CONTROVERSY OVER THE ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT OF THE KHUDONI HYDRO POWER PLANT

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Abstract

The Republic of Georgia has vast underexploited water resources. The Khudoni Hydro Power Plant (HPP) project is one of the most controversial projects in the history of Georgia, and has been under discussion for more than 30 years now. The project’s proponents, which include the Government of Georgia (GoG), the Ministry of Energy, the investing company and a number of energy experts, claim it will meaningfully contribute to the country’s economic development, energy independence, and trade balance. However, the project also has numerous opponents including the Ministry of the Environment and Natural Resources, non-governmental organizations, environmentalists, student groups and local people who are successfully halting the implementation process. Overall, this latter group is dissatisfied with what they describe as inappropriate standards of the Environmental and Social Impact Assessment (ESIA), inadequate impact mitigation plans and inaccurate estimation of costs.

This thesis aims to understand how the existing ESIA could be modified to enable more realistic cost-benefit analysis and possibly resolve conflicts. The first part will discuss historic and contemporary energy development in Georgia, which is important for understanding why the country strives so hard to implement this project. Then, the paper will go directly into the history of Khudoni HPP and its associated conflicts. This thesis will analyze the existing ESIA, and based on historical examples of other controversial dams and the peculiarities of the region, will suggest how the ESIA can be improved, what further research has to be done and what kind of impact mitigations should be incorporated. This should enable a well-informed and fact-based conversation among the opposing parties over the Khudoni HPP.
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ABBREVIATIONS

ADB - Asian Development Bank
AFOLU - Agriculture, Forestry, and Other Land Use
AP – Affected People
APLR - Association for Protection of Landowners Rights
BOO - Build-Own-Operate
CENN - Caucasus Environmental NGO Network
CPS - Cubic Feet per Second
CHM - Cultural Heritage Management
CP - Cultural Property
DO - Dissolved Oxygen
EBRD - European Bank for Reconstruction and Development
EIA - Environmental Impact Assessment
EIO-LCA - Economic Input-Output Life Cycle Assessment
ESIA - Environmental and Social Impact Assessment
FSL - Full Supply Level
GDP - Gross Domestic Product
GEL – Georgian Lari
GHG - Greenhouse Gas
GoG – Government of Georgia
HPP – Hydropower Plant
ICOLD - International Commission on Large Dams
IHM - Institute of Hydrometeorology
IPCC - Intergovernmental Panel on Climate Change
KW - Kilowatts
KWh – kilowatts per hour
LCA – Life cycle analysis
NGO – Nongovernmental Organization
O&M - Operation and Maintenance
OP - Operational Policy
PGA - Peak Ground Accelerations
PHABSIM - Physical Habitat Simulation System
PPM - Parts Per Million
RAP - Resettlement Action Plan
RPF - Resettlement Policy Framework
SPV - Special Purpose Vehicle
TN - Total Nitrogen
TP - Total Phosphorus
WCD - World Commission on Dams
I. Introduction

In the economic development of each country, the choice of its energy development strategy is of crucial importance. This issue is a particularly critical one for Georgia, as the nation is not rich with oil and gas reserves. In 2011, 75% of the supplied energy was imported, out of which 43% was natural gas and 29% oil (Gvilava 2014:10). Being so highly dependent on foreign energy supply is not favorable for any country, as it creates uncertainty and financial burden for the country. Although Georgia has scarce mineral resources, there is a vast supply of water which, if utilized fully can possibly change the status of the country from being energy-dependent or energy-importer to being energy-independent and even energy-exporter. Although the GoG is willing to make this change happen, the path is full of challenges, controversies and conflicts, as with any path that involves major change. Social and environmental problems arise due to a number of factors, including the lack of experience of the country in the energy generation industry, poor environmental standards and exclusive and non-transparent decision making processes. Whether it is reasonable and socially beneficial to start building huge hydropower dams in Georgia is a debatable question and worth examining in depth.

While the benefits the project is intended to bring to the economic development of the country are substantial, the issue of careful estimation of its economic, social and environmental costs and negative externalities has raised concerns among the general public. Standards based on which the ESIA was conducted do not correspond to international good practice, and many disadvantages of the project seem to be significantly downplayed or completely omitted from the analysis in favor of the developers. Ultimately, the document itself serves as just another formality, rather than as a key to informed decision-making.
The Khudoni HPP could possibly be one of the most successful development projects in the history of Georgia, but only if the system of decision making undergoes significant changes, includes all affected parties and carefully considers disadvantages along with the alternatives to the project.

