and foremost on primary elements such as human health protection, earth and air control as well as on earth, water and air quality protection.
- Protect or rehabilitate the natural environment through new positive interventions, special construction works in the context of this project or in parallel with the project, which ensures the sustainable existence of the biological environment including the human environment, the fauna and flora in the environs surrounding the area taken into consideration.
- Identify common ground and coordinate the project with the national and international legal regulatory framework in the field of the environment,
- Point out the special status of the areas where the project is going to be developed.
- Describe the natural and environmental values in the project areas,
- Identify the essential potential negative impacts on natural values and on the environment by recommending at the same time the measures for mitigating them and protecting the environment from these impacts;
- Facilitate decision-making among competent planning and environmental bodies for the project.

2.1 The reasons for the EIA preparation

The design of this EIA for the construction design of three HPP-s has the following objectives:

- An overall, integrated and timely assessment of all environmental impacts resulting from the project to be implemented, preventing and reducing negative impacts on the environment;
- An open and impartially administered assessment process through the participation of central and local bodies, public, environmental non-governmental organizations, project proponents and physical and legal persons specialized on this field. The design of this EIA report was also based on the Law for the protection of the

Environment, which aims in itself to:

- Regulate the relation between humans and the environment,
- Protect the environmental components and environmental processes,
- Ensure the material conditions for sustainable development, complementing the necessary framework for implementing the constitutional requirement for an ecologically clean environment.

- Use rationally the environment and limiting the amount of pollution it is exposed to, preventing its deteriorations and rehabilitating and strengthening the already damaged environment;
- Improve the environmental conditions related to quality of life and human health protection;
- Protect and maintain well natural resources, renewable and not renewable, and a rational and fruitful management;
- Coordinate governmental activities to fulfil the requirements for the protection of environment;
- Encourage international cooperation in the field of the environment;
- Encourage public participation in environmental protection activities;
- The coordination of the country's social and economic development with the requirements of sustainable development;
- Establish and strengthen the institutional network for the protection of the environment on a local and central level.

2.2 EIA design principles

The basic environment protection principles supporting this EIA are:

1. The principles of sustainable development;
2. The principle of care;
3. The principle of prevention;
4. "Polluter pays" principle;
5. The principle of repairing environmental elements, recuperating and rehabilitating the damaged environment;
6. The principle of legal responsibility;
7. The principle of protection on a large scale;
8. The principle of integrating the protection of the environment with sectorial policies;
9. The principle of public awareness and participation in environmental decision-making
10. The principle of transparency in environmental decision-making.

"Sustainable development" is development that fulfils the needs of the present and future without affecting the potential and capacities of future generations to fulfil their needs.

"The sustainable use" of natural and mineral resources ensures the fulfilment of today needs, without undermining the needs of future generations for these resources.

"The best possible techniques" stand for the most advanced stage and highest level of environmental protection, used for an activity that is completely applicable both from the practical and economic point of views.

"The principle of prevention" is the selection and approval of the best option, from the initial phase of decision-making, in order to avoid the negative impacts on the environment caused by a development activity.

"The principle of rehabilitation" is the necessity to repair environmental damages caused by individuals or companies and to recover and rehabilitate the damaged environment.

"Polluter pays" principle means the cost that a polluter pays to improve a polluted environment and to turn it into an acceptable condition. This is reflected on manufacturing and consumption costs of goods and services causing pollution.

2.3 The main strategic elements of environment protection

These are the main strategic elements of environmental protection, also necessary applicable for "Çinar" Company ltd. which requests to develop its activity described in this EIA report:

a) The prevention and reduction of air, water and earth pollution and other types of pollution
b) The protection of biological diversity according to the natural and biogeographic characteristics of the country;
c) Rational use of natural and mineral resources and avoiding their overuse;
d) Ecological rehabilitation of damaged and polluted areas caused by human activity and destructive natural phenomena;
e) The preservation of the ecological equilibrium and quality of life improvement;

<u>During the activities and installations, individuals and legal person:</u>

a) Implement all measures that prevent discharges and environmental pollution above the norm;
b) Avoid and reduce waste and also neutralize them when their use is not technically and economically possible, avoiding and reducing thus their impact on the environment;
c) Restore the place in satisfactory environmental conditions at the end of the activity;
d) Announce every planned change on the technology line;
e) Respect the requirements and the conditions of the environmental permit;
f) Inform the regional environmental agencies about the self-monitoring results no less than three times per month, and about accidents and emergencies with a negative impact on the environment at any given time;
g) Fulfill the requirements of the inspectorate of the environment while controlling their activity;

h) Inform the public on the state of the environment and on the environmental profile of their activity;
i) Keep records of discharges to the environment, water and energy use, and techniques used.
j) Social and economic with environmental protection and improvement of quality of life.

2.4 The goal of the EIA report is:

- To present information on the geographical setting of the area;
- Present information on the technical project;
- Provide data on the environmental and social status of the area;
- Analyze the social and environmental impacts resulting from the development of the project;
- Draw conclusions and recommendations on the importance of the project regarding negative and positive impacts and its social importance;
- This material provides the description of the HPP construction;
- The objectives of the report are to present in a clear and understandable way the importance of the project, identifying the expected and accidental impacts;

2.5 A summarized description of the legal environmental and institutional framework

The development of a modern legal system for environment protection in Albania started in 1991. Besides all efforts made for the improvement of the legal system for the environment, still there are deficiencies especially in relation to the protection of the environment, biological diversity and landscape. For this reason the actual legal system is constantly improving. The government is paying special attention to harmonizing and adapting its laws with the European Union Directives (EU).

The Constitution, approved in 1998, calls on the Albanian authorities to preserve a healthy environment, ecologically suitable for the current generations and generation to come. In order to achieve this, the government should improve and complement more the legal and institutional framework addressing the protection of the environment, nature and biodiversity. Currently these are the regulating laws:

- Law on Water Reserves "(8093/ l 996)
- "Law 8561 dated 22.12.1999", "On expropriations and on entitlement to use temporarily private properties for public interest" and the four decisions of the Council of Ministers which define the procedures for expropriations of real estate in Albania.
- Law 9482, April 3, 2006, defines the conditions for the legalization of a building that has been built not in compliance to the law.

Law no. 98.6, dated 06.06.2002 on "Protected Areas", includes the legal base for managing protected areas in Albania. The law includes the legal framework on the designation, protection, administration and sustainable management of protected areas

and natural and biological resources, with the purpose of informing and educating the local communities on direct and indirect benefits, and promoting the development of eco-tourism.

The legal framework on EIA procedures in Albania is based on:

- Law No. 10440 on "Environmental Impact Assessment" dated, July 07, 2011.
- Decision of the Council of Ministers, No. 247, dated 30.04.2014 “On Defining the Rules, the Requirements and the Procedures for Public Information and Decision-making in the field of Environment”. The law presents two levels of assessments:
    - The profound process
    - The preliminary process (on general terms).

Different project categories and projects of different dimensions are presented on the Law Annexes, divided according to categories. Based on the above-mentioned Legal Framework and in order to comply with the IFC Performance Standards and World Bank references, it was necessary to harmonies the national requirements with the international ones. These are respective laws and regulations currently regulating the process:

- Law no. 10 440, dated 7.07.20 13 "On Environmental Impact Assessment"
- Law no. 10 431, dated 9.06.2011 "On Environmental Protection"

Based on law no. 10440 dated 07.07.2011 " On Environmental Impact Assessment", annex 1, point 15 " Dams and other installations designed to keep water from flowing out or to keep water deposited permanently, in which new or additional amounts of water trapped or deposited is above 10 million m3

This project is subjected to the in-depth procedure. In addition, the activity requires a **“Type A”** Environmental Permit.

2.6 Description of the implemented approach for designing the profound EIA report

The contents of this in-depth environmental assessment report will be based on the procedure that this document will go through, including in its contents even the requests or suggestions that will be presented by the National Environmental Agency and that will be drawn by public consultations held during the design stage of the in-depth report.
The structure presented in the EIA is in compliance with the DCM No 13, dated 04/01/2013, Annex II, and Environmental Assessment Report details.
The report was designed by taking into consideration also previous researches on the state of the environment, biodiversity, sea flora and fauna. Opinions and evaluations of different specialists and academics were also taken into considerations (on special issues).
The ideas, suggestions and the opinion of the public, actors and interest groups were

presented and were also taken into consideration.
The EIA draft report was published on the AKM official page, not only to become familiar with the project, but even to enable the consideration of opinions, observations and evaluations made by all interested parties.

2.6.1 The authors of the in-depth EIA report

The authors who have designed the in-depth EIA report are specialists from different fields:

2.6.2 The public consultation procedure

The public consultation procedure is based on Chapter II of DCM no. 247, dated 30.04.2014 "On defining the rules, requirements and procedures for public information and participation in environmental decision-making". Based on this information, public participation includes the following stages during the in-depth EIA procedure:

a) Informing the public on the proposed project and have the public express its ideas during the definition stage of issues that will be addressed in the EIA in-depth report, along with clarifications for the procedure to be implemented;
b) Informing the public on communications held between NAE and the developer on issues that should be treated in the EIA in-depth report;
c) The developer informs, consults and makes the public aware during the design of the in-depth EIA report;
d) Public information and inclusion during the organization and realization of public hearings
e) Public information and NAE expresses its opinion during the examination and approval of the Environmental Declaration.
f) Public information while monitoring the environmental impacts of the project.

In order to enable public information and receive feedback from the public and NGO-s, NAE, within five (5) days from the day of receiving the request from the developer, publishes on its website, for 20 (twenty) days in a row, the entire information presented by the developer. On this publication NAE gives information on:

a) The procedure to be implemented for public information, consultation and hearings on the project until the approval of the Environmental Declaration;
b) The manner and time (20 days), making clear that opinions can be given within this timeline on issues aimed to be treated in the EIA in-depth report;
c) The foreseen timeline for approving the Environmental Declaration and its publication on its website;
d) The manner and deadline for complaints against the public participation procedure and the Environmental Declaration.

With the purpose of making the public aware on the potential project impacts on the environment, the developer, during the design of the in-depth EIA report, informs and consults the public independently on these impacts by:

a) Publishing complete information on the project, exposing the available information on the project in a special office and in the area where the project is proposed or in the office of the respective local government unit (LGU);
a) Surveying directly the public of inhabited centers located in the areas that have a potential to be impacted by the project;
b) Explaining, during the publication and surveying process, the goal and the form of the contact where feedback can be sent to (postal address, telephone number and e-mail).

All materials used and the respective documents produced during the public information and consultation processes will be documented by the developer, keeping and presenting then as part of the application for the Environmental Declaration. The developer, the NAE[1], RAE[2] and LGU[3] follow the procedures for organizing the public hearing, based on the responsibilities defined by this DCM[4].

2.6.3 Company Profile and Development

Çinar - grup San is a company interested in renewable resources for energy production by investing in use of the water sources of Vjosa River in construction of Poçem Hydropower project.

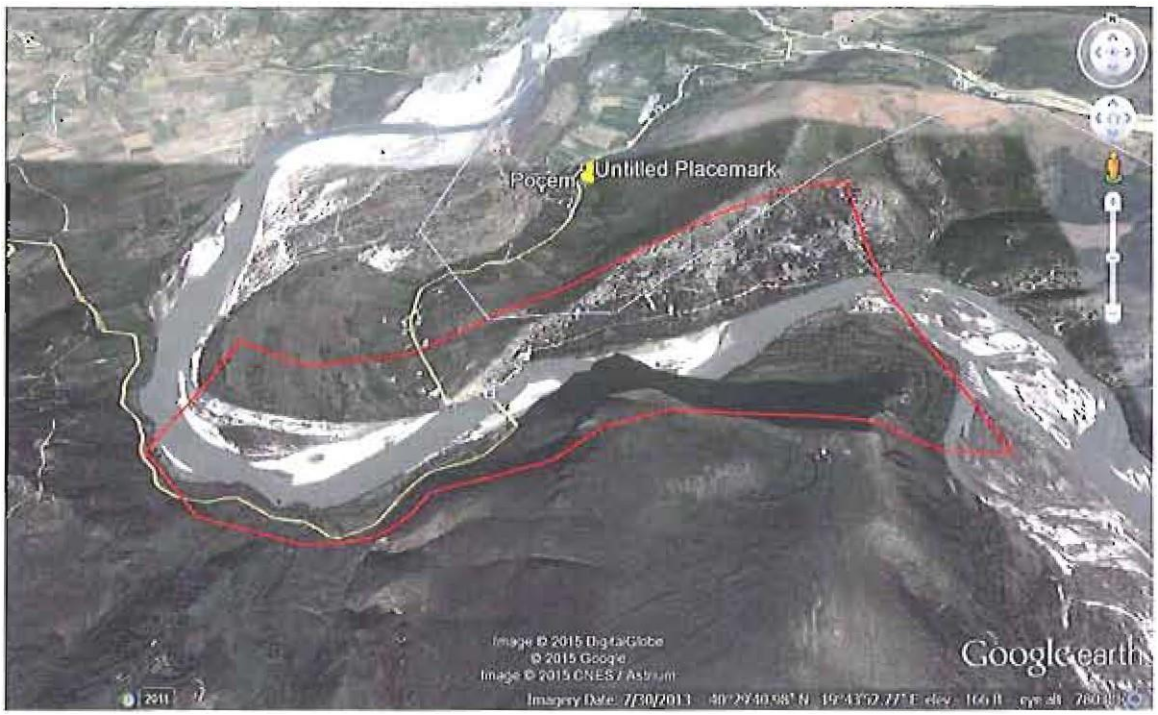
To this purpose Çinar – San has prepared the proposal and has presented it to be examined for further development of Poçem resources hydropower project based on the respective Albanian legislation and all of the highest standards for dams, construction works, environment, etc.

The draft was prepared to show a comparison between the alternatives presented so far and the new alternatives presented by Çinar-San which takes into consideration all of the included partners.

[1] National Agency for Environment
[2] Regional Agency for Environment
[3] Local Government Unit
[4] Decision of Council of Ministers

3. Project Description

The HPP will be constructed in the Vjosa River. The area where it will be built is in Poçem village in Kutë Commune.



HPP construction site

3.1 General description of the project area

3.2 History of Vjosa

Vjosa (in Greek: *Αοως, Aoos*) springs northwest of Greece in Epirus and flows through Albania into the Adriatic Sea. In Antiquity, Vjosa was known by the name of Ania. North of Greece the names Vojioussa dhe Vovoussa[5] (*Βωβούσα*) are rarely used.

The river flows from the Pindus Mountains east of Ioanina, while the source is in *Mavrovouni* Mountain. Its flow continues northwest in the direction of Albania. The river is 272 km long, 80 km in the territory of Greece, while about 192 km within the territory of Albania. Vjosa watershed covers a surface area of 6.706 km^2: 2.l54 $k.m^2$ are within the Greek borders, and 4552 km^2 are within the borders of Albania. The average water flow in the estuary is about 204 m^3/s. In April, water flow is ten times higher than in August!

[5] Source: Wikipedia: http://sq.wikipedia.org/wiki/Vjosa

View of the Vjosa River

The upstream of the river in Greece often goes through mountainous areas with forests. Part of them are natural protected areas that belong to the national Vikos-Aoos Park which lies around the Timfi Mountains (2.497 m above sea level). In this park, which is the second biggest park of Greece, there exist even today brown bears. Voidomatis stream, a branch of Vjosa, forms the Vikos gorge which is an amazing gorge. Considering the depth (0.82) coefficient (900) in relation to the width coefficient (1.100 m), the Vikos-Aoos gorge ranks as the deepest gorge in the world (there are areas in the world which are deeper but wider and vice versa). This area is known as Zagoria and is well known not only for alpinism, but even for the characteristic villages with houses made of stone. No far from Konica, inside the national park runs Vjosa through a narrow gorge. In Konica there is also an historic bridge with arches made of stone which is built over Vjosa. Starting from here the river is also used even for economical-agricultural purposes.

Immediately after Konica, the river passes the Greek-Albanian border, in the same place where the Sarantaporos stream flows into the river from the east. Sarantaporos is also used as a Greek-Albania border line for some kilometers. Somewhere near the border has been built across point for people[6].

3.3 Vjosa in Këlcyra Gorge

Vjosa River and its flow which runs through South Albania, is also the natural dividing border between the District of Fier (north) and the District of Vlora. It is a very navigable river, because it mainly flows in flat areas. The touristic and sport landscape of Vjosa. A resting place where there are mountainous water resources that flow in Vjosa River, surrounded by a mass of trees. It is a characteristic landscape where there is a natural combination of grass vegetation, forest trees and hygro - hydrophilic vegetation that is in the water resources of Vjosa River bed. This habitat has a good representation of all types of vegetation. The length of this valley is 13 km and the width is 1 – 1.5 km[7].
Three kilometers from the city of Këlcyra is the Rrepet e G1ykes, which is also a tourism

[6] Source: Wikipedia: http://sq.wikipedia.org/wiki/Vjosa
[7] Source: Wikipedia: http://sq.wikipedia.org/wiki/Vjosa

attraction. The landscape of forest trees harmonized with abundant water resources has attractive, esthetic and eco-tourism values. Along the Gryka e Këlcyrës valley is the Uji i Zi water source, which keeps its blue color even when its waters mix with the waters of Vjosa River. This landscape has irreplaceable landscape values, very relaxing and recreational for visitors. It is visited by national and foreign visitors.

Vjosa River has a special and important place in the everyday lives of the inhabitants vying along its banks. Its terraces provide villagers with fertile land for such activities as agri-cultural productions and livestock breeding. The quantity and the variety of fish are vital for the economy and the well-being of local fishermen. Recreation tourism in Vjosa and its branches is always on the rise, especially in recent years as enthusiasts have started to organize such activities as rafting, rowing, swimming, etc.[8]

8 Enronatur, River Watch : The wild pearl of Europe – Vjosa River in Albania

Many small and new businesses such as developing eco-tourism companies, have based their existence on the natural Vjosa streams. Furthermore, Vjosa and its crystal-clear waters have had an influence in the hearts of the Albanians and their cultural values.

4. Description of the Existing State of the Environment

4.1 A Description of the physical characteristics of the area

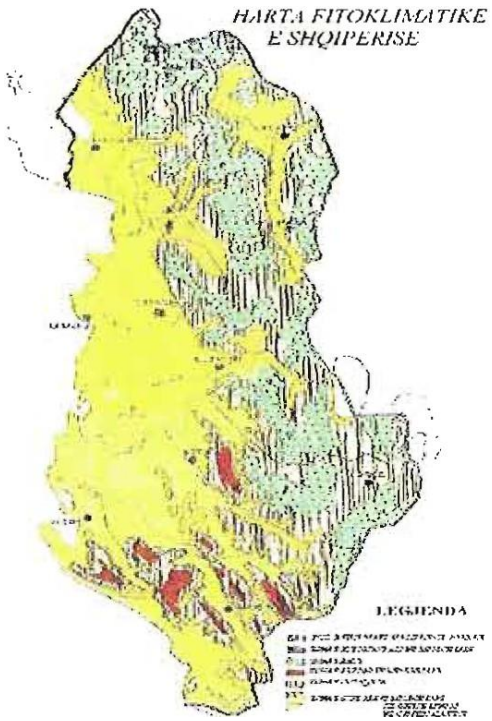
4.2 Biodiversity in Albania – General Considerations

Albania has a variety of ecosystems and habitats. Flora accounts for about 30% of the overall flora in Europe.

The following picture presents the protected areas in Albania, the proposed areas for protection and the areas containing species at danger. The territory of Albania is rich in: sea ecosystems, coastal areas, lakes, rivers, broadleaved evergreen bushes, broadleaved forests, pine forests, alpine and sub-alpine pastures, valleys and mountainous ecosystems. The country is rich in forest resources and pastures.

4.2.1 Habitats and Biodiversity

The impacts related to the construction of the new road, have a low magnitude on affected habitats and biodiversity, given that the proposed mitigation measures (which are also part of the Contractual Plan for Environmental Management) are correctly implemented and on the right time. Regarding use, the proposed road will result in an increased traffic speed and a slight increase in traffic volume. Traffic signs can be used to warn drivers in the areas where this might happen, reducing thus risks from accidents. The higher levels of noise along the proposed route course are expected to result in a small increase in bird disturbance.



Picture: The Map of Phyto-climatic Areas

The typical vegetation in these two areas are summarized below:

The Southwestern region is characterized by typical "Mediterranean Vegetation", with a dominance of evergreen trees, coastal Mediterranean bushes and forests, especially Quercion ilicis Br. – 81. This area includes also maquis, shibliac, pseudo-maquis, garrigue and phrygana vegetation as well as Mediterranean mountain pastures, mostly in a degraded stage following the peak development of vegetation (*Quercetum ilicis* Br.-Bl. 1947).