II. Historical & Contemporary Energy Development in Georgia

1. Historical Energy Development

Georgia imports 98% of its primary energy requirements in the form of natural gas and oil products. The country has 15 oilfields with total reserves of about 8.3 million tons, while annual oil demand of the country is around 900 thousand tons, which means that if all demand was met by domestic production, the proven reserves would be exhausted in less than 10 years (Gvilava 2010:8). In the past oil was produced in small quantities only in the areas with surface oil leakage (pits). In the second half of the 19th century oil production was initiated at shallow drilled wells in some regions with up to 2000 tons of annual production. The scale of production remained low because of lack of geological understanding of the oil fields and the use of unprofessional methods. During the 1970s several prolific oil fields were discovered near the capital city Tbilisi, considerably increasing oil production after they became operational. The maximum oil output occurred from 1980-1983. Since that period oil production has dramatically decreased; today, with no new discoveries, the annual production at the already existing fields has reduced to between 60-140 tons ("Ministry of Energy of Georgia" 2014).

2. Contemporary Energy Development & Status

Georgia's power grid was previously part of an integrated South Caucasus network. After the collapse of the Soviet Union, Georgia experienced a severe energy crisis. Before 2006,
Georgia heavily relied on Russia for energy imports. That year, Georgia switched to Azerbaijani gas after Gazprom, the largest extractor of natural gas in the world and one of the world's largest companies based in Russia, increased prices and experienced a series of blasts hindering gas shipments from Russia. Lack of heating resulted in the coldest winter in the history of Georgia. Currently, 10% of the country’s gas needs are still satisfied by Russian gas. (Belkin 2013:9-14).

Although Georgia has no proven large-scale oil and gas resources or production, it can generate revenues from oil and gas transit because of its geo-strategic location on the Silk Road, the quickest route linking Europe with Asia. Specifically, Georgia has rights to 5% of the annual gas flow through the pipelines running through its country, and can purchase a further 0.5 billion cubic meters of gas a year at a discounted price (Gvilava 2010:9-20).

3. Potential of Renewable Energy

Because it relies on imports for virtually all oil and natural gas, Georgia's economy is very vulnerable to global energy price movements. Plus, its reliance on highly variable annual flow in the pipelines to obtain the energy in the form of a transit fee, makes Georgia’s energy situation even more unstable. In order to achieve energy independence, the Georgian government decided to utilize the wind and solar power, geothermal waters, bio-gas and various environmentally clean energy sources for electricity generation and other uses ("Independent Statistics and Analysis of Georgia" 2014).

The GoG has approved the “Renewable Energy 2008” state program which includes the list of potential greenfield projects and guidelines for new renewable energy sources development. The total primary energy supply in 2008 was 35 billion kilowatts per hour (KWh) of which 36.1% was natural gas, 28.6% oil, 20.5% hydro power, 12.6% combustible renewable
and waste (including biomass and biogas), 1.8% coal and peat, and 0.5% geothermal, solar and wind.

Georgia’s wind potential is evaluated at 4 billion KWh, which, if fully used would increase total primary energy supply by 3.9 billion and comprise up to 10%. At this point, feasibility studies are being prepared to identify prospective wind farms. ("Ministry of Energy of Georgia" 2014).

Because of its geographical location, the effective radiation of the Sun is considerably high in Georgia. Solar transformers are believed to be efficient and reasonable to be used only in the mountainous, non-compact settlements and remote places ("Ministry of Energy of Georgia").

4. **Hydro Development**

Among the natural riches of Georgia, water resources stand out. There are 26,000 rivers in the country, with total length of approximately 60,000 km. Of these, about 300 rivers are significant in terms of energy production with total annual potential capacity of 15 million KW, and the average annual production of 50 billion KWh. However, Georgia’s rivers are characterized by distinct seasonality, meaning that these resources can be utilized only by building hydro power stations with regulating water reservoirs.

Georgia’s Ministry of Energy has announced plans to rehabilitate older hydropower generators and build new ones in an effort to increase electricity generation. These projects are funded in part by foreign investors, such as the European Bank for Reconstruction and Development (EBRD).

Over time, Georgia has become self sufficient in electricity due to hydro plants. However, most of electricity production comes in summer when the demand is low, while in
winter the hydro potential is still insufficient to meet the demand without the need of further imports.

The situation has even worsened, since the chain of Enguri/Vardnili hydro power plants, a key contributor to Georgia’s electricity generation, became unreliable after Georgian-Russian conflict. The power house and switchyard are located on the territory occupied by Russia, while the dam and reservoir are on the territory controlled by Georgian state. This can result in serious energy problem in case of political escalation with Russia, which already occupies 20% of Georgian territory.

While the majority of the energy produced in Georgia already comes from hydro sources, the country has one of the largest undeveloped hydro power potentials in the world: about 32 billion KW per year, which is considerably higher than that of the world’s biggest hydro power producers, Norway and Canada. ("Ministry of Energy of Georgia" 2014).