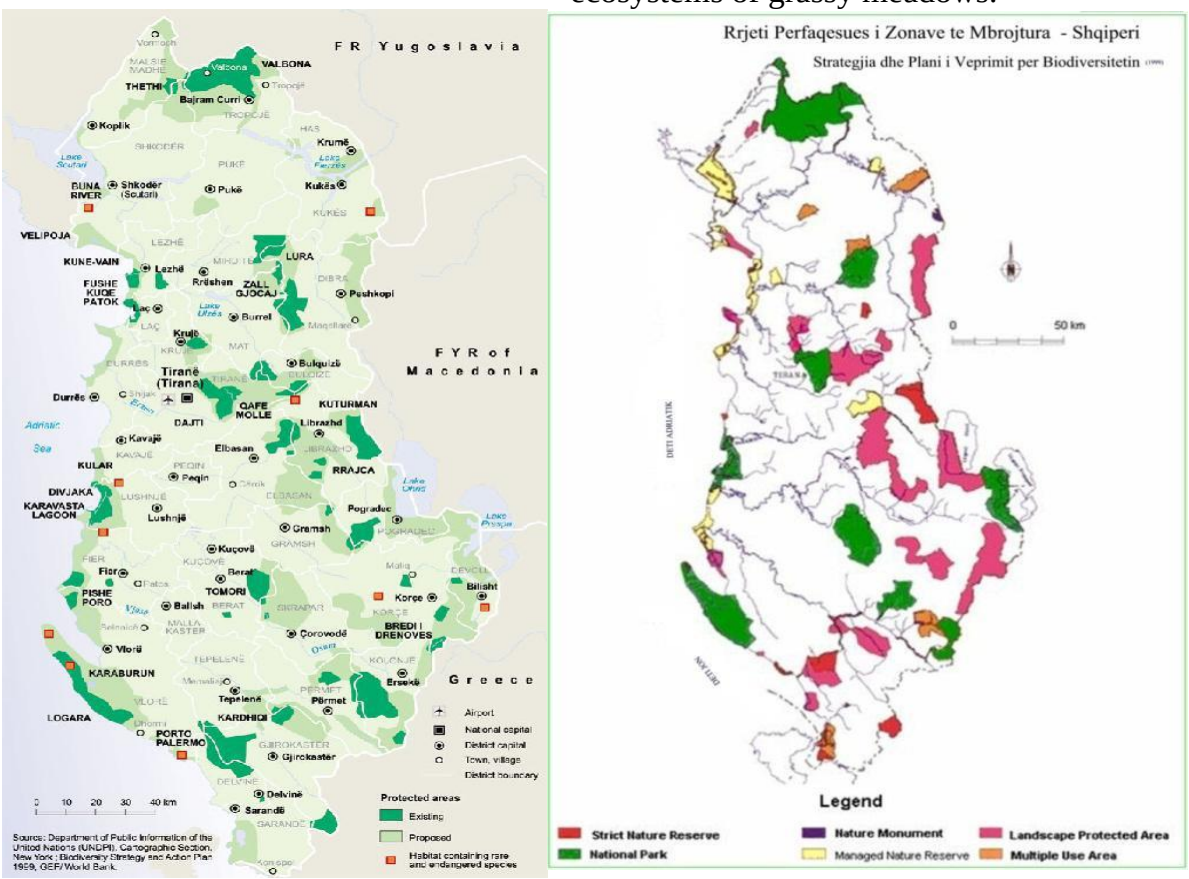
The Northeastern region is characterized by "Vegetation typical for central Europe", where there is a dominance of deciduous trees. A considerable part of Albanian forests are here, especially common silver birch (*Fagus sylvatica* L.), common ash (*Abies alba* Mill.), oak (*Quercus sp*. L.) and black pine (*Pinus nigra* Arn.). These forests usually are at a considerable distance from the populated areas, partially because of lack of infrastructure has left the forests unaffected. This makes them very important as biogenetic reserves.

In these two big regions there are 4 phyto-climatic belts:

- The Mediterranean sclerophyll forests and scrub belt is mainly composed of evergreen trees and scrubs (up to 700 meters above sea level) which is found in the western and southwestern territories. Its lower part is populated by evergreen scrubs (maquis) such as: strawberry tree, heather, juniper, forsythia, laurel etc. Some high woods grow along these scrubs such as: cypresses, sumacs, wild pines and soft pines etc. which, in some cases, form small forests. The upper part of the Mediterranean scrubs is populated by scrubs that lose their leaves during winter season, such as: white or black hornbeam.
- **The oak belt lies** above the Mediterranean scrub belt, up to 1000 m high. It has a wider spread than the other vegetation belts, especially inside the Albanian territories. The most characteristic plants of this vegetative belt are: some types of oaks, linden, ash, maple, chestnut etc. Thermophilic forests are mainly composed of different formations of broad-leaved oak, mainly Hungarian Oak (*Quercus frainetto* Ten.), Turkish Oak (*Quercus cerris* L.) Macedonian Oak (Quercu s trojanae Eebb.) or Oak woods that have lost their leaves such as the mix formations of the Oriental Hornbeam (*Carpinus orientalis* Miller.), Manna ash (Fraxinus ornus L.), Prickly juniper (Juniperus oxycedrus L.), Blackthorn (Prunus spinosa L.), Almond Pear Tree (*Pyrns amygdaligonnis* Yill.), Christ's thorn (*Paliurus spina-cristi* Miller.), Common Hawthorn (*Crataegus monogyna* Jacq.) etc. This belt lies between the Mediterranean schlerophillic forest and scrub belt and the belt of broad-leaved forests (the Belt of Beech Woods). Their altitude is between 500 m and 1100 m above sea level. It is important to underline that its expansion in the most populated area makes it more prone to human-induced damages, especially because of intensive use of forests and overgrazing.
- **The Beech and Coniferous Belt** lies above the oak belt, up to 1600-1800 m high. Beech woods, needing more humidity, are more spread on the mountains of the Albanian northern and eastern territories and on the mountain slopes facing north and east. In many areas, beech woods are mixed with coniferous trees (plants with needle shaped leaves), such as: pine trees, spruce trees etc. This belt has the denser forests which are the main repository of wood materials.

Vegetation in the broad-leaved mesophilic forest belt (The Belt of beech Trees) is dominated by Oak forests (Fagus sylvatica L.), hop hornbeam (*Ostrya carpinifolia* Scop.), common hornbeam (*Carpinu s betulus* L.), Chestnuts (*Castanea sativa* L.) and small ecosystems of Black Pine (*Pinus nigra* Arn.) and Bosnian Pine (*Pinus leucoderrnis* Antoine).

The belt of alpine pastures lies above the belt of oak and coniferous trees. Because of very low temperatures only grass vegetation grows in this belt and very rarely low-lying scrubs. Grass vegetation is best developed on the mountain regions of northern and eastern regions. Forests with most interesting vegetation and wild life and better preserved have been designated national parks. Logging and other similar human interventions are forbidden by law in these parks. In some selected area tourist visits can be organized in order to enjoy fresh nature. There are such parks in Albania (Thethi, Lura, Llogara Parks etc.), in Kosovo (Berzovica etc.), in the Albanian territories in Macedonia (Galicica, Pelisten) etc. The belt of Alpine pastures or mountainous Mediterranean pastures is characterized by interesting ecosystems of grassy meadows.



The map of biodiversity

The park area contains valuable ecosystems and habitats. In general, the entire area is in a good ecological condition, mainly because of limited antropogenic pressures within the area and a population decline in the villages. "Bredhi i Hotovës - Dangelli" National park has high biodiversity values. The area stands for a wide variety of ecosystems, including an important collection of Macedonian spruces (*Abies borisii-regis*), mixed forests of Hungarian Oak (*Quercus frainetto*), Turkey

oak (Quercus cerris), Maple (*Acer*), White hornbeam, (*Carpinus betulus*) and juniper (*Juniperus*). The scrub vegetation with strawberry trees (*Arbutus unedo*), elm leaf blackberry (*Rubus ulmifolius*) and others are some of the most important values of the National Park. The Park Area is known for its endemic types. The most common types include: The brown bear (*Ursus arctos*), the wolf (*Canis lupus*), the fox (*Vulpes Vulpes*), the beech marten (*Mattes foina*), the wild boar (*Sus scrofa*), the wild rabbit (Oryctolagus cuniculus), the red squirrel (Sciurns vulgaris) and many others. The most important inhabitant of the forest, however is the European roe deer (*Capreolus capreolus*) which lives on the field and in deep forests.

Scientific knowledge on Vjosa and its biodiversity are very limited. Perhaps it is one of the less studied in Europe: This is so true that it can be said that there is more complete information on river systems in South America or Asia than there is for Vjosa. Only a few researches have been done so far. Nonetheless, even these few researches have been made mostly for the valley rather than for water habitats and species such as fish or fowls which have made Vjosa to be considered as a key area of Albanian biodiversity. Vjosa has a sustainable population of the Euroasian otter (Lutra Intra), an almost endangered type, and different types of migratory fish, such as the critically endangered European eel (*Anguilla anguilla*), and other types of sub-endemic fish such as the ochrid and pindus barbatula, *Cobitis ohridana* and (*Oxynoemacheilus pindus*). The flora of Vjosa ecosystem is also very impressive. Upstream there are some endangered types of endemic plants, such as *Solenanthus albanicus*. The middle and the lower stream is characterized by mixed oak trees (*Qurecus sp*.) A special and a rare type is *Arbutus andrachne* because upstream Vjosa is its only habitat in the country.

4.2.2 Forest Habitats

In general within the park there are three types of vegetation divided between them according to the variations in altitude: evergreen forests and grass lands, broad-leaved thermophilic oak trees and mixed forests (broadleaved and coniferous) dominated by the Macedonian fir (*Abies borisii-regis*). Forests have different types of scrub vegetation such as the Greek strawberry tree and (*Arbutus andrachne*) and strawberry tree (*Arbutus unedo*).

Forests in high altitudes are mainly composed of broadleaved and coniferous forests; mixed forests can also be present on these altitudes. Variations between different altitudes are closely related with the diversity of forest vegetation. Mountain slopes facing north (400 – 1200 m) are mainly covered by oak forests dominated by the Downy Oak (Quercus pubescens) and Turkey Oak (*Quercus cerris*), mixed with Manna Ash (*Fraxinus ornus*) and evergreen Oak (*Quercus ilex*). The latter are present only in steep and unreachable areas. Only in a few places have matured forests remained. In general, the areas are considerably degraded with very few old trees and no dead woods. The spruce forest (800-1500 m) is dominated by the Macedonian Fir.

In some places it is mixed with the common hazel (*Corylus avellana*), the Sessile Oak (*Quercus petrea*), the Hungarian Oak (*Quercus frainetto*), the Maple (*Acer pseudoplatanus*) and Holly (*flex aquifolium*). In general these areas are not

disturbed and have a relatively large amount of dead wood and lichens, such as *Lobaria sp*., which show a long continuity, lots of humidity and fresh air. In general, the areas of the park at high altitudes are mainly dominated by broad-leaved forests and mixed forests with Macedonian Fir (*Abies borisii -regis*), Hungarian Oak (*Quercus frainelto*) and Turkey Oak (*Quercus cerris*).

The park also has natural pine forests, mainly wild pine and black pine (*Pinus halepensis* and *Pinus nigra*). Important species are inside this park area, including: the Horse chestnut (*Aesculuss hippocastanum* - **CR**), the large leaf linden (*Tilia platyphyllos* - **CR**), the Turkish hazel (*Corylus colurna*- **EN**).

4.3 The Hydrology of Vjosa River (Poçem Access)

- The characteristics of the hydrographic network

The river Vjosa, with a drainage basin 6710 km2, 272 km long, is the largest river in South Albania and one of the largest Rivers in the country.

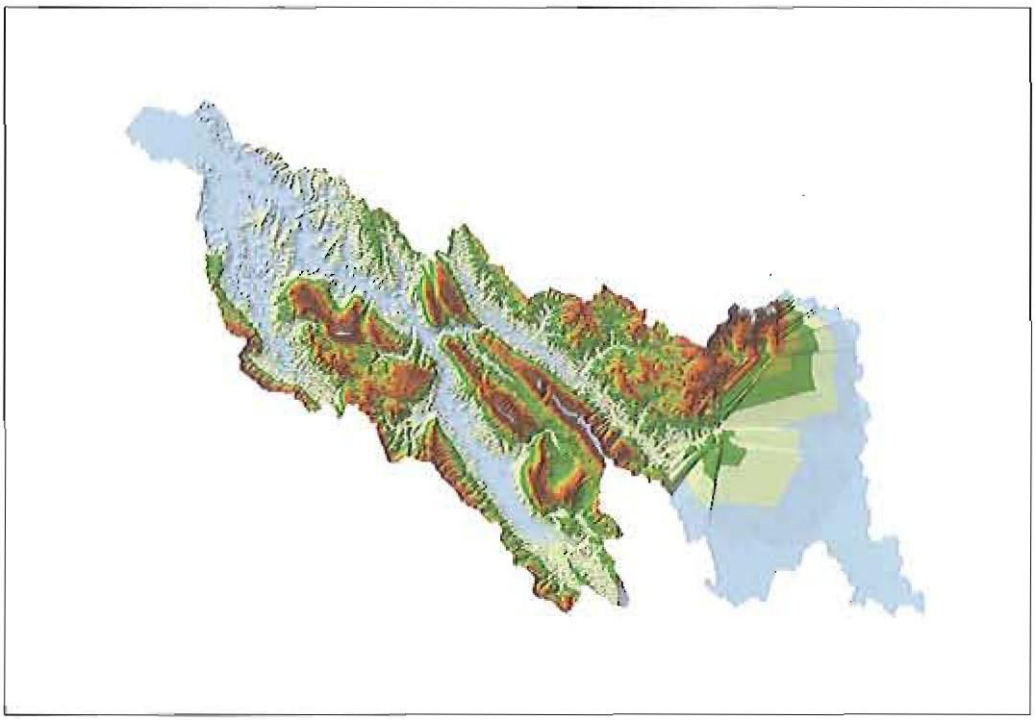


Figure 1: *The Drainage Basin of Vjosa River*

Vjosa River starts outside the territory of Albania on the southern slope of Voljakalldi Mountains, stretching south of Pindus mountain range in Greece. Before reaching Albania, Vjosa takes in the waters of Vojdomarë (from the left) and the main Sarandaporos tributary flows into the River from the Greek territory shortly before Vjosa enters the Albanian territory. Outside the Albanian territory, the surface area of Vjosa drainage basin is 2085 km^2, which consists of 31.1% of the overall surface area of the drainage Basin of Vjosa and the length inside the Greek territory is 85.6 km.

Vjosa enters in the Albanian territory as an already formed river and runs through the lowland between Nemëçka range on the northwest and Leskovik and Grabova on the northeast.

From the place where it enters the Albanian territory to Dragot, the river forms a valley with terraces on both banks of the river, or occasionally on one bank and then on the other. In this part, river bed is narrow and its banks are composed of conglomerates full of holes. In the Këlcyrë - Dragot sector, Vjosa runs into an erosional type of valley, on an east-west direction, where it cuts transversely a series of anticlinal structures such as the Nemënçkë- Dhëmbel range from the Trebeshina Mountain and further down Lunxhëri-Golik Mountains from the Shëndëlli Mountain.

Here the valley is "V" letter shaped and in general is symmetrical. Special about this part is the fact that the mass calciferous Nemençke- Dhembel anticline as well as Trebeshina-Shëndëlli anticline drain their waters in the Këlcyra Gorge directly into Vjosa, among which the most famous one is the socalled "Black Water Source" with a flow of some m^3/s.

The hydrographic area of Vjosa, after passing Dragot, joining Drinos River and flowing into the sea, is characterized by a wide valley. In the areas where it cuss into calciferous rocks it has formed narrow gorges such as the Dorëz-Kalivaç gorge which is about 4 km long and 150 m wide. Further down the Poçem gorge, Vjosa River bed becomes wider and the slope become less steep creating conditions for sand and gravel deposits. After the river flows into the sea, the river bed narrows gradually with windings and deep banks.

Numerous tributaries flow into the Vjosa River; besides the two main tributaries, Drinos and Shushica, which are rivers in themselves considering the size of their drainage basins and the amount of water they carry, there is a series of streams with a surface area of 300 km^2 which flow in the Vjosa main river. The streams flowing into Vjosa River from the entrance into the Albanian territory to Dragot, are the streams of Çarshova (90 km^2), Langarica (337 km^2), Lemnica (103 km^2), Dishnica (173 km^2) on the right side and Zagoria stream (171.6 km^2) on the left side.

Similar to Vjosa River, Drinos River has its source in Greece. In the Greek territory, the drainage basin of Drinos is 256 km^2 which makes up for 19% of the entire drainage basin of Drinos, while its length is 23 km.

The main tributaries discharging in Drinos River are the Suha stream (264.9 km^2) on the right side and Kardhiqi stream (181.9 km^2) on the left side. One of the main characteristics of Drinos River from the hydrographic point of view is the fact that part of its drainage basin runs underground through the calciferous massif of wide Mount, in order to supply with water "Blue Eye" source in Bistrica, outside the Drinos catchment area. Drinos River has an average watershed altitude that varies from 687 to 746 above sea level, a catchment slope varying from 21 to 28 % and an average width from 10.1 to 15.7 km.

Shushica River is the second tributary of Vjosa in terms of size. Its source is in Zhuri i Kuçit, but in reality Shushica starts after the Buronja of Kuçi. The two main streams

flowing in Shushica are the Vranishti stream on the left side and the stream of Smokthina on the right side. Even Shushica is famous for abundant supplies of karstic ground waters, such as in the area of Kurvelesh.

The watershed of Shushica River, along its bed, has an average height that fluctuates between 759 and 540 meters above sea level, a slope gradient that varies between 21 and 28 % and an average catchment width from 8.8 to 10.1 km.

- The climatic characteristics of the catchment

Because of the large extension of Vjosa drainage basin, from the border to the Adriatic Sea, it is understandable that the climatic areas of the catchment will be different. However the influence of the sea even deep in Vjosa gorge is shown in the form of winds blowing from the sea and special climatic conditions in Vjosa catchment area. Mediterranean climate is dominant with all of its special aspects such as the field, hilly, mountainous and pre-mountainous Mediterranean climates.

During the second coldest part of the year, cyclonic activity is denser and is accompanied by clouds and precipitations. On the eastern part, during winter they are in the form of snow. Winter season is characterized by intense precipitations often in the form of thunderstorms. During the warm part of the year, and especially during summer there is a prevalence of anti-cyclonic weather with high temperatures and small amounts of rains and even droughts which causes the reduction of water reserves. However, Vjosa River in comparison to the other rivers of the country stands out for a high sustainability of its water reserves even during the warmest period of the year.

One of the climatic elements which has a direct impact on the waters of a region are precipitations. On the Vjosa drainage basin the hydrographic regions of Drinos and Shushica are known for a large amount of precipitations all over the southern region of Albania. Most precipitations here fall on the mountain range confining Vjosa on the west, in the Mountains of Lungara, Çika, Gjerë, and Kurvelesh Highlands where average annual precipitations have more than 1500 mm of rain up to 2300 mm of rain per year. There also abundant annual precipitations in the Dhembel-Trebeshine- Nemërçkë massif.

Along the right slope of Vjosa River it is possible to observe an immediate and abrupt reduction of rainfall. This happens because air masses saturated with moisture coming from the sea release the major part of their precipitation on the first belt of the mountain range opposite the sea (the Çika Mountain, the Wide Mountain) and then on the second belt (Lunxhëri-Bureto). The remaining part discharge on the right eastern side of Vjosa River.

So, while in Kuç and Nivica there are about 2.300 mm of rainfall per year, in Kardhiq there are also 2310 mm, in Gjirokastra 1860 mm, in Llongo about 2.000 mm, on the eastern side there are small layers of rainfall such as in Leskovik 1170 mm, in Gërmenj 1250 mm, in Peshtan 968 mm, in Pennel 1250 mm and in Këlcyra 1290 mm.

- Water Flow

❖ Data Analysis

Along the Vjosa river drainage basin there have been some hydrometric stations during 1948-2000. Given that a part of those stations did not fulfil the appropriate conditions for water flow measurement, they were closed and with time new ones were opened. In the following table are the main stations and the time period they were operational, focusing on the area of interest to this research.

Tab. 1: The characteristics of the main stations in Vjosa River

No.	Sampeling Station	Surface of catchment km^2	The operational period
1	Vjosa Biovizhdë	2170	1969 - 1975
2	Vjosa Çarshovë	2 180	1977- ongoing
3	Vjosa Petran	2420	1948 - 1978
4	Vjosa Badëlonjë	2785	1982 - ongoing
5	Vjosa Përmet	2820	1968 - ongoing
6	Vjosa Dragot	3470	1978 - 1990
7	Drinos Lekli bridge	1300	1948 - ongoing

In this research we have focused on the water regime of Vjosa River down the city of Tepelena. In Tepelena, Vjosa River grows into a very big river because there it joins with Drinos River which is its main tributary with a catchment surface area of 1300 km2. After Tepelena there are only two important branches that discharge into Vjosa River: The Bënçë River (133 km2) and Shushica River (over 600 km2). Both tributaries flow on the left side of the main flow

Along the main flow of Vjosa River there were three hydrometric stations and specifically in Dorëz, Poçem and Mifol. The time these stations were operational and some of the main characteristics of these stations are shown on the following table.

No	Stations	Coordinates
1	Vjosa Përmet	40° 14' 25.91 "N 20° 2 I ' I 3. I 2" E
2	Vjosa Dragot	40° 17' 32.82" N20° 04 ' 45.03" E
3	Drinos Lekli bridge	40° 15' 33.12" N 20°03' 19.68" E
4	Vjosa Dorzë	40° 23' 30.74" N 19° 49' 18.47" E
5	Vjosa Poçem	40° 29' 34.73" N l9°43'4l.45"E
6	Vjosa Mifol	40° 38' 05.87" N 19° 27' 42.07" E

No	Stations	Basin in km2	Time of operation	Data collection
1	Vjosa Përmet	2820	1968 - continues	1968 -2000
2	Vjosa Dragot	3470	1978 - 1990	1978 - 1990
3	Drinos Lekli bridge	1300	1948 - ongoing	1948 -2000
4	Vjosa Dorzë	5420	1958-1990	1958-1990
5	Vjosa Poçem	5570	1968 - ongoing	1968- 1990
6	Vjosa Mifol	6680	1948 - ongoing	1948 - 1980

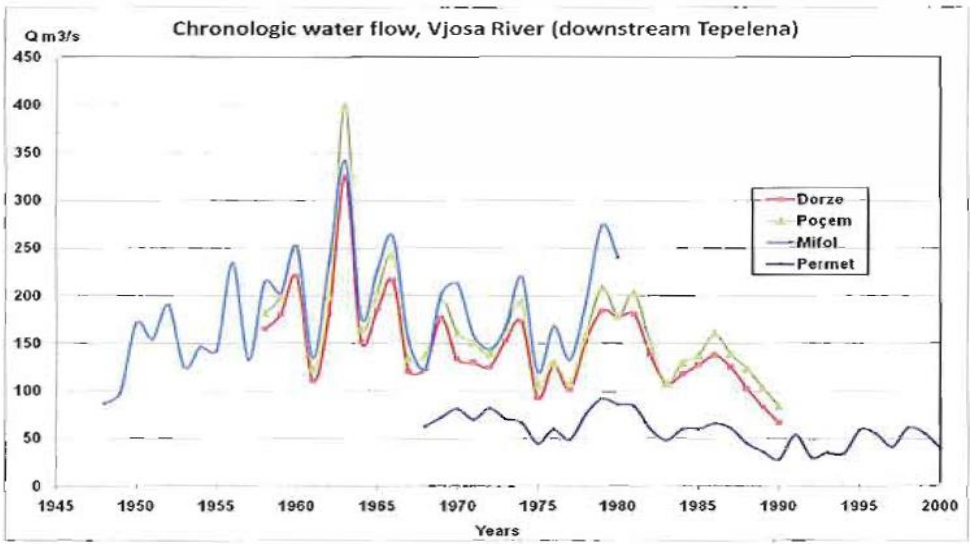
As it is possible to see from the data shown above, some of the River Vjosa stations have a relatively short period of observations. In the context of further hydrological

calculations the period from 1948 to 2000 was decided to be set as the period for calculations.