III. Khudoni Hydropower Plant Project & its Associated Conflicts

1. History of Khudoni HPP

The Khudoni Hydropower Plant (HPP) project has a long history. The project is a part of the general plan of construction of hydropower plants on the Enguri River, in the Samegrelo-Zemo Svaneti region of Georgia. The United Power System of the Caucasus Region and the Energy Institute of the Academy of Sciences of Georgia worked on the possible use of Enguri’s energy potential. In 1920s the Soviet Union’s Research Design Institute carried out the final review and approval. This approved plan envisaged construction of Enguri Hydro Power Plant and Vardnili Cascade Development. Accordingly 5 hydroelectric projects were constructed (Picture 1) (Trans Electrica Limited 1-15).
The construction of the first hydro station Inguri on the Enguri started in 1961. Despite initial plans to construct the highest arch dam in the world (300 meters), the construction site and the length of the arch was changed (to 270 meters high), due in part to problems resulting from geological formations along the banks of the Enguri River (Trans Electrca Limited 1-15).

*Picture 1. The Enguri River and the Inguri Dam*
The first idea of Khudoni HPP on the Enguri River was approved on August 31, 1978 by USSR Ministry of Energy. The initial project, involved construction of a 200 meters high of arch concrete dam and an underground power station. With the initiation of construction of the Khudoni Dam in 1979, came protests from local populations, civil society groups and the national movement who worried about unsatisfactory geological and seismic conditions surrounding the area as well as the threat of flooding. Finally, the dissolution of the Soviet Union led to the termination of construction in June 1989. In spite of decree\textsuperscript{1} requests from the Academy of Science to prepare a list of the measures that would support restoration of ecological balance in Khudoni, the Georgian Ministry of Energy and Fuel responded that ecological restoration would be impossible (Trans Electrica Limited 1-15).

In the period 1992 to 2003, the GoG several times attributed the country’s energy crisis to the halting of the Khudoni construction. Following the 2003 Rose Revolution, the new Georgian government started to actively seek investments and at the same time acquire public support for the Khudoni project.

Afterwards, the project was reviewed twice – first in 2005 by Core International Inc., as a part of advisory help for the Ministry of Energy in Georgia, and a second time in 2007, by Stucky Colenco JV Company, which was initiated and financed by the World Bank. The World Bank is currently helping the Georgian Government by financing consultants to prepare a feasibility study for Khudoni. The World Bank approved a technical assistance grant of USD 5 million for the Georgian government, of which around USD 1.75-2.35 million was intended for preparatory works, including preliminary and feasibility studies, technical studies, and an

\footnote{\textsuperscript{1} an official order given by a person with power, by a government or by a court of law}
The GoG announced a 30 day period during which companies interested in implementing the Khudoni project had to provide a project plan that would include the minimum price at which they would sell the generated energy in Georgia. The winning company would be obliged to sell 20% of generated energy in Georgia, while the rest could be exported according to their own arrangements. Trans Electrica Ltd. won on the basis of 5.86 cents per KWh for internal sales.

Trans Electrica Ltd. is a project company with a clear focus on planning, investigation, execution, operation and maintenance of Hydro-electric power projects. The company was established as Special Purpose Vehicle (SPV) by the Continental Construction Corporation based in New Delhi, India. SPV is a legal entity, a limited company of some type, created to fulfill narrow, specific or temporary objectives in this case created for owning and implementing Khudoni HPP in Georgia with further interest of expanding in the Hydro Power sector in the region and also European countries (Trans Electrica Limited 1-15).

In December 2009, Trans Electrica Ltd. and the Georgian Ministry of Energy signed a memorandum of understanding regarding the right to build, own and operate Khudoni. The project implementation agreement was signed on April 28, 2011. According to the agreement, energy produced during winter months has to be reserved for use in Georgia, while during other seasons energy can be sold freely elsewhere. The project involves construction of arch concrete dam 200.5 meters high and 522 meters long, with a reservoir of 528 hectares and installed capacity of 702 thousand KW. The total budget of the project is estimated at 1.2 billion USD and the forecasted annual energy production is 1,500 million KWh, which would increase country’s energy production by 20% (Trans Electrica Limited 1-15).
2. Description of the Svaneti region and project site

The Khudoni HPP is situated in Svaneti, one of the most beautiful and picturesque alpine regions of Georgia, situated on the southern slope of the main Caucasian range (Picture 2). In addition to its natural setting, Svaneti is home to a long history of celebrated traditions and culture. Notably, the Upper Svaneti region is dominated by medieval-type villages, tower-houses and famous Svanetian towers, erected mainly in the 9th-12th centuries. There are around one hundred Georgian Orthodox churches, with unique frescoes paintings and icons, representing the unique samples of Georgian culture. The Svans, a group of ethnic Georgians inhabiting Zemo Svaneti, are unique in their traditional life style. Ancient customs still continue as an important part of everyday life; this includes a mixture of paganism and Christianity. The pace of life is still different here from that of the modern world.
The Khudoni dam will be located inside the Khaishi village (Map 1) in Zemo Svaneti (Upper Svaneti), which is the highest inhabited area in Europe. The landscape of Svaneti is dominated by mountains that are separated by deep gorges. The region lies 1,800 meters (5,904 ft.) above sea level and is mostly covered by mixed and coniferous forests made up of tree species such as spruce, fir, beech, oak, and hornbeam.
3. Conflicts

3.1 Arguments for the project

The Khudoni HPP has generated conflicts in many different arenas. The Ministry of Energy defends the project on the basis of its economic profitability. Proponents of the project have put forth several arguments for the project that are connected to economic growth, energy independence, and trade balance, all of which are proffered to show the absolute necessity of the project implementation.