The following chart shows the chronological distribution of the main flows in these stations.

In order to have data for all stations for the same period of time, the method of correlation was used for annual flow series. Attention was focused in Poçemi and Doreza stations, which are the most representative stations of Vjosa downstream Tepelena. Mifol station is the lowest part of the Vjosa River and does not have any interest for hydropower. However its data were used to make longer the series of the other stations.

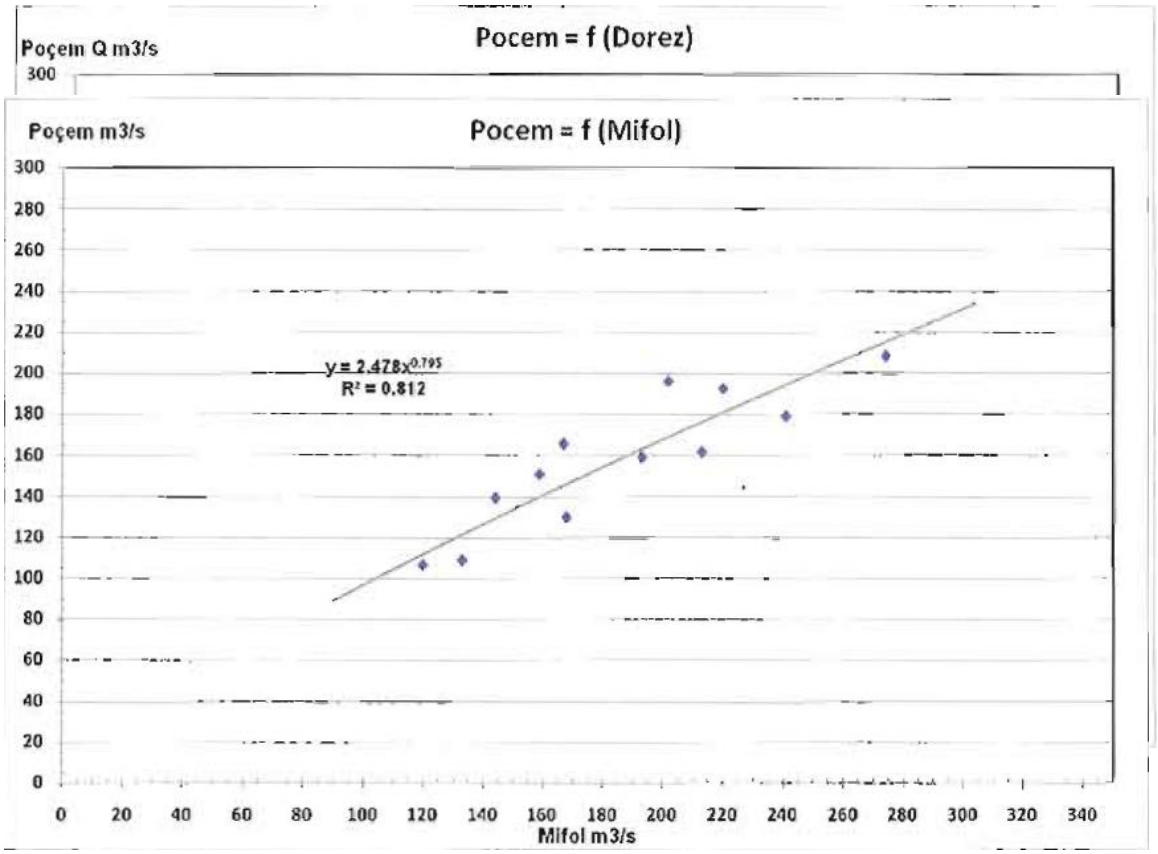
Data from the Përmeti Station were used to expand the series to year 2000, while data from Mifol station were used to go back as far as 1948. As it was mentioned above, the method used to make the series longer is correlation.



Chronologic water flow, Vjosa River (downstream Tepelena)

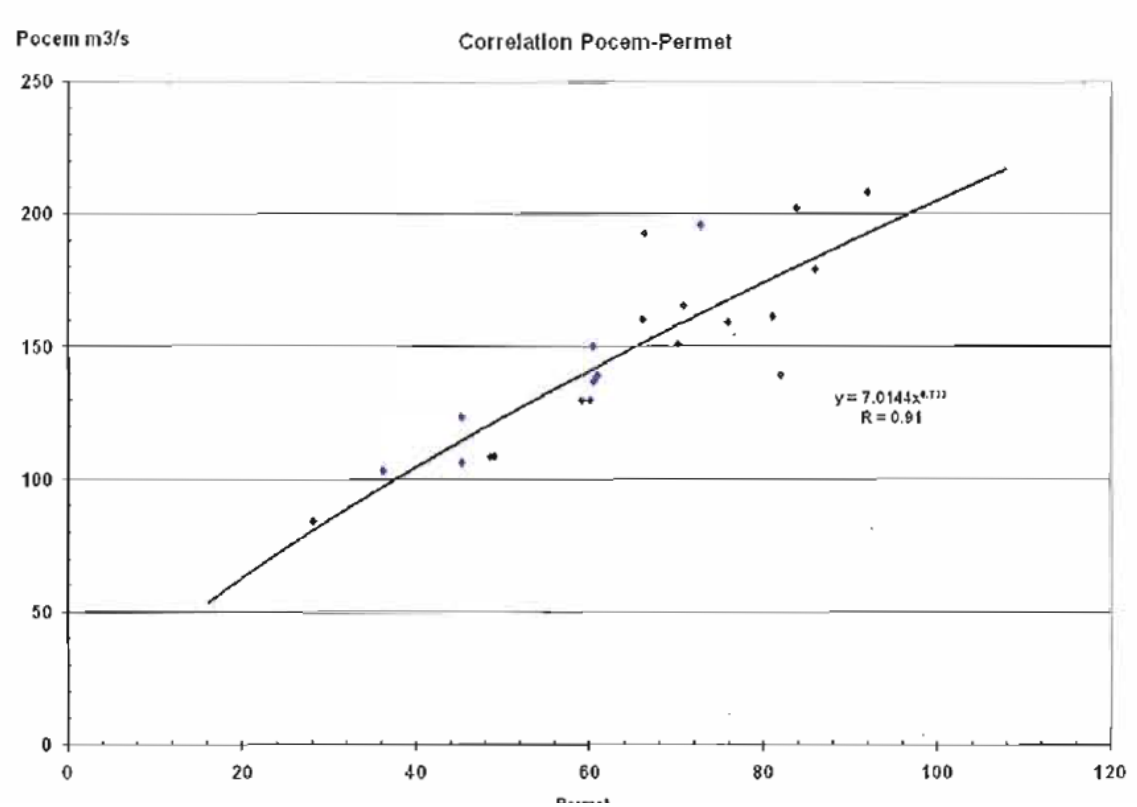
The type of regression was based on the highest value of the correlation coefficient. Initially the correlation between Poçem and Dorëz stations was set up, and in this case the type of regression is polynomial with a high correlation coefficient, 0.98 (R2=0.952). The equation has the following form:

$\mathbf{Q}_{Poçem} = 0.001\mathbf{Q}_{Dorëz}^2 + 0.546_{Dorëz} + 40.26$

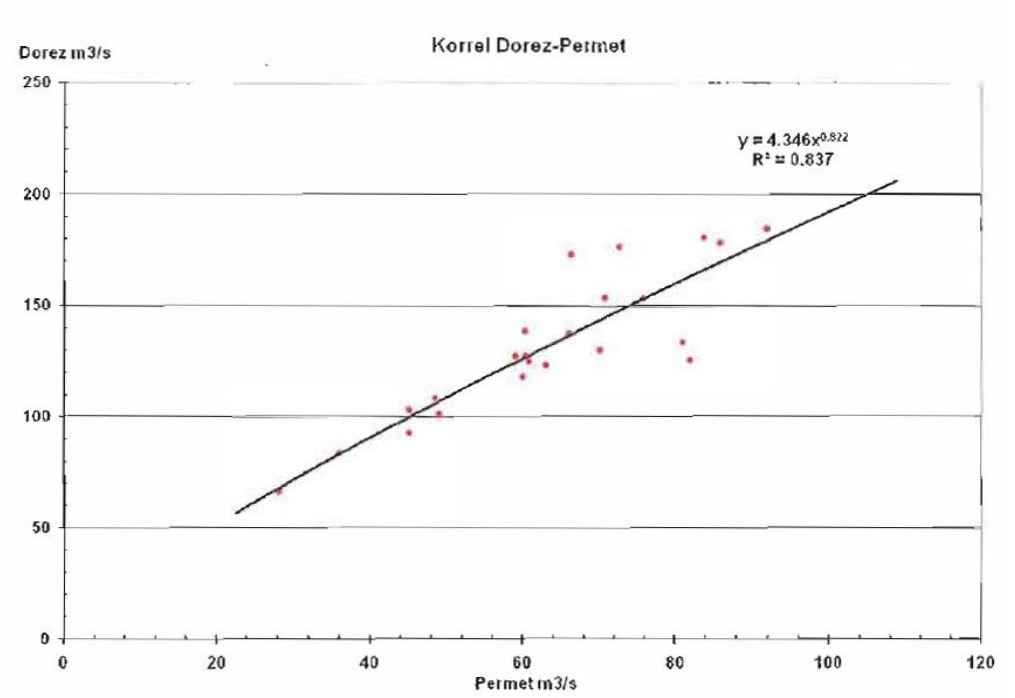


For Poçem-Mifol correlation the equation is $\mathbf{y = 0.2478x^{0.795}}$ and the correlation coefficient is **R = 0.90**

The equation of Poçem -Përmet correlation is: $\mathbf{y = 7.0144x^{0.733}}$ and **R = 0.91**



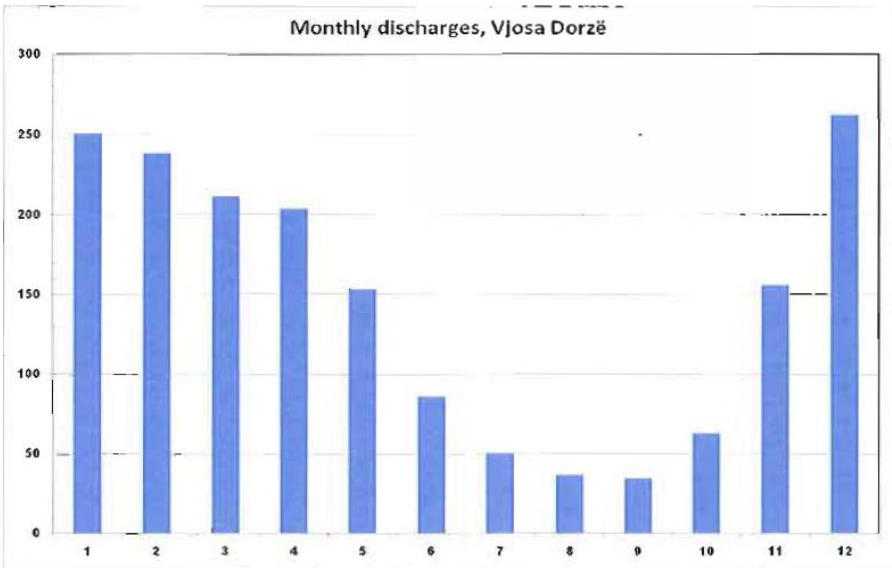
The equation of Dorëz-Përmet correlation is **y=4.346 x$^{0.822}$** and **R= 0.91** and following is the chart:



Based on the equation above, the series were made longer forming the same period of time for all stations. The results of the calculations above have yielded the average annual flows for many years in the Vjosa River stations, which are given in the following table (the flows of the research area).

The average monthly flows, Vjosa Dorëz

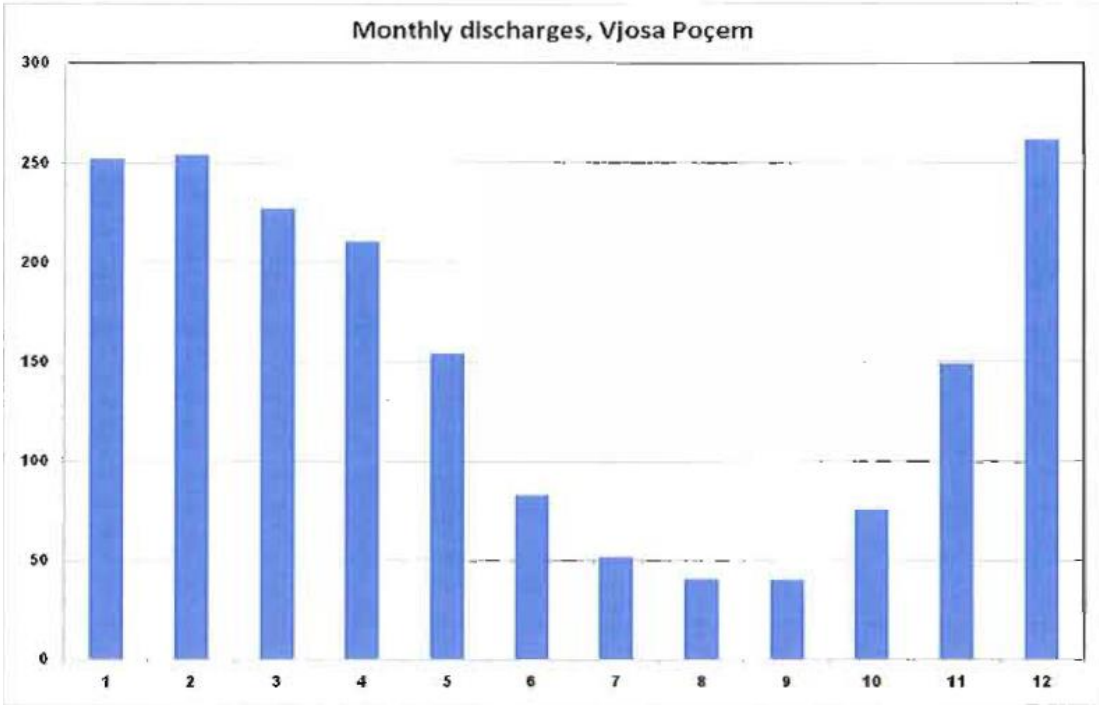
1	2	3	4	S	6	7	8	9	10	11	12	annual
251.0	238.6	211.7	204.0	153.3	85.9	50.5	36.7	34.8	63.0	156.1	262.6	145.7



The multi-year average flows in Vjosa River

The average monthly flows, Vjosa Poçem

1	2	3	4	5	6	7	8	9	10	11	12	annual
252.1	254.3	227.2	210.5	154.3	83.0	51.6	40.S	40.0	75.5	149.2	262.0	150.0



❖ Calculating annual flows with different probabilities

In order to calculate annual flows with different probabilities we were based on the annual flow series at the hydrological stations. The method used is the statistical method and to this purpose a French software was used "SAFARHY". With this program, the Normal, Longonnale and Pirson III distributions were tested, which later became subject of a statistical Khi2 test in order to define which one of these probability distributions was more appropriate for the series of the stations being studied. The analysis conducted shows that the best distributions were Lognormal and Pirson III distributions. The results are shown in the following table:

Annual flows with different certainties

Sampling station	**Assurance in %**							
	1	**2**	**5**	**10**	**25**	**50**	**75**	**100**
Dorëz	286	263	232	207	171	143	122	102
Poçem	297	274	242	217	182	148	125	102

❖ The sustainability curves of daily flows

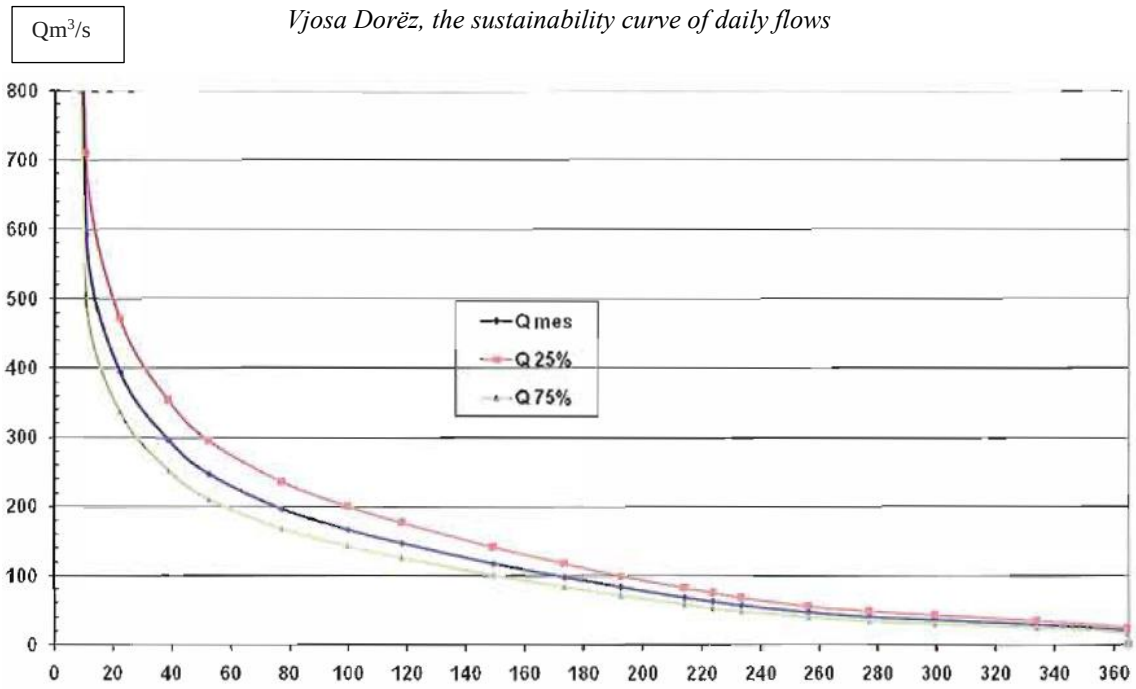
Because this hydrological research deals with the calculation of different water parameters for designing hydro power plants, it would be important to design also the sustainability curve of daily flows, which shows the frequency of a certain flow during the year. Daily flows recorded in the stations that are being researched were used to build this curve. After building these curves with the data of the time period, they were transformed for a multi-year period. It is important to point out that that the curve known as an average multi-year curve has been. At the same time sustainability curves were built for the wettest observed year and the driest observed year at each station. Following are the respective charts of these curves along with their respective coordinates.

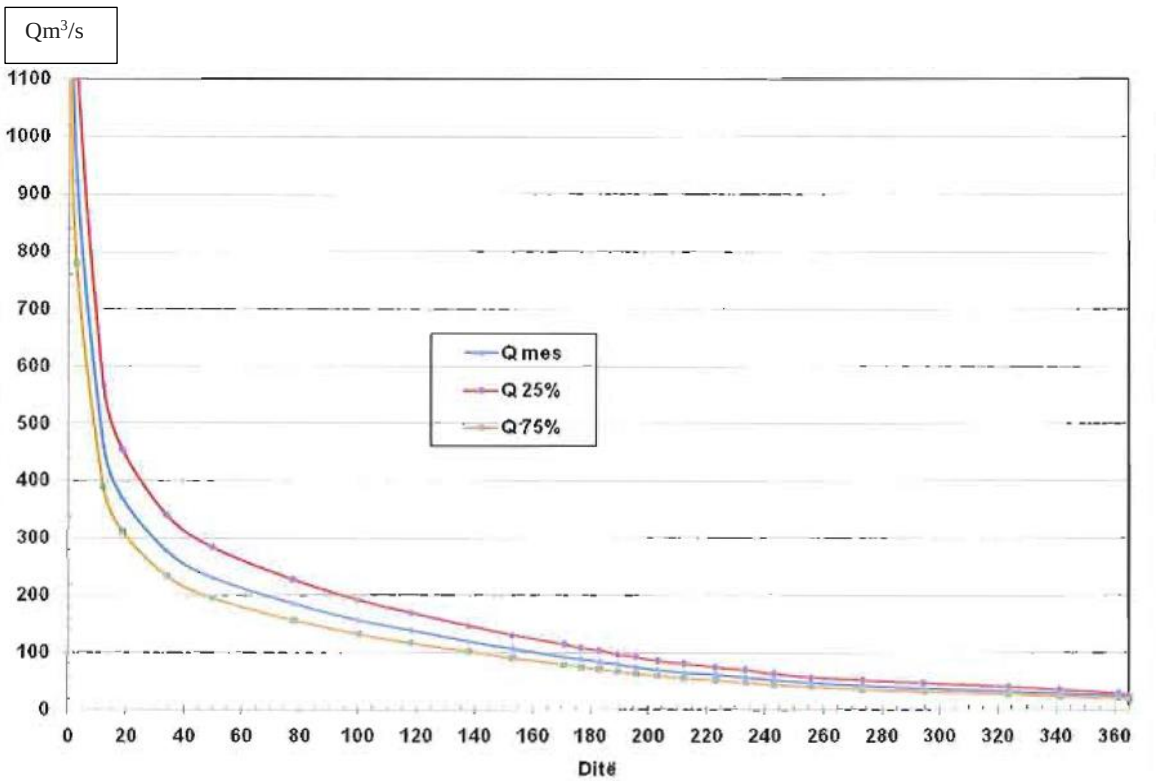
Calculated daily flows for all years with data.