The Enguri River is estimated to have an approximate power production potential of 10.3 billion KW. Out of this potential, the operation of the Enguri and Vardnili hydro power plants has already developed 5.5 billion KW. Not going forward with the Khudoni project would be a waste of the remaining unutilized but economically feasible hydroelectric potential. During

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All information in this section was obtained from personal interviews, unless otherwise noted.
winter months, when electricity demand is the highest, there is a power shortage from hydropower plants in Georgia because of low river inflows. With the construction of Khudoni, this shortage is believed to be satisfied. During summer months, excess energy production is expected to be exported to Turkey. Thus, Khudoni Hydropower Plant is Georgia’s priority and a way to energy independence.

According to the Deputy Energy Minister Irakli Khmaladze, Georgia must currently purchase 700 million KWh of electricity from the Russian Federation. The cost of this imported electricity is 6.64 US cents per KWh. In contrast, the electricity generated by Khudoni would cost 5.64 cents per KWh for 10 years after the Khudoni HPP starts operating. The Ministry of Energy estimates that the 50 million USD that Georgia currently pays for the energy from Russia would remain in the budget, saving half a billion USD over a period of 10 years.

Khmaladze also says that over the past six or seven years, electricity demand has increased by 5%-10%, while the cost of electricity has risen by 7%-10%. According to forecasts of the Energy Ministry, as the country’s economy continues to grow, so will the electricity consumption, leading to increased energy deficit while the price of imported electricity also continues to grow. By 2018, the shortage is expected to reach 1 billion kWh, while the price of imports is expected to rise by 8 or 10 cents.

Since 2011, just from the property tax paid by Trans Electrica Ltd., Svaneti has been receiving 600,000 USD annually. The taxes will further increase after the hydro power plant becomes operative. During the operation of the Khudoni HPP, the company has agreed to pay 20 million Georgian Lari (GEL\(^3\)) in annual profit tax, 20 million GEL in income tax, 19 million GEL for the use of the power transmission line to export energy to Turkey, and 4.5 million GEL

\(^3\) 1 GEL = 0.57 USD as of 04/13/2015
to about 350 people who will work on constructions. Consequently, country's Gross Domestic Product (GDP) is estimated to increase by about 1.1%.

In addition to economic development, Khudoni HPP has the potential to change the country’s status from net energy importer to the net energy exporter. Today, with Georgia’s imports being 4 times more than its exports, the country is running a major trade deficit, which would go down by 8% annually if the Khudoni Dam is constructed. In addition to having large positive economic effects, according to the Ministry of Energy, running a trade surplus, will create a stronger name for Georgia on international arena.

3.2 Conflicts over profitability and loss of property

All the arguments of the project’s proponents have met with counterarguments and skepticism from the side of its opponents who believe that the construction of the Khudoni Dam – or any other large dam – does not represent effective investment for the Georgian power sector. Rather, these opponents believe it would lead the country’s development along an unsustainable path. The major difficulty of the Ministry of Energy’s efforts to persuade the public and decision-makers on the economic profitability of the Khudoni HPP has been the lack of a thorough cost-benefit analysis of the project. Decision-makers keep talking about numbers, costs and profits, people read about possible outcomes in the newspapers, independent parties make prognosis, but in reality there is no official, publicly accessible, neutral and unbiased cost benefit analysis that would serve as a strong basis for understanding the true outcomes of the mega-dam project.

The main concern is that the desire to construct huge HPPs results from the desire to expand energy exports, rather than from the desire to satisfy domestic demand. While politicians and decision-makers present the new hydro project as if simultaneously providing export
capability as well as inexpensive internal electricity, skeptics believe that it cannot simultaneously do both. If Georgia were to export huge amounts of electricity, the majority of the population, at least 50%, would continue to live in poverty unable to pay for the electricity. Furthermore, once Georgia becomes net energy exporter, critiques believe, the exporting company would favor artificially high domestic energy prices that would generate more revenues for exporters but make energy even more costly for local populations. In sum, opponents believe that decision makers seek to turn Georgia into a large power-exporting country without addressing existing deficiencies at home.

The already acute debates over whether Georgian lands should actively be sold to foreign investors, was further intensified by the Khudoni HPP project. The GoG transferred 1,500 hectares of land that did not officially belong to anyone to the investor company for a symbolic USD 1. The “gifting” of lands generated a great deal of controversy. In January 2014, Student groups, in collaboration with environmentalists and non-governmental organizations, organized several peaceful protests against the act of giving away lands to foreign investors. Students marched around the capital city of Georgia and gathered in front of the Ministry of Energy with posters saying “Save Svaneti,” “STOP giving away Georgia,” “OUR lands are for OUR people,” etc. The strong opposition and protests were also common amongst the local people. Even though the state acted correctly in terms of law, the local population claimed that the land (pastures, arable land, etc.) belonged to them and that the state illegally sold them.

The issue of who owns the dam was also addressed by the First Deputy Minister of the Environment, Nino Sharashenidze: “There is no satisfying argument for why we should be willing to give up our own land and resource, and then buy our energy from foreign investors.
Theoretically, our imports will go down, and we will gain more ‘energy independence,’ but in reality, we just found another company to buy the energy from.”

There is also an important risk connected with the location of the Khudoni Dam. Khudoni is located just above the Enguri Dam, which since the 1993 Georgia-Abkhazia conflict has been under Georgian-Abkhaz joint management. Since August 2008, Russian troops partially control the Dam. During the August 2008 war, there was a risk of terrorist attacks that would damage the Enguri Dam, while in September there were concerns raised about safe operation of the Dam by Georgian staff. Adding another dam in a conflict zone, which is already under risk, did not seem reasonable to much of the public.

3.3 Social conflicts

Threatened with displacement and the flooding of their villages, the Svani people believe their cultural identity is under risk of destruction as well. Khudoni construction will flood the village of Khaishi – the ‘Doors of Svanetia,’ a center of Upper Svaneti region that unites a number of villages and 500 families. The school, hospital and all other important facilities for all surrounding villages are located in Khaishi, and thus its flooding will automatically translate into disrupted livelihoods and even displacement of neighboring villages. In total, around 1,500 people will be displaced, equivalent to about 10% of the Svaneti region’s 8,000-10,000 inhabitants. In addition, the already isolated Upper Svaneti region will become even harder to reach since dam construction will increase the road distance from Khaishi to Mestia, the administrative center of the entire Svaneti, by more than 10 kilometers.

Khaishi villagers are extremely fearful of Khudoni construction (Picture 3). They have already experienced resettlement during construction of the Enguri Dam and have no desire to repeat the process. Ioseb Pirveli remembers those painful memories: “When resettlement started
in June 1949, the situation was unbearable. Everyone cried as they were leaving forever their motherland, where their fathers and grandfather were buried. They were leaving their houses that carried centuries of history and culture. The village where once everyone was happy, was abandoned forever, destroyed.” Ioseb fears that if the Khudoni Dam were to be constructed, the same type of misery would follow.

*Picture 3. Khudoni Dam protests in Khaishi Village*
Another villager, whose house was destroyed during Enguri Dam construction remembers that: “The new place of resettlement was unbearable. We, people of the mountains were taken to the desert, with water shortage and houses that could fall on our heads any minute. We will never let same happen to us.”

Locals also fear that they will be lied to and that the compensation will not be adequate:

“What amount of money would be enough for you to leave your home where your ancestors have been living for centuries? If they are trying to calculate the damage done to us, they should start from 1979\(^4\). We already know how this will end: the Government always lies to us. We would rather die on our land than leave it.”

Local people feel that they have been left out of the process, that they are told what will happen to them when the decisions have already been made, and that no one asks for their opinion in the process. Neither the local Government of Svaneti nor Energy Ministry have made any attempts to meet with people and discuss the fate of their village with them.

3.4 Environmental conflicts

Environmentalists believe that the Khudoni project poses extreme risks for the natural world surrounding the project site. As a result of flooding, forests and wildlife habitats of one of the ecologically most diverse places in Georgia will be destroyed, and that various flora and fauna will be threatened. The upper Enguri basin combines sub-alpine forests and meadows, rocks and alpine tundra, an area well-known for its endemic wildlife. Species include different forest birds, a community of large raptors (golden eagles, griffon vultures and lammergeyers), and other endemic birds that include the Caucasian black grouse, the Caucasian snowcock and the Caucasian chiffchaff. Mountain goats, chamois, brown bear, wolf, lynx, roe deer, and wild boar are quite common. Conservationists oppose construction of Khudoni HPP because of their

\(^{4}\) The year when initial constructions of the Khudoni Dam started
concern and uncertainty about how the wildlife will be affected and in what ways their habitat will be changed. The environmental NGO, Green Alternative predicts that the construction of the Khudoni Dam will further exacerbate problems of habitat loss, degradation of endemic species of flora and fauna, water quality and the natural flood regimen.