The coordinates of sustainability curves of daily flows

Dorëz					**Poçem**			
No. of Days	**Q_m^3/s**	**25%**	**75%**		**No. of Days**	**Q_m^3/s**	**25%**	**75%**
365.0	0.0	0.0	0.0		365	18.5		
364.2	19.8	24.5	16.9		361.2	23. l		
334.2	29.7	36.7	25.3		341.3	27.7		
299. 1	36.3	45.0	31.0		323.4	32.2		
276.8	41.6	51 .4	35.5		294.3	36.8		
256.4	47.5	58.8	40.5		273.2	4 l.4		
233.6	57.4	71.0	49.0		255.8	46.0		
223.6	63.3	78.4	54.0		243.1	50.6		
214.3	69.3	85.7	59.1		233.3	55.3		
192.4	84.1	104	71.8		223	59.9		
173.4	99.0	122	84.4		212.2	64.5		
149.2	119	147	101		202.9	69.l		
117.8	148	184	127		195.5	73.7		
99.7	168	208	144		189.2	78.3		
77.2	198	245	169		182.9	82.9		
38.9	297	367	253		176.6	87.4		
22.5	396	490	338		170.5	92.l		
10.3	594	735	507		153. l	106		
0.0	3464	4287	2955		137.8	119		
					118	138		
					100	156		
					77.7	185		
					50	231		
					34.2	277		
					19	368		
					12.l	460		
					2.7	921		
					0.7	1382		
					0.2	1842		
					0	3361		

Vjosa Dorëz, the sustainability curve of daily flows





Vjosa Poçem, the sustainability curve of daily flows

❖ Maximal flows of different probabilities

The maximal flow in Vjosa River are mainly caused by rain, which, as it is known, are more present during November- March. The snow has a little influence on the formation of maximal flow. Based on the hydrographic analysis of the largest flows observed along Vjosa bed, in most of the cases the flows have a single peak. However, there are cases when they have two peaks and as a result they have a larger volume than the single-peak flows. Dual-peak flows are formed as a result of an uneven distribution of rains in time. The pluviometric data analysis, for the largest synoptical flow in Vjosa River, has led to the conclusion that rains causing larger rainfall have a duration of 5-6 days. Almost in the center of these rains, there is a 2-day interval when there is most of the rainfalls.

Two methods were used to calculate maximal flows with different probabilities: the statistical method and the Gradex method. The statistical method is the most classical method for calculating the maximal flows and it consists in adapting the observed maximal flow series with a probabilistic theoretical distribution which enables the extrapolation of maximal flows for the required probability. It is obvious that in this case the longer the observed series the more reliable are the results given by this method. In this research were used the two most known distributions for maximal flow assessment such as Pirson III and Gumbel distributions.

Regarding Gradex method, it should be said that it consists in extrapolating the distribution function of maximal flows in parallel to rain distribution function, with a similar time unit for rains and flows which is close to the duration of the peak hydrograph. Gradex is the slope of the rain distribution curve built on a Gumbel diagram.

This method is based on the assumption that water bearing and infiltration capacities achieve their maximal values for peaks that occur less than once in 10 years. Starting from the 10-year peak, the basin is supposed to be saturated with moisture and as a result each falling rain is then entirely transformed into water flows. In this case it is accepted that the probabilistic distribution curves of these elements are parallel. Meanwhile knowing that there are more complete data for precipitations than water flows, we have a more reliable curve for them and in consequence the flow curve drawn in parallel is more accurate. In conclusion we can say that Gradex method can be used for bigger axis but in contrast to the statistical method it is also used in those axes that have not enough data.

The following maximal flows resulted from the calculations that were made as described above:

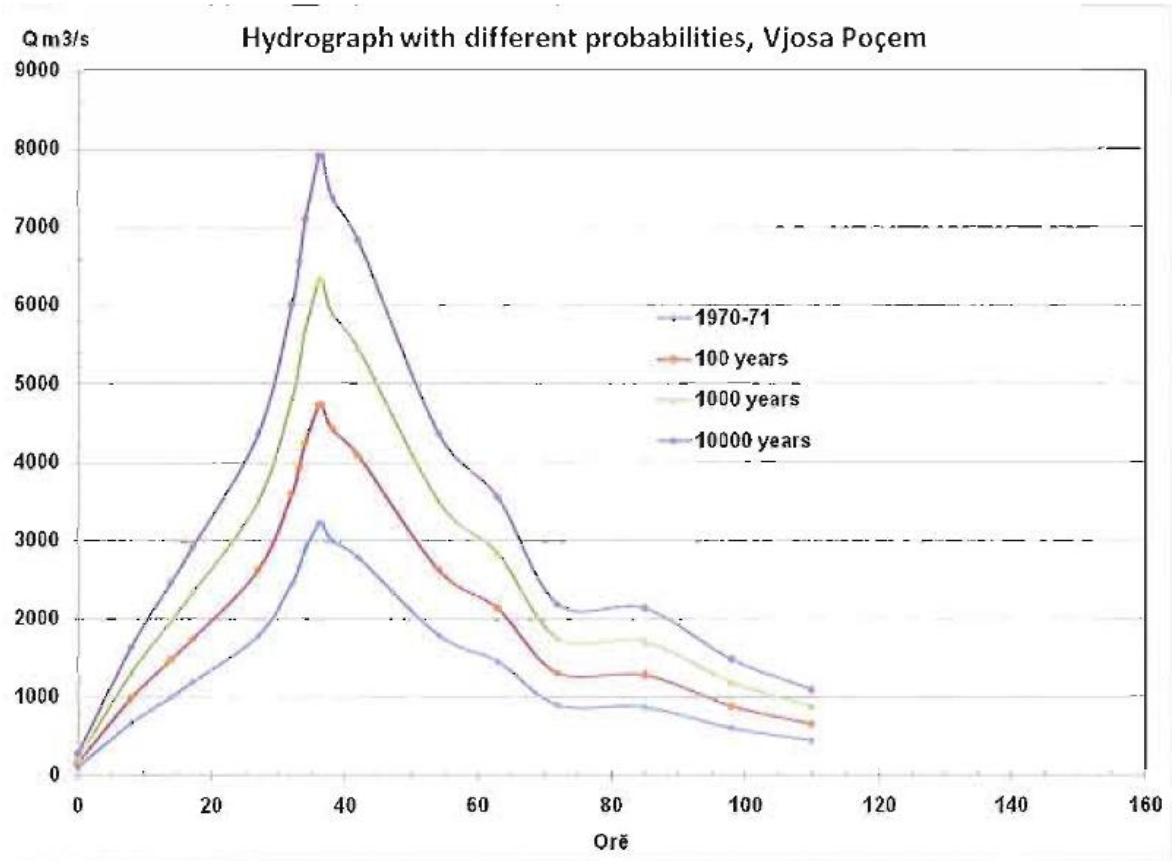
Maximal flow with different probabilities, the statistical method

Station	**F km^2**	**Probabilities**					
		0.90	0.95	0.98	0.99	0.999	0.9999
Dorëz, Gumbel	5420	3090	3570	4200	4660	6210	7760
Poçem, Gumbel	5570	3120	3610	4260	4740	6330	7920

Maximal flow with different certainties, Gradex method

Station	F km^2	Probabilities				
		0.95	0.98	0.99	0.999	0.9999
Dorëz	5420	3310	4110	4710	6680	8650
Poçem	5570	3410	4170	4750	6630	8520

In the following chart there is a hydrograph of maximal flows with different probabilities for Poçem axis.



Hydrograph with different probabilities, Vjosa Poçem

❖ Solid flow

The solid flow is an important characteristic of the hydrological regime of river basins. Solid flow data are necessary parameters during the design and use of different hydro-technical works.

In Vjosa River hydrographic network there were some stations where observations were conducted of the suspended solid flow. More specifically, solid flow measurements were conducted in Çarshova, Përmet and Ura e Leklit Stations (at least for the stations being analyzed). The observation period was from the time these stations were opened, until 1990 when the activity was suspended.

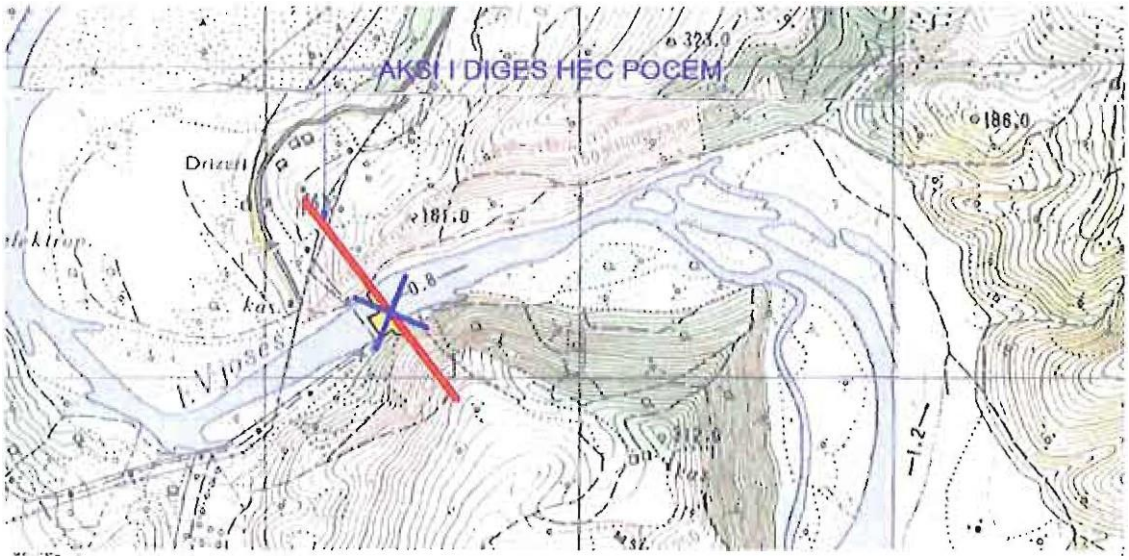
In the following table are the respective calculations for the multi-annual period.

The parameters of the suspended solid flow in Pocem axis

Axis	F (km^2)	Q (3/)	Average Turbidity (gr/m^3)	Solid flow (kg/s)
Vjosa Poçem	**5420**	**150**	**1000**	**150**

❖ Topography

On Geodesic and Topographic data for Pocem HPP (Fier-Vlorë)



❖ Topographic data

In order to draw and process data according to the necessary components of the Poçem HPP Assessment, a system was set up for the goal of this assessment. The assessment includes the necessary maps on l: 25.000 scale, and different digital data such as SRTM (Shutle Radar Topographic Mission) which is known on an international level for their data and accuracy, DTM data (Digital Terrain Mod el) and other characteristics in order to create a data component for different goals.

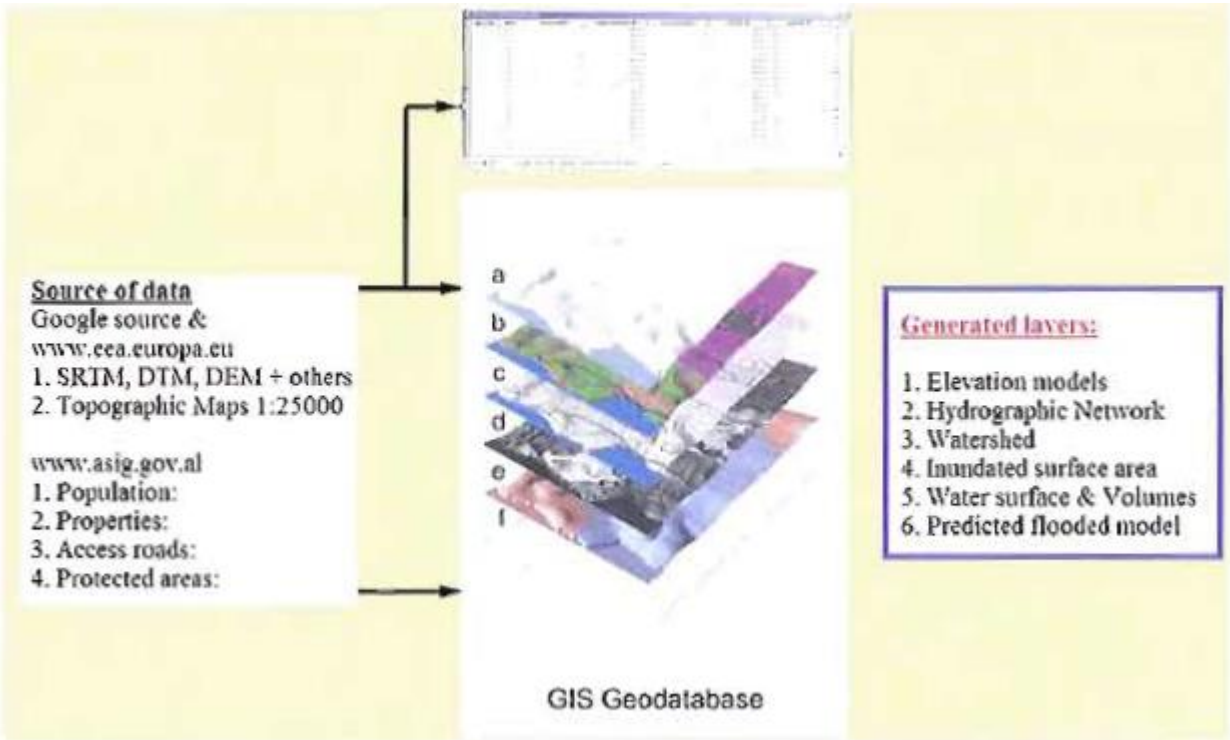
The global geographic (GIS) and portable sensor (RS) systems were used to generate isohypses on various scales, deciphering them from the 1: 25.000 scale to 1: 5000 scale.

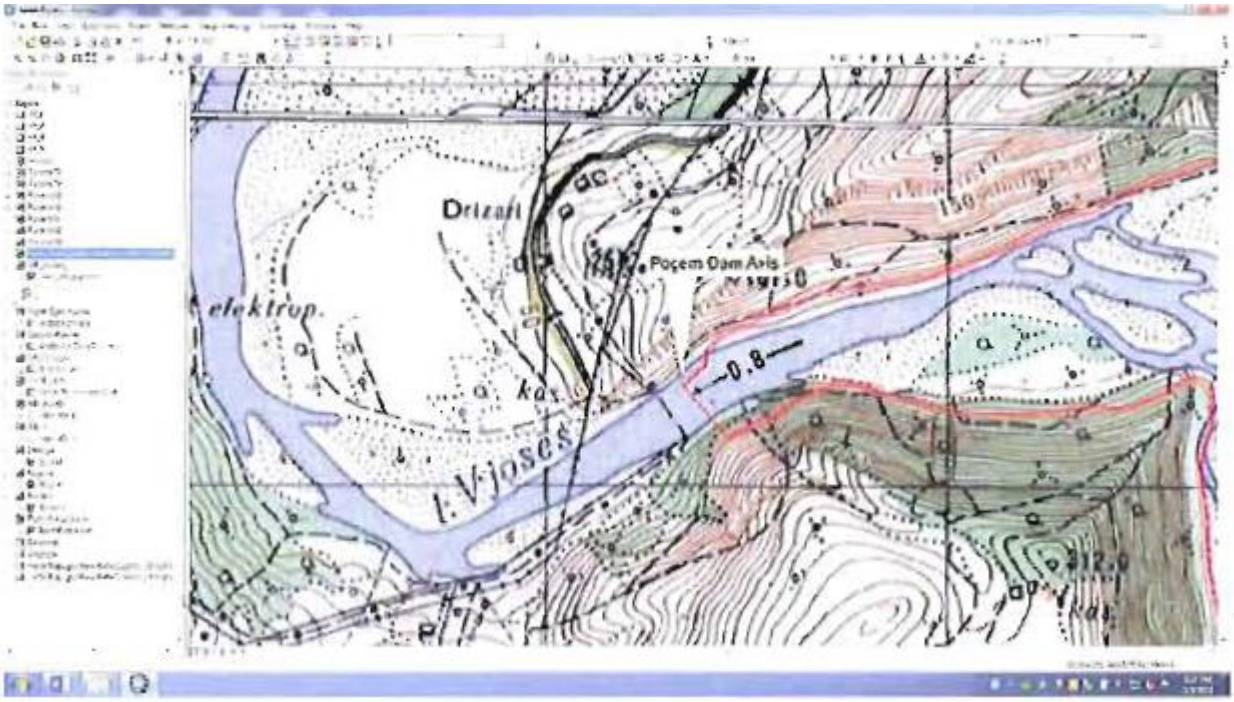
It should be underlined the fact that the terrain digital data support a maximal accuracy therefor they have been used in order to define water levels for each given solutions.

The impact from the surface area of the reservoir on natural features, such as roads, affected houses, cultivated areas and other components of human life in the area which will be affected because of the construction of the reservoir.

Another fact to be underlined is that an in situ topography on a 1: 2000 scale has been conducted for the axes where dams and other related objects have been proposed to be built.

Data used and sources	**The created system**	**The generated data**
Google source & www.eea.europa.eu	GIS	The triangulation system
Various SRTM, DTM, DEM+		The hydrographic network
Topographic map I :25000		The Drainage basin
www.asig.gov.al Population Properties Roads Protected areas		The reservoir area
		Finding the volume and the surface area for every 5 meters of a level
		Predicting the flooding effect in the Vjosa estuary area





The topographic map of the Pocem dam axis (N = 4483261.35 m, E= 392263.94 m)

❖ The belt surveying

Based on the polygonometric and geometric levelling points the topographic measurement network was developed for HPP Pocem axis plan.

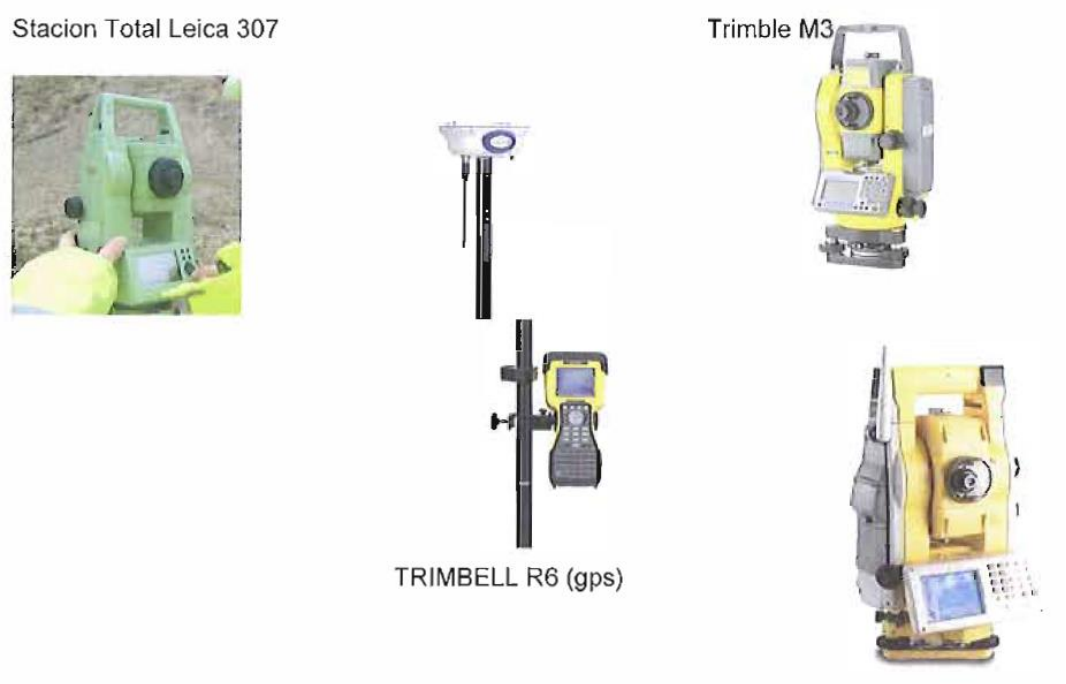
❖ Task description on the field

In order to support the construction works, three strong points were initially created which are sufficient for making detailed surveying points. The points were measured with the statically method, focusing on the point for about 40 minutes within a 1 sec interval and providing millimetric accuracy of point coordinates.

The geodesic and topographic construction works for HPP Poçem were conducted based on the technical general and specific requirements foreseen by the project designer. Before the start of the topographic works, necessary cartographic and geodesic materials were provided which are connected in a system with the GIS operation unit and respective equipment for terrain measurements.

In order to ensure the unique geodesic relation of all projects, the company used the geodesic data of the state network for triangulation and levelling. The system used by the republic of Albania is UTM - EGS84 projection.

Measurements were made with GPS TRIMBELL R6 Total station Leica type 307, Total station Trimble M3 Type, Topcon GPT 900 A and with levelers which technically provide for the measurement of the distance between angles with the necessary accuracy for projecting different engineering infrastructures.



Sonarmite

Following are the point coordinates and the respective numbers for each point taken from the field work in the stations.

Landmarks	**X**	**V**	**Z**
ST 1	392199483	4483295,183	51754
ST2	392296 .094	4483 149.852	51.818
ST3	392.199.483	4.483.295.183	51.727
RR1	392.066.403	4483257 .976	53.51
RR2	392 184.156	4.483.026.369	47.62
RR3	392296.39 1	4.483.374.604	69.39
RR4	392.034.932	4.482.975.477	74.15
SK 1	3923 13.703	4.483.437.990	72.88
SK2	392.253.623	448334 I .923	68.160
SK3	392.398.587	4.483.247.652	47.29
SK4	391825.69 1	4.482.747.458	49.720

4.4 Geology

❖ Report on the geological engineering conditions of HPP Poçem

Upon the request of "GR ALBANIA" Company, the assessment of the geological-engineering conditions was made for the area where Poçem hydropower plant will be constructed, in the Vjosa River valley, east of the automobile bridge connecting the area of Mallakastra with Vlora in Poçem village. Within this space, Vjosa River cuts into some rocks, which conditions the shape of the valley and its geomorphology.

In this report there are data which were supported by archival collections of materials. Regarding the different geological assessments conducted in this area, the surveys made by our group, in the area where the HPP object will be set up (the dam, the diversion tunnel, the tunnel of use) we have consulted also the geological maps on a l: 200000, scale, the hydrogeological maps on a 1: 200000 scale and the seismological map on a 1:200000 scale.

❖ The geological construction of the area

The geology of the area where the Poçem Hydropower plant is going to be built is diverse and inside there are parts that have different lithologies (carbonates, flysch, molasses) dating from the average geological period (triassic) to the most recent one (quaternary).

1.1 Carbonate depositions of the upper Triassic – Eocene (T3 - Pg2)

The carbonate depositions are relatively widely distributed in the region. These depositions, on the north-eastern part of this region, compose the anticlinal carbonate structure of Kermenarë which is spread in the regions of Klos, Kremenarë, Drizë, Poçem and Kutë villages. On the south-eastern side of the region being assessed the carbonate depositions are distributed on the villages of Krahës and Kalivaç.

1.1.1 The deposits of the Upper Triassic (T3).

These depositns were encountered deep in the Kremenarë structure, through oil wells. They are mainly represented by dolomites and crystalline calciferous dolomites, granular dolomites, thick and massive layers. Bituminous schists were also encountered in the deposits. The greatest width known for these deposits is about 700 m.

1.1.2 Jurassic deposits (J)

The Jurassic deposits are represented by different types of calciferous rocks, and are connected with the anticlinal structure of Kremenarë and other structures lying near the region under assessment (in Patos- Verbas, Ballsh).