The hope of settling environmental conflicts was shattered after the publication of the ESIA, which, according to multiple allegations, neither satisfactorily described the extent of project’s impacts, nor proposed relevant mitigation plans. According to Nino Sharashenidze, the First Deputy Minister of the Ministry of the Environment of Georgia: “The ESIA is supposed to evaluate all possible risks, and propose ways that will at least lessen if not fully eradicate these risks, ESIA for Khudoni HPP does neither of these.”

3.5 Role of the Ministries

Deputy Environmental Minister Sharashenidze expresses her open support for the opponents of Khudoni HPP and claims that the Government, and in particular the Ministry of Energy, is sacrificing too much, including private property, and social and environmental wellbeing, in order to attract foreign investors. The GoG created the most investor-friendly environment by offering Projects based on the Build-Own-Operate (BOO) principle. The lands were granted to the investing company without any fee. All new construction is totally deregulated and there is no tariff set for the newly built HPPs. Export of electricity is completely deregulated as well, with no license being required to export the electricity. There are no written standards, based on which the ESIA would be performed. All parts of the ESIA were performed, funded and monitored only by the investing company, which has a personal interest in imposing low standards that will lead to low construction costs. Sharashenidze believes that the Ministry of Energy is just too scared to lose potential investors by imposing stricter rules and regulations,
and she describes the Energy Ministry’s acts as unfair and harmful to the citizens and to the
country as a whole.

“We are happy to hear any alternatives, but we cannot sign the project as it is today,
since it will have devastating social and environmental impacts which are the main concern and
focus of the Environment Ministry,” declares Sharashenidze. She claims her goal is to achieve
sustainable use of resources, sustainable development and economic growth without devastating
the environment or affecting numerous families.

Deputy Energy Minister Khmaladze calls the BOO principle a strategy for the
development of commercially oriented energy market. Archil Mamatelashvili, former Deputy
Minister of Energy of Georgia (2005-2007) characterizes the way Environment Ministry
approaches the project implementation debates as very non-collaborative and unhealthy. “They
just say ‘No’, never suggesting necessary mitigations that would enable the Government to carry
on with the project without conflict. If they say ‘No’, they should at least be able to say what can
be done to change that ‘No’ to ‘Yes’, which they have no willingness to do.” According to
Mamatelashvili, such an active negative attitude of the Environment Ministry towards mega-dam
projects is partly determined by the Ministry’s limited abilities in the previous government. The
government that headed Georgia for 9 years until 2012 was one-sidedly development oriented
because that was what most Georgians believed the country needed at that point in the history to
put an end to the “black years” that followed the Soviet Union break-up. The previous
government was also undemocratic; with the President in charge of all decision-making, the
Environment Ministry did not have the power to interfere with any projects approved by the
president. With the change in government in 2012, Georgia started to “see the light of
democracy,” says Mamatelashvili. Having experienced years of functionless operation,
Mamatelashvili claims, the Environment Ministry decided to prove its power, take critical measures and regulate the implementation of any development project that would in any way interfere with the environment without any further consideration. “That’s why they only say ‘No’ now, and refuse to even come to the discussion table,” says Mamatelashvili.

Mamatelashvili does not believe that the Khudoni HPP will create any considerable social and environmental difficulties for the country. “Dams do not harm the environment, they change the environment, which is a good thing; a sign of development and progress. Untouched nature is a waste and the cause of much more problems for the country,” says Mamatelashvili.

When asked about the social concerns, Mamatelashvili responded that “it is not a problem. People will get much better living places and better deals when displaced.” He considers that the problem is not the loss of homes, lands, cultural heritage, or ancestor graves, but rather the propaganda that NGOs use to halt the project. “NGOs get money for every project they will successfully stop. They do not care about the environment, or the people, all they care about is money,” says Mamatelashvili. He also claims, that NGOs have used one of the oldest “word giving” tradition of Svani people as a tool for manipulation, to make sure their resistance would last. Svani people have centuries long tradition of giving their word. If they swear on the icon, or on the grave of their ancestors that they will complete their promise, they will never break their word, no matter what. Mamatelashvili claims that NGOs convinced local people to swear that they would never take any deal from the government, and would never let themselves or their heritage be displaced.
IV. Environmental and Social Impact Assessment (ESIA) of the Khudoni HPP

In order to discuss the reasonability of the project, it is crucial to be fully aware of all the costs and benefits. The major obstacle to accurately calculating the costs of the project is the belief that the Environmental and Social Impact Assessment does not adequately reflect all the costs and does not provide rational mitigation plans. An ESIA is a process of assessing the possible negative and positive impacts that a proposed project may have on the environment, considering natural, social and economic aspects. The purpose of the assessment is to ensure that decision makers consider the environmental and social impacts of the proposed development prior to final decision-making. The detailed analysis of the ESIA might reveal possible weak-points that if properly addressed before any decision is made might serve as a way to resolve the conflicts.