The deposits of the lower Jurassic were found deep underground in the deep wells dug for oil. These deposits are represented by massive limestones, micrite limestones, calcareous clay and schist clay combined with flint stones.

Characteristic for these deposits are also dolomites with a sandy appearance and clay schists from the micrite limestone layer.

The deposits of the Middle Jurassic are composed of the lower flint layer, micrite and turbidic limestones with flintstone and marl concretions. In the surveyed area, in the anticlinal structure of Kremenarë, these deposits are more spread deep inside. On the surface they have a limited exit. They build the core and the braches of this anticlinal structure. The deposits of the upper Jurassic spread on the surface to the center of the carbonate structure. They spread from Kremenarë village, on the northeastern side, to the left bank of Vjosa River, southwest of Kutë village. Lithologically these deposits are represented by a combination of micrite limestones and calcareous clay with flints. On the upper part of the intersection is the upper flint layer with a combination of calcareous clay, bituminous marlschist and white calcareous micrite. The incomplete thickness of these deposits in Kremenarë is about 50 m.

1.1.3 The Cretaceous Deposits (Cr)

In the surveyed area and even near it, there is an abundance of carbonate deposits from 2 sections: the lower Cretaceous and the upper Cretaceous. The Cretaceous deposits are mainly spread on the sides of the carbonate anticlinal structure of Kremenarë.

The deposits of the Lower Cretaceous (Cr1)

These deposits are on the surface, from north of Kremenare village, southeast of the carbonate structure to Kute village. The contact with the other older rocks is normal.

Lithologically, the deposits of the lower Cretaceous are represented by a combination of porcelain, micrite limestones, with clay schists and Flintstones. In the lower part there are calcareous micrites and skeletal limestones as a middle layer. The thickness of these deposits on surface intersections is between 250-500 m.

The deposits of the lower Cretaceous (Cr2)

The deposits of the lower Cretaceous (Cr2) are on the surface, on the eastern side of the Kremanere structure and are in normal contact with the older deposits (Cr1)

These deposits on the lower part are represented by micritic and biomicritic limestones and a rare combination of Flintstones that reach the phosphate limestones. The latter are represented on a higher level by the organogenic – granular pack of limestones. The deposits in the lower cretaceous on surface intersections are between 200 to 500 m thick.

1.1.4 Paleogene deposits (Pg1-Pg2)

The carbonate Paleogenic (Paleocene, Eoscene) deposits compose mainly the sides of the Kremenare anticline. These deposits surround this structure on the northwest and northern part and entirely on its eastern side.

The Paleogene deposits (Pg1)

The paleogenic deposits are in normal contact with the deposits of the upper cretaceous and form the sides of the Kremenare anticline structure.

These deposits are represented by massive turbidic limestones and by less micritic and biomicritic limestones combined with thin and rare layers of flint stone. At the Kremenare intersection, between the upper Cretaceous and Paleocen there are underwater falling materials. The thickness Paleocene deposits on the surface ranges between 70 to 100 m.

Eocene deposits (Pg2)

The Eocene deposits are in normal contact with the Paleocene deposits and they build the most peripheral part of the Kremenarë anticline structure. Lithologically these deposits are represented by micritic and biomicritic limestones with interlayers of flints in the lower part of the intersection and with biomicritic limestones in the upper part of the intersection. Their thickness at the intersection is 130 m.

1.2 Oligocene Flysch and Flyschoid deposits (Pg3)

Oligocene flysch and flyschoid deposits of (Pg3) are widely spread on both sides of Vjosa River. They are mainly in the southern half of the lake formed by the construction of Pocem Hydropower Plant. In the surveyed area there are deposits of the entire section: the lower Oligocene, the Middle Oligocene and the Upper Oligocene.

1.2.1 The deposits of the lower Oligocene (Pg_3^1)

These deposits are spread over the entire eastern side of the carbonate structure, in the form of a narrow belt, in normal contact with the Eocene deposits. Lithologically the deposits are represented by marls, clay with a combination of calcareous layers. Marls have a bright grey color with peel-like fractures. They contain alevritic material.

Limestones are up to 15 cm thick. They have a grey to beige color and are represented by granular limestones. Thickness on surface intersections, from east to west, ranges 100-300 meters.

1.2.2 The deposits of middle Oligocene ($Pg3^2$)

The deposits of middle Oligocene are spread on the surface of the eastern part of the area and continue from Çorrush village (on the south) to Bejar village and to Dames village further north. Lithologically, these deposits are represented by a clay-sandy flysch with rare layers of microtic, biomicrotic and turbidric limestones.

1.2.3 The deposits of the Upper Oligocene ($Pg3^3$)

The deposits of the upper Oligocene are widely spread in the area, on the surface and deep inside. On the surface, on its eastern part, and on the right side of Vjosa River, these deposits have a normal contact on the deposits of middle Oligocene from Çorrush village in Zhulaj to Beja village. On the

southern part of the area these deposits are widely spread south of Shkoze village, and on the western part they are widely spread north of Poçem village and south of Karbunarë village up to Rexhepaj village. Lithologically, the intersection is represented by a combination of sandstones with alevrolitic clay and layers of limestone on the lower part.

Sandstones in general have from an average to a high thickness, while 10-15 m thick limestones are used as correlation repair. The thickness of the intersection in the area is 500 m.

The upper part of the intersection is represented by thick and massive layers of sandstones, combined with the alevrolite or clay with some calcareous interlays. Sandstones are characterized by the considerable presence of pieces of metamorphic and sedimentary rock and by the presence of micas, pieces and organogenic detritus-shaped materials.

1.3 Neogene deposits

Neogene deposits are created by the deposits of the Lower Miocene, N1 (Aquitanian and Burdigalian stage), middle Miocene N12, Langhian, Serravalian, Upper Miocene and To1tonian.

1.3.1 Aquitanian deposits (N_1^1a)

These deposits are mostly spread on the southwest of the area, spreading on the surface in the shape of a belt with various widths, east of Rexhepaj, Haderak and Mallkeq villages. They are represented by a combination of sandstones with alevrolitic clay and clay. The Aquitanian deposits are in contact with a number of wells dug mainly on the eastern sides and on the synclines of the structures in the area.

1.3.2 Burdigalian deposits (N_1^1b)

These deposits have limited outcrops and they have been identified south of Kute village and between Dushkarak and Shkoze villages. The deposits are lithologically represented by clay and carbonate clay and even by marls combines with sandstones and some interlays of calcareous detritus. The thickness of the deposits is in compliance with the geological position and the way successive or transgressive deposits have been placed.

1.3.3 Langian Deposits (N12l)

These deposits spread on the surface and make normal contact with the Burdigalian deposits to their east. The deposits of this stratum are characterized by the presence of marls, mainly organogenic – microforaminiferal, which, after coming into contact, are transformed into clay. There is also a small presence of sandstones and alevrolites. In addition, in the lower part there are also olistostromes and underwater rocks.

1.3.4 Serravalian deposits (N_1^2s)

The molasic deposits of the serravalian stratum make normal contact with the Langinian deposits and are located to their east, south of Dusharak village. The deposits of the stratum are characterized by the presence of clay, alevrolites and other rare layers of sandstones.At the intersection there are lithothamnic limestones.

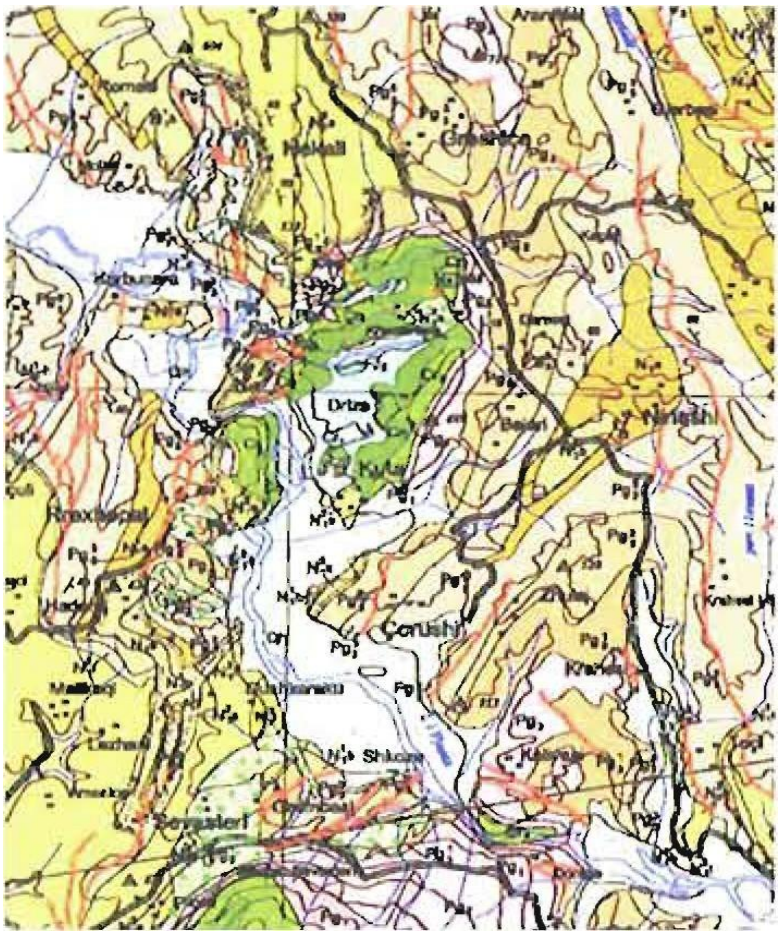
1.3.5 Tortonian deposits (N_1^3t).

These deposits are very limited on the surface. On the surface they can be seen only near Dushkarak

village in normal contact with serevalian deposits.
Lithologically, the deposits in the peripheric part of the Adriatic Plain are made of clay and sand with big or average grains. The thickness of layers is between 0.5-1 meters up to 5-6 meters.

1.4 Quaternary deposits

Quaternary deposits are mainly developed along the Vjosa River valley and along some stream tributaries discharging to this river. In the Vjosa River valley, they spread from the Karbunare and Pocem fields lying north of the surveyed area to Kute field in its center, and on to Çorrushi, Shkoza and Kalivac fields on the southernmost part of the surveyed area, composing their gravel areas and terraces. The extension of these deposits ranges from tens of meters up to about 3 km. The quaternary deposits are spread by gravels of average sizes and are composed by sand and dirt. These deposits are up to 20 m thick.



The hydrological map for the area (according to the geological map of Albania scale1:200000)

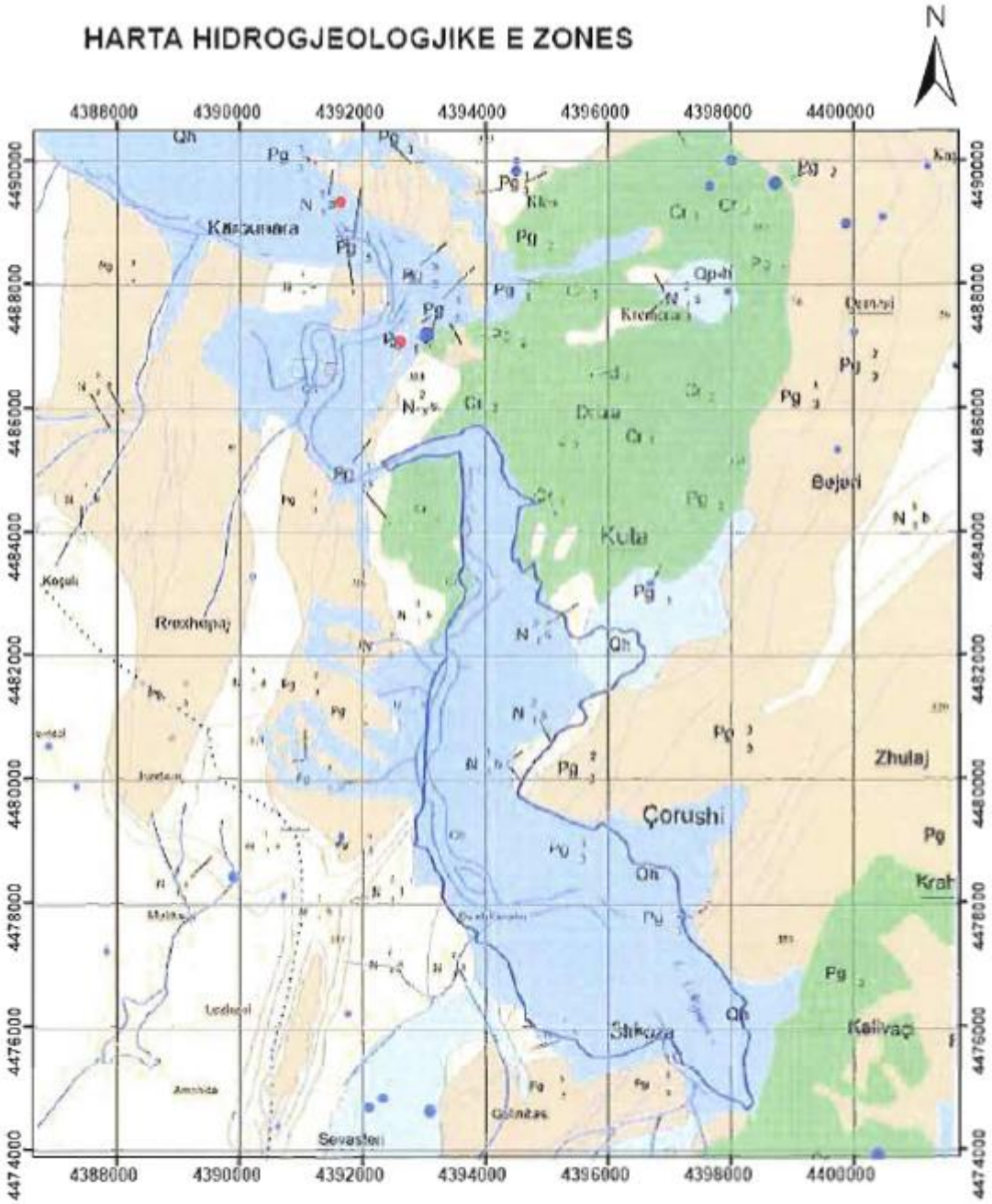
The hydrology of Poçem area

Hydrologically, the Poçem area is very interesting. In the area there are many types of aquifers, ranging from aquifers with a high-water capacity to the practically so-called “non-aquifers”.
In the area, as shown in the Hydrological Map, there are these types of aquifers:

- Aquifers with an intergranular porosity and a high to very high water capacity.
- Aquifers with an intergranular porosity and a low to very low water capacity.
- Aquifers with a poro/fractured porosity and an average to low water capacity.

- Aquifers with a fractured-karst porosity and a very shifting water capacity – very high – very low
- Non aquifer with insufficient porosity to allow for the circulation of ground water in amounts that can be use.

Hydrological map of the area



LEGEND
The Hydrological Units Aquifer

The Hydrological Units	**T [m2/d]**	**Lithology**
Aquifer		Soft rocks
With intra-granular porosity		Sediments
	$>10^2$	Sand, gravel, argil
		Argil, sand, gravel
With poro-fractured porosity	10^2-10^{-1}	Argil, gravel, sand
		Compact rocks
With fractured/karst porosity		Sedimentary rocks
	10^2-10	Argil, sandy, conglomerate
	10^1 - 10	Sandy, argil, conglomerate
		aerolite and argil, rare sandy
Non aquifer		Flysch
		calcareous

Sources

very small small medium big very big

Surface water

Lake borders

Works build in order to use ground waters

☐ with average flow 100-1000 vs

Diggings

● diggings in aquifer without pressure

2.1 Aquifers with an intergranular porosity and a high to very high water capacity.

This type of aquifer is spread in the Vjosa river valley, on its bed and terraces, from the Karbunara and Poçem fields lying north of the surveyed area to the Kutë field in its center, and on to Çorrushi, Shkoza and Kalivaç fields on the southernmost part of the surveyed area.

They have a high water conductivity and have a practical importance for tap water supply as is the case with the Karbunara and Poçem field. In general the aquifers have small impermeable cover and this is why they are fed directly by Vjosa River.
In the Karbunara and Poçem field, the gravel fields are 10-15 meters while the complete thickness of river alluvia is up to 20 metres. On to the south there is lack of data on thickness, but their thickness can be accepted to be up to 15 meters.

The aquifers at this part of the valley have no pressure and this is because of lack of cover or its small thickness. Ground waters almost move to the direction of the river flow.

Water conductivity of water carrying layers and the specific flows at the dug in Poçem and Karbunara areas are high, and as an analogy, even those aquifers south of Poçem Bridge can be considered as having a high flow that reaches values up to 1200 m2/day. Water conductivity and specific flows have a reciprocal connection and dependency, so in general a high specific flow indicates a water carrying layer with a high conductivity and a low specific flow indicates a layer with a low water conductivity. The chemical composition of ground waters in these aquifers is very good. Ground waters have no color, no smell and no taste. All chemical elements are within the Albanian standard norms that are used for tap water supply. Overall mineralization ranges between 300 -500 mg/L.

2.2 Aquifers with an intergranular porosity with an average to low water conductivity

This aquifer is represented by the Holocen-Qh deposits with a lithological composition of sand, clay and subargille. They are very little present and mainly on stream valleys, and less in the areas where they join with the main river. This type of aquifer is not important regarding the size of their water carrying capacity.

2.3. Aquifers with a poro/fractured porosity and an average to low water capacity.

Loamy aquifers with an average to low water conductivity occupy a relatively big surface area. They are lithologically represented by sandstones, clay and thin conglorneratic layers. They are mainly spread in Pocem village and Mallkeqne Village, north of Klos and in Damës.

In these aquifers there have been no hydrological diggings which can define the specific flow or other hydraulic indicators. Based on the analogy with other areas, the specific flow in these aquifers is from 0.1 to 0.31/s/m. A relatively high number of sources are connected with this type of aquifer but which have a flow which is less than 1 litter per second.

The hydraulic connection of ground and surface waters is not a good one. Only a few reserves are usable in this aquifer. They can be used to provide drinkable water for small communities. In general their chemical-physical properties are good, and the quality of ground waters is good. The overall mineralization varies between 500-800 mg/l, while overall strength varies between 14 - 26 °german.

2.4 Aquifers with a fractured-karst porosity and a very shifting water capacity – very high – very low

This type of aquifer includes also the Kremenarë karstic carbonate aquifer. This aquifer is represented lithologically by the carbonate deposits of the Triassic, Jurassic, Cretaceous and Paleocene periods.

The aquifer lies in the areas of Klos-Poçem villages (on the western side) and in Kremenarë-Drizar-Kutë villages.

The Kremenarë carbonate Aquifer

The river has cut into the aquifer (on the south of the bridge)

The breakability of the massif and especially the secondary phenomena reflected on the activity of the karst, enable focused drainage in Poçem source.

The largest source in this aquifer is Poçem source, which drains into a sector of about 400 meters and with a flow of 840 l/s, being one of the sources with the largest flow compared to the other sources on a national scale. Currently the source is used to supply with water the city of Ballsh.

The Pipes of Poçem source

View of the pumping stations

In the following picture there is piped water deriving from this source near a bar in this village.

Water quality in this aquifer is very good. Waters have a small mineralization 272.3 - 499 mg/l, while dry residues are between 190 - 243 mg/l. Low mineralization can be explained by a short contact between water and the formation and because rocks are a little damaged chemically. The pH indicator of these waters in most of the cases is around 7.32. Overall strength is between 7.8 and 15.4°german. According to predominating ions, the type of waters is HC03 - Ca - Na.

2.4.1 Groundwater as feeding sources for Poçem source

The Pocem Source is a karstic source, which besides precipitations is thought to feed on the Vjosa river in the area where this river interrupts with the carbonate deposits.
The opinions that the river feeds the source have existed since the 1970s when similar values were identified for the overall mineralization between the water source, river water and ground waters in Poçem field.
The opinion that this source is fed by the river was given in a research made by R. Eftimi in 1990.

2.5 Non aquifer with insufficient porosity to allow for the circulation of ground water in amounts that can be used.

Non aquifers are lithologically represented by clay-alevritic-sandy flysch with layers of Oligocene limestones.

These deposits spread on both sides of Vjosa River flow. On the right side of the river, they spread in Damës, Bejardhë, Çorrush villages while on the left side these deposits are mainly spread in Rexhepaj village close to Karbunarë.

They are represented by some lithological packages: the thick flysch package, thin clay-alevritic-sandy flysch, thin clay-alevritic-sandy flysch with interlays of organogenic-granular limestones, thick flysch and coarse sandy flysch with underwater sliding rocks. The sandstones of this package have a yellow color and contain iron oxides.

The water capacity of these deposits is very low. This is proved by the low number of sources. The number of the latter is not only limited but even flows are very small while dug wells also are very poor in water resources so that they are very deep especially during summer months. Sources flow from broken sandstones. Flows range between 0.01 - 0.2 l/sec. Ground waters feed on precipitations but often even from tectonic disruptions. Ground waters drain through erosion networks cutting into these deposits. In general water quality is good.

4. The geological engineering conditions of Poçem HPP

4.1 Geodynamic Processes

The geodynamic processes in the surveyed area are closely related with internal and external energy. Internal energy is related with tectonics and neo-tectonics while external energy is related with alteration, slides, rolling and erosion.

Alteration is physical. It was developed in soft rocks, especially in rocks with a soft relief. During the field work conducted on these rocks, complete sections of altered crusts were encountered. Soft rocks are represented by clay and flysch and molasses. The altered crust ranges between 1.0 - 2.0 and 3.0 - 4.0 m, and in average strong rocks composed of sandy-clay, conglomerate–clay and clay-aleovrolitic-conglomerate the altered crust is 0.5-1.0-2.0m, while in limestones the altered crust does not exist at or it has a negligible thickness.

Erosion is related with the climatic conditions and the lithologic composition of rocks that compose the surveyed area. Erosion in the surveyed area is on the surface and linear.

Surface erosion entails large deposits in the Vjosa River basin area which is characterized by lack of flora, bared areas and a high intensity of erosion. In these areas this leads to leaks and slides. Linear erosion is best seen on the corroding activity of Vjosa and its branches in this field.

The movement of delluvial-alluvial covers towards the lower relief. Landslides and leaks are characteristic where terrigenous sediments are spread in the areas of the Vjosa River valley. This phenomenon is obvious in the altered root formations and on the delluvial-eluvial cover. Water currents during mass rains erode the delluvial-alluvial cover and the altered part of the root formation. In general they are developed on valley and hilly slopes with an over a 20° angle. In general slides have small dimensions (some meters long and wide). The moving mass is mainly composed of clay, subargille, sand containing pieces of rocks.