By the end of the last century a vast number of countries and development agencies joined the US in requiring an Environmental Impact Assessment before the implementation of any major development project, later expanding to incorporate social impact assessments as well. Today, no one doubts that a systematic assessment of potential costs and benefits is necessary for every proposed dam project. However, writing the ESIA has become just a bureaucratic formality for the developers. ESIA are more often used as a rubber stamp on already approved projects, rather than as a basis for debate over whether the project is reasonable and justifiable.

Even clearly independent environmental consultancies have a strong self-interest in underestimating the environmental costs of projects and overestimating their benefits. In short, the more they act in favor of those funding the ESIA – typically those who have an interest in developing the project - the better their chances are to get hired again. There is an even greater

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5 All information in this section, unless otherwise noted, is obtained from the ESIA of the Khudoni HPP provided by the Ministry of the Environment, written in Georgian, and unavailable for public review.
bias when the consultants conducting the impact assessment directly work for the builders, as in the case of Khudoni ESIA.

To make things worse, there is usually no quality control on the ESIAs. They are almost never peer reviewed and they are often kept as state secrets, with limited or no public access. Hiding an ESIA from public access or excluding people from the decision making process leads to rising concern among affected communities. Estimating environmental impacts, attaching dollar values to costs and benefits, and coming to a final decision, is a very complex and somewhat subjective process that requires an informed debate by the general public.

Even before reading the ESIA, its conclusions can be guessed: in most cases, all environmental impacts will be minor, negligible or easily mitigated, so that the costs cannot possibly outweigh the benefits of the project. There may be some sections that raise concerns regarding certain effects, but the overall conclusion is almost always in favor of the project.

There is very limited information available on how accurate the predictions of environmental impacts of different dams have turned out to be, or how well the mitigation measures proposed by the ESIA worked. Although almost all ESIAs make a claim to monitor the success or failure of their planned measures taken against negative externalities of the dams, more than 60% of 31 national dam agencies surveyed by the industry journal Water Power & Dam Construction stated that they “had no formal system for monitoring the impacts of dams in operation” (McCully 2001:49).

An argument often used by dam builders in developing countries, such as Georgia, to defend low-standard ESIs is that at current stage of the development they cannot afford concern for the environment. In fact the opposite is true. More people in developing countries depend directly on their environment for subsistence than anywhere else in the world. People in developing
countries, and especially the poorest sections of society, can least afford the environmental impacts of large dams.

1. **Pre-process**

The preparation of Khudoni ESIA started rather late in the process. The project implementation agreement was signed in 2011, while the ESIA was prepared only in July 2013. Thus, the agreement to implement the project was signed even before its possible impacts on the environment and local communities would be known. It is also notable that the company that carried out ESIA, Caucasus Environmental NGO Network (CENN), and the Association for Protection of Landowners Rights (APLR) that worked on resettlement plan, were both retained directly by Trans Electrica Ltd. This fact puts the objectivity of the document under question even before reading it, as the CENN has incentive to prioritize its client’s interests, which in this case is the investing company.

The process of writing the Khudoni ESIA was conducted in following stages:

a) Scoping;

b) Environmental baseline study;

c) Potential impacts assessment; and

d) Development of environmental and social management plans

a. **Scoping**

CENN Identified applicable legislation, guidelines, standards and criteria, determined the scope of the environmental and social baseline and defined key environmental and social issues and concerns. How CENN decided on the most important components of the ESIA was never
checked or monitored by any authority. All decisions were made based on the judgments of the company that is arguably biased.

b. **Environmental Baseline Study**

CENN then obtained the baseline information on the project area and potential impacts of the project on natural and social environment.

c. **Potential Impact Assessment**

CENN described potential environmental and social risks and impacts, evaluated the significance of risks and impacts during construction and operation, identified beneficiaries and affected parties, and measures to avoid, minimize, mitigate or compensate any adverse and residual impacts. Again, all judgments and decisions were made by CENN alone without any standards or guidelines being provided beforehand.

d. **Environmental and Social Management Planning**

CENN was also in charge of defining the main goals of management, acceptance criteria and responsibilities for implementation, outlining and prioritizing management activities, resources required for implementation and monitoring programs, and specifying timeframes for implementation.

The whole process of conducting the assessment raises doubts regarding its objectivity and neutrality, as well as regarding standards, regulations and guidelines according to which it was performed.
2. **Summary and Analysis of Conclusions on Environmental Impact of Khudoni HPP** Within the scope of this paper, potential weak-points of the ESIA were identified, analyzed and suggestions for improvements have been made, with the belief that consideration of following suggestions can lead to a favorable consensus among involved parties.  

2.1. Flooding  

2.1.1. Summary of the ESIA  

In the Enguri gorge, flooding is expected to expand about 9 km above, 2 km on the left and 3 km on the right of the dam. The flooding will cause destruction of roads, collapsing processes and activation of dangerous geological processes.