Rollings

Rolling in the surveyed area are on the slope of Vjosa valley and they are represented by boulders and massif blocks of limestones and sandstones which have different sizes with irregular shapes. This phenomenon takes place on the western side and on the eastern side of the dam in the areas where slopes fall sharply towards the valley.

Slides

The surveyed area is characterized by a hilly-mountainous relief with slope gradient ranging between 15-20, 30-40° and above 70° and in some places even more. In

addition, as we have underlined above, most of the morphological composition of the hill is generally composed of soft rocks, which, because of their inherent nature and physical-mechanic attributes, resulting from physical processes and phenomenon, have created the altered crust of these rocks which is 0.5-1.0 to 2.0 - 4.0 m thick. In addition, on the hill slopes there are delluvial – colluvial deposits composed of clay, subargille, boulders with a sandy and cancerous composition and the altered crust as a result of the water oversaturation. While in some strong formations, such as on limestones we do not have problems with slides.

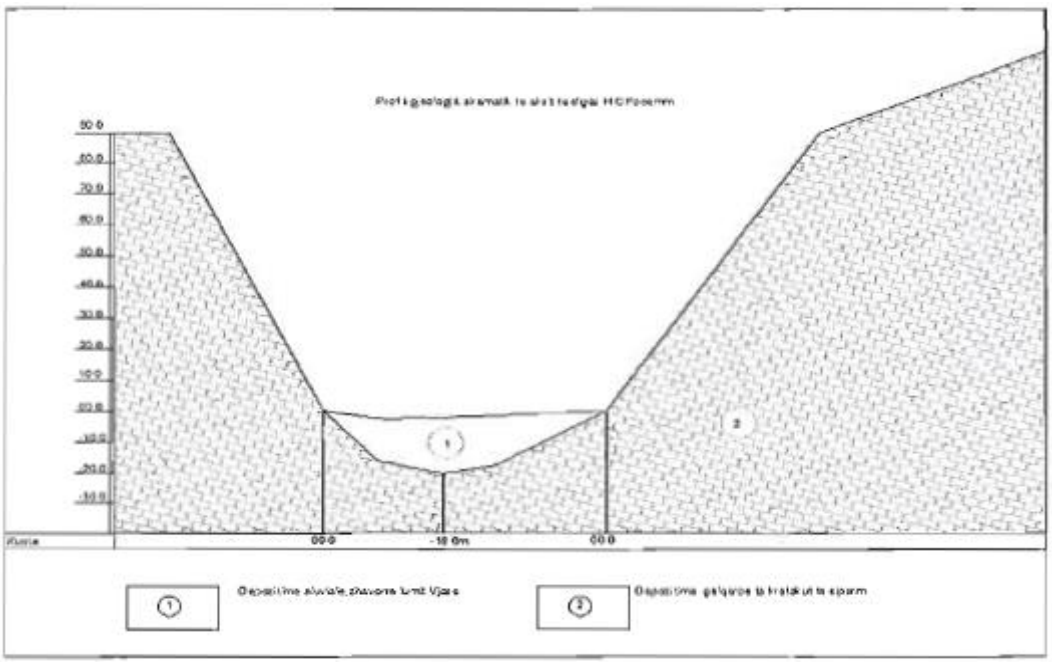
Alluvial deposits

Based on previous research data, the deposits from Karbunarë village to the axis of the HPP dam are 25 to 18 m thick. They are composed of gravels, boulders and sand with a calcareous composition.

4-1 The location scheme of the HPP-s

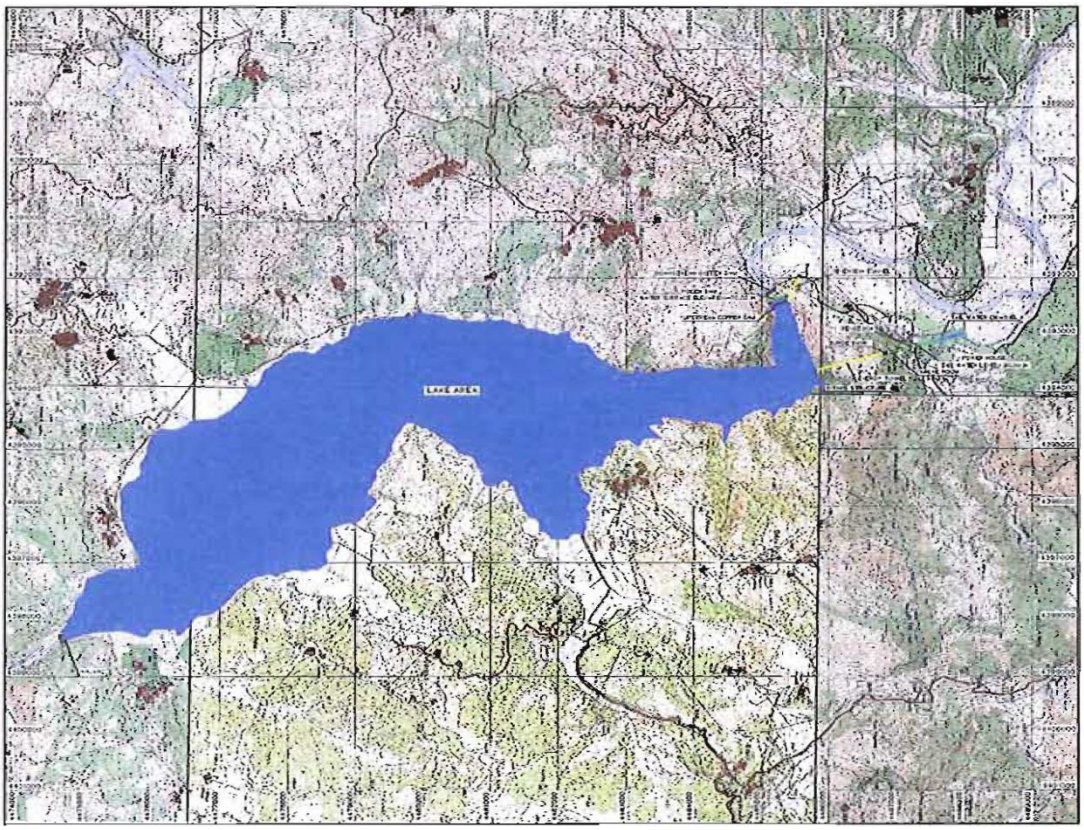
In the design prepared by the project group there is the option for the components of the works which enables a better use of the hydropower potential of the Vjosa River downstream. The presented option, represents a scheme of the hydropower work, composed of the Dam, the diversion tunnel, the tunnel of use.

Following we will present in a summarized form, the geological-engineering assessments for placing the works in the selected scheme option. This option uses the hydropower potential of Vjosa River downstream. In the selected option we are dealing separately with the geological-engendering conditions of the hydropower work.



The HPP Dam

This dam is thought to be 50 m high and about 150-200 m long, and its dike 10 m, embedded in alluvial formations. Referring to a geological-lithological schematic profile, the formations where the dam will be based on are deposits on the lower part composed of micritic and biomicritic limestones and a combination of rare flintstone up to phosphate limestones, while higher they are composed by the organogenic limestone package. The deposits of the lower cretaceous on surface intersections range between 200 and 500 m thick.



The approximate physical-chemical attributions for this layer

The physical-chemical attributions are:

Specific weight	y = 2.68gr/cm^3
Natural moisture	En=0.26%
Natural volume weight	Δ=2.6 lgr/cm^3
Cohesion	c=9T/m^3

Layer nr-1

It is composed of quaternary alluvial which are spread along the Vjosa River. They are a mixture of boulders, gravel and sand. Boulders and gravels are composed of cancerous and sandy rocks. Along the valley from Pocem to Kalivac this layer is approximately 20 m in Pocem and 7-10 in Kalivac.

The physical and mechanical characteristics of the prolluvium:

Volume weight in natural form	Δ = 2.01 gr/cm^3
Specific weight.	y = 2, 6-2, 65 gr/cm^3
Deformation module	E1-3= 300kg/cm^2
Internal friction angle	φ= 28-38°
Filtering coefficient	Kf=1.10·1 cm/sec

The diversion tunnel

It is about 250 m long. The formation that the deviation tunnel cuts into is Cr2. These deposits in the lower part are composed of micritic and biomicritic limestones and a combination of rare flints reaching the phosphate limestones, while higher they are composed by organogenic limestone package.

The power tunnel

It is about 1 km long. The formations that the power tunnel cuts into are Cr2 and Pg2. These deposits in the lower part are composed of micritic and biomicritic limestones and a combination of rare flints reaching the phosphate limestones, while higher they are composed by the organogenic limestone package. The Paleogene deposits are composed of the deposits.

Eocene Deposits (Pg2) Eocene deposits make normal contact with the Paleocene deposits. They compose the most peripheric part of the Kremenarë anticline structure.

Lithologically these deposits are composed of micritic and biomicritic limestones with interlays of flints in the lower part of the intersection and with biomicrtiric limestones in the upper part of the intersection. They are 130 m at the intersection

The physical-mechanical attributes are:

Specific weight	y = 268 gr/cm^3
Natural moisture	En=0.26%
Natural volume weight	Δ =2 .61gr/cm^3
Cohesion	c=9T/m

The approximate physical-mechanical attributes of this layer are:

The physical-mechanical attributes	y = 2.68 gr/cm^3
Specific weight Natural weight	En =0.26%
Natural volume weight	Δ =:2.61gr/cm^3
Cohesion	c = 9T/m^3

4-1 Seizmic Activity

The structurally complex environment of Albania is part of the central region of the Mediterranean. African and Eurasian plates collide here.

Especially Albania is at the crossroads of Adriatic micro plates and Eurasian plates and is characterized by an intense activity of micro-earthquakes and small and medium earthquakes and only rarely do large earthquakes happen.

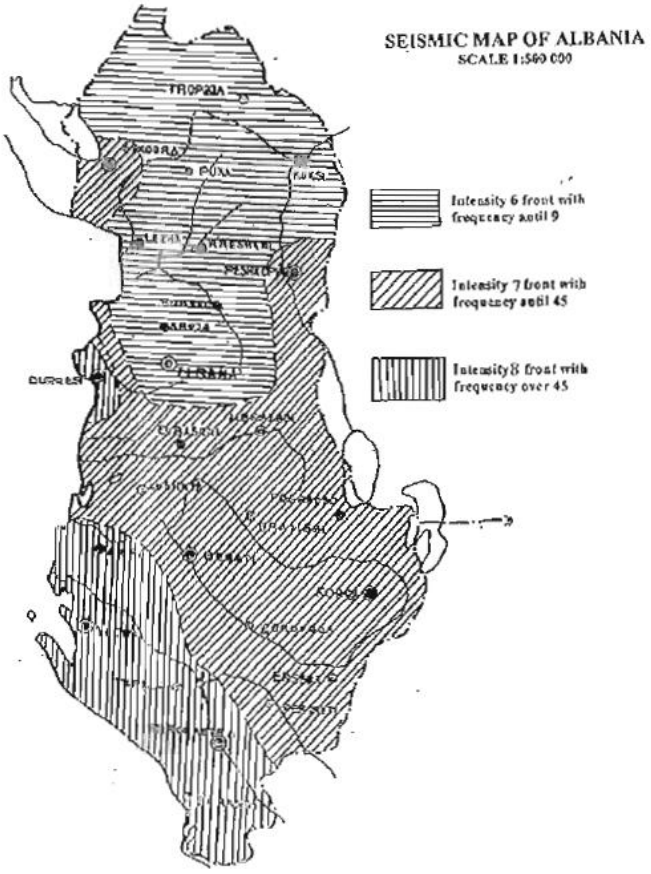
These are some historic data:

- The city of Durrës – was hit by strong earthquakes in (177 before Christ), 334, 506, 1273, 1896 AD. The earthquake on March 1273 destroyed entirely the city of 25.000 thousand inhabitants.
- The antique city of Apollonia – was hit by strong earthquakes in II and III Century before Christ.
- The ancient city of Buthrontum – It was hit by a strong earthquake in 1153 which destroyed it.
- The city of Vlora - it was hit by some strong earthquakes with a IX intensity scale (MSK - 1964) during the XIX century, 1883-1866. In the chronicle there are some data on the city of Vlora, which was hit in 1601 by strong earthquakes.
- The city of Berat was hit by strong earthquakes in March 1551 and December 1851.
- The city of Tepelena – It was hit by strong earthquakes in March 1701 and April 1868.
- The city of Elbasan – It was hit by strong earthquakes in 1380 and September 1842.
- The city of Konispol – it was hit by strong earthquakes in July 1823 and February 1872.
- The city of Himara – It was hit by strong earthquakes in October 1858 and August 1869 and July 1893.
- The city of Delvina – It was hit by strong earthquakes in June 1854 and January

1897.

- The city of SHkodra – It was hit by a strong earthquake in June 1855.
- The city of Shkodra - July l, l 905, M = 6.6, lo = IX scale (MSK - 64).
- The Ohrid Lake – February 8, 19 11, M = 6.7, lo == IX scale (MSK - 64).
- The city of Tepelena – November 26, 1920 M = 6.4, Io = I X scale (MSK - 64).
- The city of Durrës - December17, 1926, M = 6.2, lo = lX scale (MSK - 64).
- Llogara area –November 2 1, l 930, M = 6.0, on IX scale (MSK - 64).
- The city of Lushnja – September 1, 1959, M = 6.2, Io= VIII – IX scale (MSK - 64).
- The city of Korca – May 20, 1960 M = 6, 4, lo = IX Scale (MSK - 64).
- The region of Dibra – November 30, 1967 M = 6.6, lo= IX scale (MSK - 64).
- The border area Montenegro - Albania - 15 April, 1979, Ms= 6, 9, lo= IX scale (MSK – 64)

Based on historic and instrumental data, the Seismic Map of the country (with 1: 500.000 scale) was designed by Sul Starova (1980). This map shows expected intensities for the average conditions of the earth for the next 100 years, with a 70% probability norm.



The Seismic Map of Albania 1:500000

The seismic design parameters in the design area. The up-to-date and official documents related to the seismic design parameters of Albania are included in the Seismic Regionalization Map of Albania created by the Institute of seismology in Tirana "Design seismic Norm KPT - no 2 - 89", edited by the Institute of Seismology and the Ministry of Constructions in Tirana in 1989.

The Seismic Regionalization Map shows that the entire project area has been considered with a seismic intensity of scale VIII.

The geologic formation is composed of deposits of different lithologies (carbonate, flysches, molasses) dating from the average geological age (Triassic) to the new quaternary age.

The hydrogeological composition is complicated, and the greatest difficulty is presented by the karst carbonate aquifer of Kremenare.

It is possible that River Vjosa feds on Poçem source in the area there the source interrupts the aquifer.

The connection of Poçem source with the lake needs a special research, with the aim of measuring the parameters of this source.

The formation that will be used as the foundations of the HPP, are the calcareous deposits of the Upper Cretaceous and the alluvial deposits of Vjosa River. The formations have good physical-mechanic properties.

5 Description of social and economic characteristics of the area

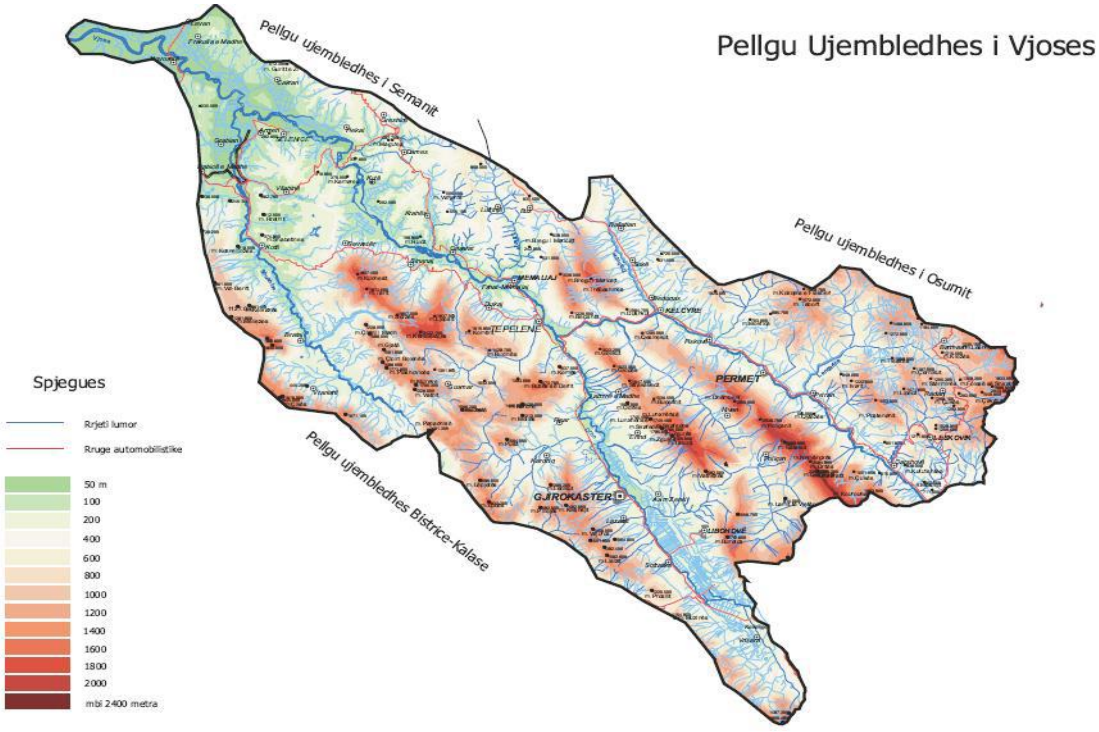
5.1 River and sport tourist landscape of Vjosa

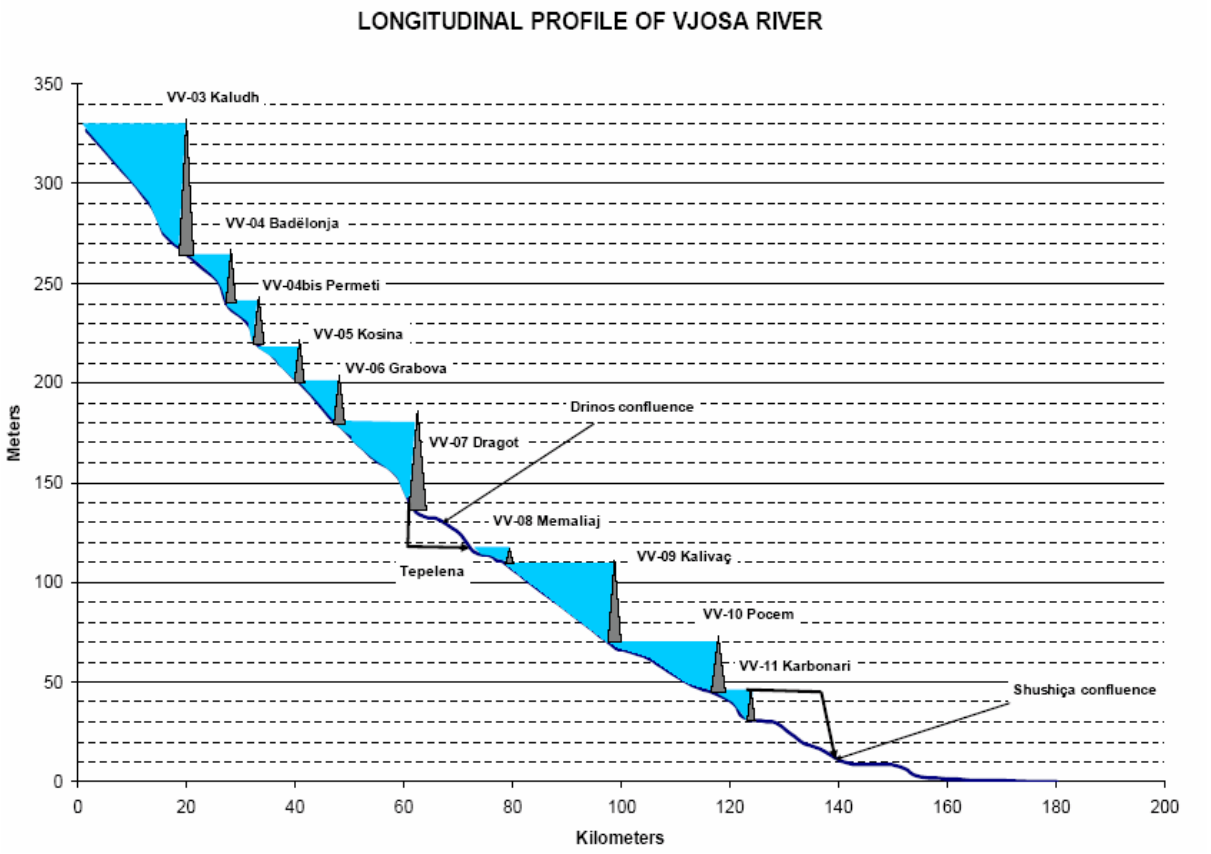
It consists of a place full of mountainous stream water discharged in Vjosa River, surrounded by a tree massif. It is a characteristic landscape of a natural combination of herbs, forest trees and hydro-hydrophile vegetation, located across water streams in Vjosa River bed, a habitat rich of all the types of vegetation. The length of this valley is 13 km and its width 1-1.5 km.

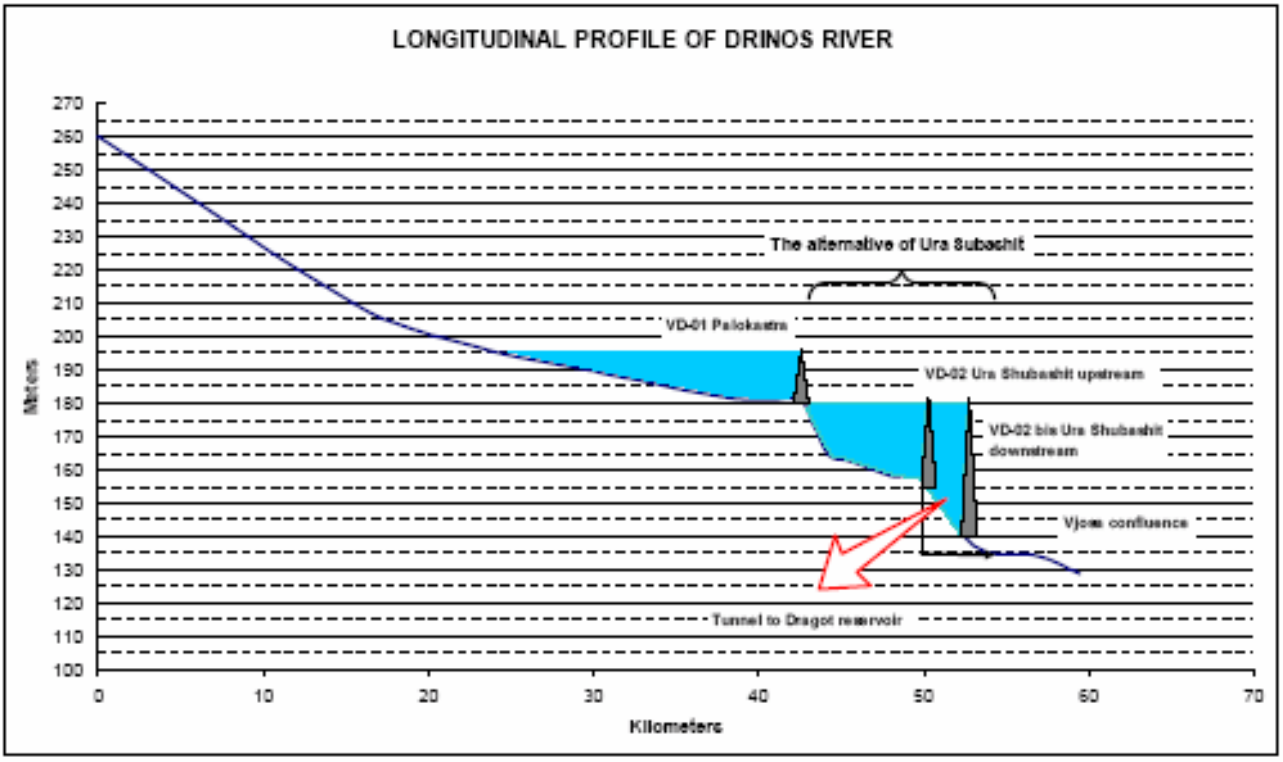
3 km far away from Këlcyra town are located Rrepet e Grykës, which are a tourist attraction. The forest landscape, harmonised with affluent water resources, has attraction, aesthetic and ecotourism values. Across the Këlcyra Gorge, you can find the Uji i Zi water stream, which remains sky-blue even when merging with Vjosa River waters. This landscape has irreplaceable environmental values; it is very relaxing and recreational to domestic and foreign visitors.

Vjosa River in Përmet

Vjosa Watershed







5.2 Population in Project area

The total population of the area affected by the HPP construction in Kutë Commune is 2433 people. Population division according to gender[9]

LGU	Total	Male	Female
Kutë	1977	1016	961

9 INSTAT – Population and Dwelling Census 2011, INSTAT 2013

There are 964 dwellings in this commune constructed as residences and 910 for other purposes. Population, inhabited dwellings and other dwellings are listed in the following table, according to municipalities/communes and dwellings types[10]:

LGU	Population	Buildings	Total dwellings	Common inhabited dwellings	Common uninhabited dwellings	Uncommon dwellings
Kutë	1977	910	964	513	451	0

5.3 Social and economic impacts

Some of the social impacts perceived for these kinds of projects will be assessed based on five main categories:

- Social-demographic characteristics
- Social services and community infrastructure
- Welfare, economy, lifestyle and employment
- Environment and life quality
- Social inclusion, social harmony and social equality

Dams have an incredible positive social impact[11], direct or indirect. Some of the positive impacts of dams for HPPs are given in the following table:

Impact	Nature of impact
Irrigation	A lot of benefits for the irrigation of the area near dam. This is a positive long-term impact.
Infrastructure-roads	New roads that will be constructed to have access to HPP and other roads that will be constructed and rehabilitated to have access in the whole area of the project will be considered as a positive impact which will improve interrelations and transportation.
Lifestyle	Lifestyle, which is mainly focused on agriculture, will be positively affected by changes in water level or micro-climate changes.
Welfare and local economy	Local economy may be positively affected by the project. Domestic products' costs and prices may decrease as a result of project's changes. This will enable a cheaper market and (as a result of constructed roads) access to the market in a wider area.
Employment and professional qualification	Employment is a positive impact of this kind of project, especially during the construction phase, in which numerous people from the area or beyond will be employed. The number will change, but the positive employment effect will remain during the operational dam phase, in which fewer people will be employed.
Houses and lands	Changes to land use and agricultural production may have an increasingly positive effect to houses and land prices.

10 INSTAT – Population and Dwelling Census 2011, INSTAT 2013
11 Cernea, Michael M., Social Impacts Risks in Hydropower Programs: Pre-emptive Planning and Counter-risk Measures, China 2004

Positive impacts will exceed in number and mass the negative impacts, if we are going to make a comparison. The same as in the cost-benefit analysis, it is necessary to make a discussion on who benefits from the positive impacts and who causes the negative ones.

Some of the negative impacts are summarised in the following table:

Impact	Nature of impact
Bridges	Floods from the lake may have a negative impact to bridges, which provide vital access to forest and pasture sources across the river, interrelations within villages and inhabited areas, as well as access to education, health and market.
Roads	Construction vehicles may have a negative impact to transport and road system, concerning the overuse.
Houses and lands	Changes to land use and agricultural production may have a negative impact to houses and land prices.
Lifestyle	Lifestyle, which is mainly focused on fertile soil/farming, may have a negative impact from the change to the water level or floods, or micro-climate changes.
Compulsory displacement of houses/residents	Some houses/residents may be obliged to move from the areas they live due to land changes, land easement from the project, or due to floods.

A summary of the expecting social impacts, based on phases they will occur and their importance, is given in the following table:

Impact	Phase	Importance without mitigation measures
New roads and interruption of access from traffic	Construction Operational	Very high
Loss of roads and passing, and waters (due to floods and overflows)	Operational	Very high
Compulsory displacement of residents and loss of houses and lands (due to floods)	Construction Operational	Very high
Damage to buildings due to erosion and land sliding	Operational	Very high
Inaccurate compensation for land loss	Construction Operational	Very high
Loss of crops and agricultural land (due to floods and overflows)	Operational	Very high
Impossibility to go to schools, health centres or other services (due to floods or overflows)	Operational	High
Potential road and construction accidents	Construction Operational	High
Marginalisation of excluded groups	Construction Operational	High
Health damage to people or animals due to the pollution of reservoir	Operational	High
Change to political situation (it may have positive impacts as well)	Construction Operational	High
Change to land and houses price (it may have positive impacts as well)	Construction Operational	High

Two of the negative impacts mentioned in the table above may have positive impacts as well.

The first one is related to changes to political situation, which create an increasing or decreasing tension as a result of this project. The second impact is related to the changes to land and houses price, which may have a positive impact as well, in case of an increase of prices. This will bring in many benefits to residents of this area.

The following table gives a summary of more positive impacts, classified based on phases they can occur:

Social impact	**Phase**
Economic benefits as a result of the influx of workers coming from other areas	Construction Operational
Skills acquisition	Construction Operational
Economic benefits from the workers' construction camp and their exploitation by local businesses	Construction
Improvement of commercial services, access to health centres and education as a result of new roads and the rehabilitation of the existing ones	Construction Operational
Regional economic growth	Construction Operational
Increase of access to project's region and surrounding villages	Construction Operational
Increase of daily tourism (visitors or project's controllers)	Construction Operational
Micro-climate changes, which improve life quality	Operational
Possibility to have access to regional markets and beyond in the area, improving the income	Construction Operational
Increase of direct and indirect employment	Construction Operational (less)
Environmental benefits deriving from the lake	Operational
Reduction of marginalisation of excluded groups due to the improved communication	Construction Operational
Change to political situation in the area	Construction Operational
Change to land and houses prices	Construction Operational
Return of young emigrants	Construction

Negative social impacts expected to occur only during the construction phase will be gradually vanished after this phase. Meanwhile, some of the expected negative social impacts of the project, which are foreseen to continue even during the operational phase, will be minimised after the application of mitigation measures. Furthermore, the importance of these undertaken mitigation measures is given in the following table:

Impact	Phase	Importance	Importance after mitigation measures
Loss of houses and properties for the owners obliged to be displaced	Construction Operational	Very high	Low
Damage to houses and land due to increase of erosion and land sliding	Construction Operational	Average	Low
Inaccurate compensation of land and houses' losses	Construction Operational	High	Moderate
Loss of crops and agricultural land as a result of floods	Construction Operational	High	Low
Road and construction accidents	Construction Operational	High	Low

5.4 Tourism

Due to its geographical features the area offers thrilling landscapes and natural and cultural heritage. It has some tourist attractions, which include thermal sources of Bënja and Kamencka Canyon. The tourist offer includes traditional cuisine, curative and health values, promenades and water sports. It has a high recreational potential for the sustainable development of ecotourism in the area. However, the actual offer of recreational activities, agro-tourism, promenades, alpinism, and water sports is limited in this area. Ecotourism is an activity, which is recently somehow developed at national and regional level. Traditional local houses and reception houses have been built using local materials, and they are used for renting purposes. Even though a few paths have been created respecting the Park habitat and characteristics, and guides and brochures are available to the Multifunctional Tourist Centre in Përmet, there is still a lack of information (signs and tables that provide guidance for paths), and the promotion of National Park remains at a low level. Waste cleaning activities have started under the frame of public awareness-raising and they are supported by local education institutions.

5.5 Agriculture and agricultural products

Agricultural structure is dominated by livestock and agricultural cultures that make 6.4% of the land. Agricultural productivity remains low because it is conditioned by a series of limitations related to small size farms, increase of the average age of farm operator,

limited access to loans, etc. Farmers' awareness-raising on best agricultural practices is low; investments in agriculture are limited; keeping costs at lower levels is a dominant strategy in agriculture and farming; cattle bred for vital living needs.
Even though agricultural production is increasing, the sector still fails to provide sufficient quantities of fresh products to the market, or to supply the agro-processing industry with raw materials. However, the area is well-known for its farming products, such as white goat cheese, white sheep cheese and yellow cheese, white goat butter, cow butter and cottage cheese. Lamb, goat meat and veal are typical for the area and they are traditionally served to local restaurants. This area is well-known for the production of fruits' products (jam and marmalade). These products are produced not only in small manufactories, but even from homemakers. Almond plums with rose essence are unique and are produced only in this area of Albania. Furthermore, the area is well-known for the production or red and white wine, and brandy is produced from mulberry, strawberry tree, blackberry, cornelian cherry and juniper. These drinks are produced in small cellars of the area and by the residents in a handcraft manner.

5.6 Handicraft products

Handicraft is another source of income for residents of this area. Handicrafts are mainly wood carving, and embroidery in folk motives. Coppersmiths are well-known for the production of brandy cask and other domestic copper objects. Stone carving and raising sheep for wool production is a well-known practice as well. Traditional handcrafted carpet, wool cloaks, bags, wool sacks are handicrafts produced in this area too. Homemakers' embroideries are used as souvenirs, which are highly appreciated by foreign visitors.

5.7 Protected areas

Impacts to the landscape and architecture heritage are assessed during the construction and exploitation. Those impacts may occur in those characteristic areas that directly or indirectly affected by the proposals. Direct impacts result in physical changes to landscape or architectural heritage features, while indirect impacts result in visual interventions that affect landscape features or the positioning of architectural heritage features. Thus, the impact to physical expansion will depend on basic characteristic assessment and visual expansion of proposed workings. Impacts will be temporary or permanent to Darsi River and Trepozisht and Lliar villages. Vjosa River in Çarshova floats to the southern part of the park.

Vjosa watershed is rich in ground waters. The left part differs from the right one, because aquifers in right part are poorer than those in the left. Thus, the area of Lumnica, Langarica and Çarshova is mainly composed of some water-repellent layers, low water-bearing capacity rocks. Accumulation in this side is flysch.
The protected area consists of some small areas characterised by karstic lime-stone conglomerates. The sulphurous thermal water sources of Benja, well-known for their curative values, are part of the hydrology network of the area.

Çarshova stream springs from a karstic place in Leskovik area, from Lipe Mountains in an altitude of 1490m above the sea level. It consists of two main branches, Çarshova and Postenani streams, which discharge their waters to Vjosa River in Çarshova village. The watershed of this area is 90.8 km2 and the average altitude is 1000 m above the sea level. Water regime is mainly pluvial. February is the month during which precipitation reaches the maximal values (2.9 m3/s). The maximal values of November and December correspond to the beginning of rainfalls. The driest months are July and August (0.230 m3/s), that correspond to rainfalls during March-April, when streams are supplied by melt snow. The discharges of this river are 1.49 m3/s. The Langarica River springs from the Kamenik Mountain (2,048 m above the sea level). It traverses through the Shala village, and the stream is named upon it, and then called upon its name, the Langarica and Sanjolla River when it merges with the Barmash stream.
In its right coast (433m above the sea level), Langarica merges with Gostivisht stream 1.5 km under the Kadiu bridge. Bënja stream discharges its water to Langarica River.ins its left coast, Langarica River transforms to Peshtanica and Koshere streams. Langarica River has a watershed area of F=299 km2, and its length of L=30 km. Its discharge is 5.21 m3, while the maximal discharge for square meter is nearly 0.51 m3/s/km2. The Lomnica River branch in the right coast of Vjosa River, springs in Frashëri area. Lomnica valley, in Kokojka Mountain, with an altitude of 1500 m above the sea level, and it ends to Piskova village, when in merges with Vjosa River. The main streams are Vlana and Stroponi, with a discharge in an altitude of 520m above the sea level, to Progri village. In its lower stream, Lomnica River, 410m above the sea level, merges with the turbulent stream. Until reaching Vjosa River, a series of streams discharge their waters to the right side of Lomnica River. Frashëri and Hotova streams discharge their weaters in the left side of it.

5.8 Cultural, historical and natural monuments

The Park consists of 11 Natural Monuments (Category III of Protected Areas in Albania), as follows (their rank is related to their location in map 1 above):

Bio monuments:

- Polmen Forest Massif (1)
- Frashëri's Tekke Chestnut (7)
- Frashëri's Kokojka Fir-Tree (9)
- Ropusha Forest (10)
- Radova Cypresses

Geo monuments:

- Lengarica Canyon (2): The canyon is 400m above the sea level. It is formed by the Crete limestones, from Lengarica stream and karst. This is 20-30 wide, 4km long and 80-100m deep.
- Shpella e Pëllumbave (3)
- Perëndia e Boroçkës
- Guri i Bletës Canyon (5): The canyon is 730m above the sea level. It is formed by karst and Lomnica stream; it is over 750m long, 100m wide and 100m deep.

- Kameniku Canyon (6): formed by karst, limestones and Kameniku stream; it is 80-10m wide, 500-600m long and 60-80m deep.
- Bokërrimat e Dangëllisë (8): dunes of Dangëllia in Frashër-Mica territory, 1000m above the sea level, have degraded because of natural factors and inappropriate use by human beings.

Hydro-monuments:

- Bënja thermal waters (4): 300m above the sea level, sources form small thermal water lakes of different sizes, which have a temperature of 25-30°C.

Some important cultural and historical buildings are found in the area, including:

- Church of Saint Mary in Ogdunan
- Church of Saint Mary in Kosina
- Ottoman Bridge Babo

6 Potential Impacts to the Environment from the Project Development

6.1 Identification of Potential Impacts to the Environment

The hydropower exploitation project in this region, as well as any other activity developed in the environment, is associated with consequences and positive and negative impacts that are part of that compromise our company has selected to develop. This assessment of potential environmental impacts of the proposed project is conducted based on factors related to the activity nature, used technology, manner of functioning, quantity of energy to be produced, raw materials used and generated waste, all of these under the physical, biological and socio-economic environment context. Identification of potential environmental impacts is analysed based on the following activity phases:

- The preparatory/installation/construction phase of engineering works,
- The functioning phase of hydropower plants and power productions.

Besides the general and common impacts, every phase of project implementation has some specific impacts as well, which depend on factors that cause them, such as nature of processes, etc.

It is important to understand the nature of these processes and their direct and indirect manifestation forms, to make objective assessments for the impacts of any activity using natural resources. Based on the nature of impacts, they can be classified into two large groups:

- Reversible impacts,
- Irreversible impacts.

Both types of impacts may be relatively minimised. Their main goal is maintaining the impact within the surface area of the object and enabling natural conditions to ensure the reactivation of complex nature processes and biodiversity regeneration.

The nature of the proposed activity dictates permanent impacts and effects, or remaining impacts in the nature of the newly created environment throughout its entirety. Some concrete mitigation measures are proposed for that.
However, mitigation measures have some impacts that still remain present. These impacts are as follows:

- Depending on land conditions faced with, it is possible to require water removal during the construction phase.
- Land may be polluted by discharges.
- Areas where soil is mild will need displacement and replacement, or engineering measures.
- Rough and eroded rocky areas may require monitoring and maintenance.
- Materials that can be used might be damaged.

6.1 Methodology for impacts' assessment

The methodology applied for the identification and assessment of the impact is planned to take into account the different nature of bio-physical, social-economic, and cultural impacts. The bio-physical impacts in this context are more widespread in the framework of setting borders and limits, as well as quantifying; while social-economic impacts are potentially more widespread and are the object of a qualitative approach. The less affected aspects of social-economic and cultural impacts have a risk dimension, which is present in their assessment, and which would not be suitable for bio-physical parameters.

For these reasons, the assessment methodology is divided to reflect the fact that the two main types of impacts are different. However, regarding the overview of these impacts' importance, the results of this division methodology are harmonised to draft a unified summary of environmental and social impact.

6.1.1 Assessment of environmental impacts of this project

In general, we would mention the following expected negative environmental impacts:

- Impact on Vjosa River water regime from the HPPs construction.
- Generation of a large quantity of rocky mass, as a result of opening channels, trenches of pipeline, dischargers and substructure for intake works, as well as HPP buildings.
- Generation of solid materials for expanding secondary roads in function of HPPs.
- Plant and vegetation cutting in areas during the preparation of areas where HPPs buildings, pipelines, channels, intake works will be built.
- Disturbance for birds which can crash each-other and they can die from being crashed to the electrical wires.
- Disturbance to water habitat because of the impact to river water regime, reduction of water flows, which will have a negative impact to conditions for water bodies that grow there (even though fishes are not present there).
- Loss of land habitat and its disturbance from the construction phases.
- Negative impacts from the ionized radiation of the electromagnetic field and current.
- Disturbance to soil layer compression and premises for erosion by the digging and construction works of HPPs components.

- Potential tree and wood cutting because of construction, which will b replaced by new saplings in other areas, as part of the rehabilitation plan.
- Generation of waste water (muddy) during the construction works of objects.
- Potential disturbance of aquatic habitat that grows in river waters during the construction and operational phase.
- Noises from machineries and construction activities in general, but even during the operational phase.
- Dust emission as a result of digging works.

6.2 Impacts to hydrology and surface waters

The measures for mitigating impacts of the proposed expansion on water streams, ecology and water quality, as well as fishing, are included to the drainage project. The non-karstic areas, where the road merges with the existing topography, the cutting point may be below the existing water level. This may result in decreasing water level near the cutting point and in dehydrating shallow wells. The best engineering practices are applied for the detailed project and the same will be followed during the monitoring of workings. In cases of extreme rainfalls, temporary floods may occur in places the road merges with fjords.

6.3 Biological impacts

The construction phase presents some small impacts, such as: temporary and permanent land servitude, temporary division of habitats and changes to the surface and ground hydrology, accumulation of materials to squares, pollution or accidental spill of fuels and other materials, dust accumulation (e.g. on leaves and land surface), disturbance of species from noises, vibrations and light, non-specific species disturbance (e.g. birds) because of the presence of workers and construction vehicles. The main impacts that can be seen during the exploitation phase are: permanent land servitude for the construction of new facilities, permanent changes to surface and ground hydrology, soil degradation because of spills from exploitation, loss of approaches to areas of visual values because of the interest in protecting their nature, reinstatement and/or creation of a new habitat.

6.4 Physical impacts

The presentation of different categories of impacts or issues is organised similar to the structure used in the basic descriptions of this report. Describing potential impacts in quantitative terms will be possible only for some categories of impacts. In the majority of cases, only the qualitative assessment of impacts' power and importance is possible.

The main impacts that can be faced during the construction phase include: temporary physical intervention with features or resources, changes to quality and quantity of ground water flows, unplanned or unforeseen disturbance of polluted soil, accidental or careless release of materials.

6.5 Natural resources

The main impacts that are related to the construction phase include: temporary change of water stream direction due to bridge constructions; temporary physical interaction with

features/resources, including direct damage to water habitats and water streams; changes to surface water quantities due to discharge of pollutants; modification of embankments against floods. The expected changes during the exploitation phase include: temporary changes to surface waters, and changes to streams may impact erosion and sediments accumulation, as well as water habitats; temporary physical interaction with features and resources, including direct loss or damage to water streams and water habitats; changes to the quality of surface waters due to pollution, which may result from accidental or routine emissions, such as maintenance, and from the permeation of pollutants to ground and surface waters due to the drainage of road track; permanent disturbance of discharges in cases of floods (barrier effect).

6.6 Impact to geology and geomorphology

- ***Impact from the construction***: A series of actions are planned for this project, such as: opening channels, extending new roads and digging works for the construction of the necessary infrastructure for this HPP in entirety. All the materials that will be used for the construction of respective HPPs will be transported to other premises where they will be accumulated and they are environment-friendly.
- ***Impact from operation and maintenance***: The geological environment will not be impacted during the operation and maintenance.
- ***Preventive measures***: The Company will use contemporary standards during the construction and exploitation phase of the HPP.

6.6.1 Generation of soil and solid materials

6.6.1.1 Construction phase

During the construction operations of this engineering work, a considerable amount of soil and rocky mass will be generated. This quantity of soil is qualified as construction waste, if needed to be accumulated or displaced from the area to another place.
The company implementing the project should clearly plan the manner of administering rocky masses to eliminate the possibility of being accumulated near coasts of rivers and streams. A good part of this mass can be reused during the construction of engineering works, but the accurate quantity can be calculated only after the finalisation of the implementation project and provision of information on works volumes. On the other hand, a part of that can be used for covering roads that are extended or that will be constructed (secondary local roads). But, the majority of these can be accumulated to a special place for which the investor has agreed upon with local authorities. Beside the possibility of reusing a part of these rocky masses, the company has taken all the respective measures for their accumulation in a special place, which after the finalisation of the project will be environmentally rehabilitated.

6.6.1.2 Solid waste management during the operational phase

The small modern hydropower plants use a lattice machine for solid materials, which removes solid materials from water in order to avoid aquatic plants or other waste, or the

damage of electrical-mechanical equipment, or that reduce hydraulic performance. Every year, a considerable quantity of waste (mainly plastic bags, bottles, cans, as well as leaves, branches and all the other objects that human beings spills to water) is removed from water.
We could not forget public interest in removing anthropogenic waste from water, which is carried out by HPPs' operators. This undoubtedly presents a positive impact to small hydropower plants, which shall be carefully taken into consideration, and the appropriate measures that support it shall be undertaken in order to reduce the economic burden for the small hydropower plant in this area.

6.6.2 Impact on land

Impact during the construction phase: For every work, the impact on land will be moderate to the maximum. Damage to land structure and its physical qualities will be present. Potential erosion during rainfalls will be present to construction areas. The area to be used as accumulation place for construction waste will be treeless and far away from planted or sensitive habitat areas. The supervisor/contractor will designate permanent accumulation places until their final removal from the accumulation place or until finding an opportunity to reuse them.
Preventive measures recommended to be applied: It is clear that during the construction phase some damage may result in land values, even though this area is not distinguished for agricultural activities. The humus part which will be removed during the construction of hydropower plant will be accumulated to a temporary accumulation place, in which this layer will be maintained to be used again (but it will be conserved according to the respective requirements, because long-term conservation of layers result in its infertility) during the reinstatement process of the area after the finalization of all the required construction works. This layer will be placed conform to the conditions set by the supervisor of works, in order to avoid damage to the surrounding landscape. In addition, in order to protect these accumulations from erosion or land sliding, it is important to compress them in such a way to avoid subsidence of these land layers. The measures to be undertaken during the rehabilitation phase include planting typical shrubberies for these sloping areas, which would decrease rains impact in these areas, as well as would reduce the washout effect in these areas compressed by rainfalls. Their planting will be regularly monitored by the company.

6.7 Impact on ground waters

Impact from the construction: The impact on ground water environment will be minimal as per the geomorphologic features of the area these construction works will take place, as well as regarding the measures applied during the construction and exploitation phases.

Impact from project physical structures: During these construction works, some of the structures would need substructure and digging works in order to implement the project. There is no risk about digging works reaching ground waters level and their positioning is above the sea level. They are mountainous and pre-mountainous areas, and their construction takes place in different premises and far from each-other.
Impact from operation and maintenance: Operation and maintenance processes will not have impacts on land.

Preventive measures: No risk of accidental spills of lubricants will be present during the construction process, because oils will be stored in an isolated and floored environment in order to avoid land pollution from drizzling. These oils will be carefully preserved and in compliance with technical conditions.

6.7.1 Impact on surface waters

During the construction phase: For every process, the impact on surface water environment will be moderate. The accumulation of solid waste generated during the construction phase will be in far distance from water sources. Solid waste will increase in surface waters, as well as in water bodies where they are discharged as a result of washout of the eroded land area (during rainfalls);

Regarding surface water parameters, which will be addressed in these HPPs and that can be polluted during the construction process, please refer to the EU legislation on water;

-Directive 91/414/EC of European Parliament and Council;
-Directive 98/8/EC of European Parliament and Council;
-Directive 2000/60/EC of European Parliament and Council establishing a framework for Community action in the field of water.

During the operational phase:
The most important environmental impacts that are identified during the exploitation phase are:

1. Due to the exploitation of Vjosa River waters, long-term impacts will be related to the river water regimen across the HPP area, or the so-called hydrological stress areas;
2. Impacts on aquatic ecosystems and species;
3. Deviation of natural river stream and reduction of its quantity.

Management of river water quantities to be exploited
The exploitation of river waters and sources feeding them may impact on water quantity needed for irrigation and ecological flows. This project foresees the necessary measures on prevention and minimisation of these impacts.
Calculation of ecological flows preservation – The general HPP scheme foresees maintaining water quantity of a permanent stream in the existing riverbed for ecological purposes. Maintaining ecological flows is very important for the protection of river natural life.
Hydrological and statistical value-based on methods
Ensuring ecological flows in stream bed in order to preserve natural ecosystem in the segment where HPP will be built. The analytic method for determining ecological flows according to hydrological data
The analytic method for determining ecological flows according to hydrological data is based on periodic statistical data analysis of the stream. The general empirical formula is embodied in easy and fast applications, or gained by the direct implementation of floor norms.
Certain countries use different applications regarding ecological flows. The following examples clearly present the application manner from different countries to determine this water stream.

- ***Preserving ecological flows***

Ecological flows in our country are mainly calculated (based on the most used practices) with minimal annual flows, which means Q_{365}. ($Q_{ecological} = 20\% Q_{minimal\ annual}$)

6.8 Impact on irrigation system

The project will have negative impacts on surface waters that can be used by the community for irrigation.

6.9 Impact on climate and air quality

Impact from construction: The fact that the impact from the construction of these hydropower plants will be at local level, air pollution (which means deterioration of air quality in the surrounding areas) will be present due to construction works.
During the construction phase, dust emission will result in different activities, such as cutting of trees and removal of top layer of soil, land digging and use of material excavated for embankment and construction of facilities. First of all, dust emission depends on weather conditions and activity level, as well as on type of operations. In addition, dust is also caused by the circulation of local vehicles and heavy construction vehicles when they go through the construction site during dry weather. The compliance of contractor with the Environmental Management Plan will reduce dust dispersion in air during normal construction activities. In general, the typical pollutants of road traffic (Cox, NOx, CxHy, small particles (PM10), heavy metals and dust) have an impact on areas near the actual roads. Diesel-powered cars, in particular, have a tendency to increase the level of particles, which are identified as an increasing serious risk for health. This is very problematic in countries that have a large number of cars using poor quality diesel. Law enforcement and improvement of the economy will minimise this impact, but it needs to be implemented at the right time, when both factors are integrated with each-other.

A part of areas across this project are mainly open, are rural area, small villages and dwellings, so there are no considerable problems of air pollution. However, since the project traverses some of the inhabited areas, cars' emissions have a small negative impact on these receptors during the construction phase.

The assessed impacts include:

- Dust and particle emission in air, which is related to destruction and construction works in the area;
- Every change to road traffic due to the increase of travelling time, which result from the temporary and permanent closure of roads;
- Every emission from cars' exhaust pipes due to the increase of road traffic during the exploitation phase.

6.10 Noise and vibrations

The road construction phase will have some negative impacts to dwellings and businesses near the road, due to the emission of noise from the traffic to the construction site and other activities. Application of barriers on noise and working hours, together with taking

of necessary measures on noise control will ensure that the noise impact will be at minimal levels.
The main impacts during construction include: noise and vibrations to the construction site, noise from road traffic because of road construction, noise as a result of changes to traffic flow. The main impacts during the exploitation phase include: noise and vibrations due to the use of new or rehabilitated road sections and corresponding supporting structures, if any; noise from traffic flow; and noise and vibrations from changes to service features and road traffic nature.

Noise limit levels for designated settings

Setting	**Critical effect to health**	**LAeq (dBA)**	**Basic hours**	**LAmax Fast (dB)**
Residences				
Outside the dwelling	Serious disturbance during the day and evening	55	16	-
	Moderate disturbance during the day and evening	50	16	-
Within the dwelling premises	Moderate conversation understanding and disturbance during the day and evening	35	16	-
Within the bedroom	Disturbance while sleeping	30	8	-
Outside the bedroom	Disturbance while sleeping, open windows (noise values coming from outside)	45	8	-
Institutions				
Classrooms, preschool institutions (inside)	Difficulties in understanding conversation, information and message transmission	35	During lesson	-
Sleeping rooms in kindergartens (inside)	Disturbance while sleeping	30	Sleeping time	-
School yard, game corners	Disturbance – (exterior sources)	55	Break	-
Hospitals, rooms (inside)	Disturbance while sleeping Disturbance while sleeping during the day and in the evening	30 30	8 1	40
Hospitals, training rooms (inside)	Impact on resting and relaxing	#1		
Social-economic activity areas				
Industrial and commercial areas, road traffic (outside and ...)	Hearing loss	70	24	110
Urban environment				
Public, exterior or ... environments	Hearing loss	85	1	110
Ceremonies, festivals and ...	Hearing loss (clients < 5 times/year)	100	1	110
Music using headphones	Hearing loss	85#4	4	110
Sounds – impulsive noise from ...	Hearing loss (adults) Hearing loss (children)	-	-	140#2 140#2
Public parks				
Natural parks and ... areas	Disturbance of tranquillity	#3		

Explanations:

LAeq (dBA) = Equivalent level measured in A scale
Basic hours = Time when measurement is performed
LAmax Fast (dBA) = Level measured in A scale in Fast way

#1 = As low as possible.
#2 = Maximal sound pressure (LAmax, fast) measured in 100 mm away from ear.
#3 = Calm exterior areas should be protected and the incoming/extra noise ratio with the natural sound noise should be kept as low as possible.
#4 = through the headphones, adapted by the free field values.

Impact from project physical structures: This process will have a long-term influence in the construction of HPPs, even though the impact will be kept al low level and localised. This impact will not be a cause of climate changes. We cannot talk about climate changes in this process only for a single area, because the impact is inconsiderable and the process does not impact it.

6.11 Impact on cultural and archaeological heritage

Preventive measures: The project for the construction of these HPPs is foreseen to apply all the measures to reduce as much as possible the negative environmental impacts. Digging works are predicted to be conducted by saturating the area in order to decrease the dust particles emission, as well as separation and elimination of all the solid waste created by the digging processes. Their accumulation far from water habitats or unsafe terrains (to avoid sliding) has an influence on reducing negative impacts.

The effective use of machineries, which use fuels, to decrease the unnecessary consumption of fuels, and as a result, reducing the quantity of CO2, SO2, NOx, HC, etc., emissions from fuel burn. Taking into account that the proposed area for the project development has a rural nature and is far away from industrial stress, air pollution as a result of operations for the construction of HPPs and road traffic should not exceed the norms of air quality for the inhabited areas, which are set forth in DCM No. 803, dated 04.12.2003 “On the norms of air quality”.

In Lapardha meander, the average fraction (nearly 3-5 cm diameter) makes up 60-70%. The thick fraction (above 5-6 cm) makes up 15-20%. The thin fraction (less than 3 cm) makes up 10%. The Skllap meander: The average fraction makes up 50-60%, the thick fraction nearly 15-20%; the thin fraction nearly 15%, and the very thin fraction 5-10%. The Drashovica Bridge: the average fraction dominates.

Environmental impacts across the transmission line

Impact	Phase	Ranking the impact level assessed before/after the mitigation measures	Potential impact
Erosion and land sliding	C	Very high (-) Medium (-)	Erosion caused by cutting of trees and construction activities
Soil compression	C	High (-) Medium (-)	Loss of soil integrity and increase of sliding
Pollution caused by waste/sub-products	C	High (-) Low (-)	Soil and water pollution from fuels/lubricants and chemical warehouse
Intervention to natural drainage	C	Medium (-) Low (-)	Change to sediment accumulation/drainage from construction activities within the river bed
Deterioration of vegetation and flora	C	Very high (-)Very high (-)	Cutting of all large trees and vegetation within the reservoir area
Accelerated spread of invasive plants	D	High (-) Medium (-)	Accumulation of plants within the reservoir area
Intervention to birds	D	High (-) Medium (-)	Bird collision and electrification (birds and bats with electrical wires)

- ***Mitigation and compensation***

Biological elements

Discussion on potential measures to avoid or compensate negative undesired impacts, which result from the development of hydropower project, is a main aspect for the Environmental and Social Impact Assessment (ESIA) process. The recommendations provided for the mitigation and compensation address different problems with different stakeholders regarding follow-up and implementation. Beside the constructor, these stakeholders consist of governmental and policy-making institutions, as well as political bodies. The potential initiatives can be classified as follows:

- Mitigation and compensation regarding the construction and operation of hydropower schemes
- Supplementary management initiative
- Improved integrated water resources management systems
- River protection

7 Environmental management plan and measures for the prevention and mitigation of impacts

Environmental Planning Administration

An essential part of EIA is the response to the results deriving from the planning and decision-making process. The most cost-effective manner for the application of mitigation measures is through planning them in the project. Once the important potential opposite effects were identified, they were included in the planning process, thus, when possible, they can be mitigated until the remaining effects are deemed "as low as reasonably practicable" (ALARP). The repetition phrase "predict-assess-mitigate" is the essence of ESIA and planning. This is applied in the identification of positive opportunities (predict-assess-achieve). The ALARP principle is mostly applicable in addressing individual effects. Determining what is "reasonably practicable" is something that the ESIA team cannot reach in isolation. Factors, such as safety, technical credibility, constructability and exploitability are all reflected to ALARP principle. Another factor is the cost. In ALARP determination of an influencing/mitigation measure, the cost-benefit proportion should be carefully considered.

7.1 Rehabilitation measures on mitigation of impacts

The main measures proposed in the Environmental Management Plan should address the optimal solutions for the minimization of negative impacts identified in the environment. These measures aim at:

- Rehabilitation of areas that will be used and affected by the construction activities.
- Accumulation of rocky solid mass that will result from construction works related to the opening of trenches, pipelines, channels and substructures of other hydropower works. A considerable part of it will be used as material in other construction works of this kind, included in the project, or for the construction of access roads. For the rest, the most appropriate accumulation place should be selected in cooperation with local authorities.
- Measures on erosion control, especially across the sedimentary basins.
- The protection of Ecological Flows, especially during the summer, is fundamental for the river water microorganisms, because larvaes are in an intensive growth period. This is related not only to the protection of the ecological parameters of the river, but even to the primary productivity, such as algae, which serve as the main food for other microorganisms (food chain).
- Construction of bypasses (for aquatic microorganisms).
- Protective measures for aquatic microorganisms (placement of nets not to hurt them, fish-friendly turbines).
- Application of environmental rules and protective measures against ionizing radiation.

<u>The following consists of some of the rehabilitation measures for HPPs</u>

- *Works for the accumulation of soil generated from digging works in HPPs*

The soil generated from different digging works will be accumulated in a specific place to be used again for the rehabilitation of dug fields. This mass of dug soil will be compressed and planted by shrubberies and local vegetation, in order to prevent the erosion phenomenon from rainfalls and waters. In addition, the vegetation that needs to be planted should be autochthonous (local plants, such as acacia, hornbeam and juniper), in order not to have a contrast with the characteristic landscape of the area. These works will be carried out at the end of each operational process, according to the respective working plan.

- *Accumulation of rocky chunks generated from the digging works in the HPP construction site*

The subject will place rocks of different dimensions in the bed near the intake in order to structure the construction site that will be empty, and then they will be covered by soil. In addition, these stones will serve as protective structures of the intake and gabion walls, which considerably reduce the large movement of materials from the place they are excavated from.

- *Accumulation of soil in empty construction sites*

The soil accumulated during the opening of constructions sites will be used for those parts of the field that do not interrupt HPP construction works, and in this concrete case the derivation channel will be covered in its length. The purpose of this is to level soil escarpments formed by excavations, which helps the channel lifecycle related to its eater temperature. In addition, these areas to be levelled will be planted by local plants such as acacia, hornbeam and juniper, which at the end of the project will not have a visual impact. The small streams will be created as drainage structures will small stones in order to minimise the influx of soil movement towards the river bed, decreasing the flow speed.

- *Works on soil bed maturity*

Before planting this site by local vegetation, it is important that the soil be maturated in order to provide more favourable conditions for planting saplings. Saplings should be planted in the presence of a forestry specialist and a specialist from the Regional Environmental Agency (REA) paying attention to the distance and varieties of saplings, such as acacia, hornbeam and juniper.

- *Planting saplings and shrubbery*

This process will take place after a period which coincides with enabling the appropriate conditions for planting saplings, such as oaks, acacia, hornbeam and juniper of a height of 3 to 3 metres. This will occur only after the movement of soil from excavations, finalisation of construction phase and re-levelling of final soil accumulations enabling

stabilisation of soil and planting of saplings before the period of rainfalls. Planting of saplings is recommended to take place at the end of autumn or in winter, during the deforestation period. These excavation and working volumes are carried out with the same material generated as a result of these excavations. In addition, the levelling of this quantity within the construction space of these HPPs is of primary importance in order to minimise as much as possible the movement of materials beyond these area, which will have an impact on total cost of HPPs and road maintenance.

Type of impact	**Measures for the mitigation of impact**	**Comments on measures efficiency**
Generation of soil and rocky masses as a result of the opening of trenches, channels, pipelines and substructures of hydropower plants	Accurate landmark of the area where works will be carried out Maximal use of existing roads; Use of rocky mass for the construction of HPPs and levelling and paving of access and rural roads; Accumulation of soil to be used in potential rehabilitation.	Impact remains within its natural limits. Minimisation of negative effect of generating solid waste through transforming them into raw materials for construction.
Emission of noise, gases, odour, vibration and dust	Periodic monitoring of machineries to make sure that the emission is within the allowed norms for gases, as well as noises. Preliminary work planning and its realization in as short time as possible. Transportation of waste and raw materials for construction by covered trucks. Periodic saturation by water (especially in dry periods) of workplace areas.	Keeping air quality within the normal limits. Reducing the impact duration.
Disturbance and partial compression of soil layer from the movement of transport vehicles	Movement and parking of machineries within specific areas. Designation of most appropriate places for this purpose.	Protection of soil layers from unnecessary and excessive damage.
Generation of soil and wood and shrubbery masses that result from the excavation works	Soil mass to be removed depends on the technique to be used, and its volume may be reduced. Use of soil mass for rehabilitation, because they are enriched in organic substances.	Minimization of the quantity of generated waste.

8 Monitoring

8.1 Environmental monitoring purposes

Monitoring on parameters that are of interest to us is conducted through continuous sufficient measurements to make possible the assessment of timely environmental situation and its changes.

The environmental monitoring purpose for HPPs' activity is to gather data which serve to assess whether the activity is in compliance with the respective environmental laws and standards, as well as to assess its environmental management performance under the frame of continuous improvement:

- ***The monitoring aims at:***

1. Assessing air pollution consequences to people;
2. Studying interactions between the pollutant substances and environmental objects (the contribution of each pollutant source is assessed separately);
3. Applying emergency procedures in areas of high level pollution;
4. Establishing an archive of environmental quality, and a database to be used in the future;
5. Guaranteeing the compatibility of an environmental object to be used for a certain purpose.

8.2 Monitoring objectives

- Assessment of pollutant substances' quantity emitted by a special source during a certain period;
- Efficiency assessment of equipment used to reduce pollution;
- Assessment whether emissions from a special source are in compliance with the respective norms or limitations.

Even though the environmental indicators to be monitored, are clearly set forth in DCM No. 103, dated 31.03.2002 "On environmental monitoring in the Republic of Albania", they should be adapted and be related to the activity.

Monitoring indicators

Monitoring element	Frequency	Responsible
Quantity of solid waste generated during the construction phase, and their accumulation and reuse	During construction phase	Exploiting company
Quantity of rocky material generated during the construction phase, their accumulation place and reuse	Construction phase	Exploiting company
Quantity of wood, trees that will be cut due to construction works	Construction phase	Exploiting company
Quantity of human activity waste generated from workers operating during the construction phase	Construction phase	Exploiting company
Quantity of water in the source place before being gathered or deviated to HPPs	Periodical	Exploiting company
Quantity of water in the source place after being gathered or deviated to HPPs (following the natural stream)	Periodical	Exploiting company
Quantity of water in the source place after the discharge by HPPs (following the natural stream)	Periodical	Exploiting company
Quantity of water to be used by HPPs, from each branch	Periodical	Exploiting company
Measurement of river water quantity to provide the level of ecological flows for each period	Periodically	Exploiting company
Physical-chemical water parameters used before being gathered and entered to the turbines Comprehensive analysis: physical parameters, temperature, pH, sludge and solid substances, etc.	Periodical	Exploiting company
Physical-chemical water parameters used after the discharge to river	Periodical	Exploiting company
Flora and fauna situation in the area near the HPPs' infrastructure and engineering works	Periodical	Exploiting company
Noise level near the HPP facilities	Periodical	Exploiting company
Quantity of fuels used during the construction phase until the finalisation of HPP construction	Periodically, every month	Exploiting company
Measurement of radiation level to objects located near the transmission lines	Periodically	Exploiting company
Quantity of river solid waste filtered by lattice machines before water reaches the turbines	Periodically	Exploiting company

The abovementioned monitoring indicators are a combination of indicators which objectively assess the environmental situation and the impact of hydropower works construction and operation.

The measurement and gathering of data on the abovementioned indicators will take place by applying the well-known and acceptable scientific methods and techniques. In order to preserve environmental data for the activity it is important to prepare and maintain a special register in which these data will be systematically inserted. The gathered data will be available to state institutions and other stakeholders to analyse them in order to assess the environmental performance of the activity and make the necessary improvements.

The investor welcomes any suggestion by REA concerning the addition of monitoring elements and used methodology.

9. Conclusions

It is worth mentioning that the projects on producing electricity by HPPs, which use renewable sources, are included in the today's list of recommendations and priorities of environmental policies at global level, because the energy produced in that way is in other words known as clean energy. Based on the analysis made, it results that positive impacts are far more numerous than the negative ones. The construction and operation of these HPPs would be a great help in solving the problem of electricity supply in the area, making possible the production of pure energy from renewable sources.

All in all, we reach the following conclusions:

1. The study conducted in order to meet the requirements set forth by an EIA has followed the national and international standards. The EIA set forth the main conditions of the construction field and assesses the HPP impact in Vjosa River. The positive and negative impacts of the proposed project are identified and calculated to as a reasonable scale as possible.
2. During its drafting, the project that is presented has maximally taken into account the compliance with the environmental criteria.
3. The project is in full compliance with the environmental legislation.
4. The project does not affect protected areas and natural monuments.
5. All the technical possibilities to take measures on the protection of environment and the biodiversity of the river and other streams that will be to be exploited are foreseen.
6. The solid waste generated by the project is foreseen to be managed in strict compliance with the time criteria and according to a plan conform to the concrete country conditions.
7. Construction works will take place based on the use of advanced technology equipment of the field, and as such, they ensure work safety and minimal impact to the surrounding environment.

8. The whole project is in full compliance with the best international standards, and this increases the safety work level during the operation process.