The reservoir resulting from the construction of the Khudoni Dam will lead to the transformation of forests, arable lands, and inhabited territories into wetlands. In case of Khudoni dam, the extent of the land to be flooded is 528 hectares. Both the process of construction and the filling of the reservoir will lead to the loss of agricultural lands (pastures, arable lands, gardens) and forest soils. The area of the lost agricultural lands is estimated at 153.4 hectares.

2.1.2. Mitigation Approaches in the ESIA  

The agricultural lands evaluated by independent parties, and private owners will be fully compensated, taking into account the replacement costs and the prices of analogous lands in the region. In addition, soil protection activities will be conducted. The soil specialist will identify the places where soil protection activities are necessary and possible. Such places are the flooded territories where the humus part of the soil is especially thick, soil is fertile, and terrain and the existence of road enables the transportation of humus.
2.1.3 Analysis of the ESIA

The ESIA only discusses the territories that are known to be flooded by the reservoir, while all uncertainties involved with the issue of flooding are neglected. The importance of the topic calls for full analysis and understanding before any decision is made.

One aspect that is completely disregarded by the ESIA is damage caused by possible dam failure. Dams can fail for one or a combination of any of the following reasons ("GBRA" 2015):

- Overtopping that exceeds the capacity of the dam
- Landslides, earthquakes or other natural disasters
- High winds, leading to significant wave action and erosion
- Failure of the dam structure or foundation
- Settlement and cracking of the dam
- Piping and internal erosion of soil in dams
- Insufficient maintenance and repairs

From 1959 to 1965, nine major dams failed worldwide. Only within the time frame of January 2005 through June 2013 the US state dam safety programs reported 173 dam failures and 587 episodes that could have resulted in dam failure, were relevant measures not taken ("Dam Failure and Incidents "). In the past two years, the National Performance of Dams Program reported more than 520 such episodes, including 21 dam failures ("GBRA" 2015).

In case of a dam failure, the energy of the water stored behind the dam is capable of causing rapid, unexpected and catastrophic flooding downstream, resulting not only in deaths, injuries, and property damage, but also in loss of water supply and power generation. The extent of a dam failure event is measured in terms of the classification of the dam. The US National

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6 Between 1918 and 1958, 33 major US dam failures caused 1,680 deaths. Some of the largest disasters in the U.S. have resulted from dam failures.
Interagency Committee on Dam Safety categorizes dams as high, significant and low hazard. A downstream hazard is defined as the “potential lives-in-jeopardy or property damage downstream from a dam or reservoir because of floodwaters released at the dam or reservoir due to a dam break” (Stevens 2013:19). Such classifications are solely based on flood initiated by the dam failure. Failure of mis-operation of “High Hazard” can cause loss of human lives. Failure or mis-operation of “Significant Hazard” dams can cause no loss of human lives, but can still lead to significant economic or environmental damage. Damage caused by the failure or mis-operation of dams classified as “Low hazard” is limited mainly to the dam itself (“GBRA” 2015).

For example, the US Forest Service has identified hazard concerns for areas downstream from five Colorado dams on Forest Service land. In 2009, the U.S. Geological Survey, in cooperation with the Forest Service, performed a flood hydrology analysis to estimate the extent and hazard of potential downstream inundation in case of a dam breach (Stevens). For each reservoir, two dam-breach scenarios were modeled: (1) the dam is overtopped but does not fail, and (2) the dam is overtopped and actually breaks. Each of the two scenarios were modeled to predict flooding in response to (1) 100-year and (2) 500-year recurrence of the probable maximum precipitation, 24-hour duration rainstorms. Using the information on topographic and geologic maps and characteristics of each dam, a flood inundation map was constructed for every combination of dam-breach and storm scenario (Stevens 2013). Results of the simulation of the model were used to classify the dams according the hazard (high, significant, or low) and to estimate the potential extent of downstream damage caused by possible dam breach initiated flooding.

Similar study has to be done for Khudoni HPP. First of all, the probability of dam failure should be calculated, taking account all possible causes separately and together. Then, a
simulation analysis should be performed to estimate the damage if such event occurs, and the results should be incorporated in overall costs of the project. Dam failure is one of the biggest dangers posed by the man-made reservoirs and completely neglecting the probability of its occurrence significantly underestimates project costs.

The flood management strategies listed in the report are mainly so called “soft engineering” projects to manage the flooding caused by the reservoir. Soft engineering projects are low-cost and more feasible for developing countries, as they use natural resources and local people’s knowledge of the river to reduce the impacts of a flood rather than prevent it and do not require special education, training or technology. Mitigation measures that can be taken within the scope of soft engineering projects include (Jackson):

- Restricting land usage in the areas surrounding a river;
- Planting trees in a drainage basin to increase interception and storage while reducing surface run-off; and
- Creating favorable conditions for the development of wetlands to store large volumes of water and reduce the river discharge.

In addition to the ESIA’s treatment of soft engineering projects, the ESIA should examine hard engineering projects, which can meaningfully reduce the flood risk. Hard engineering projects involve more sophisticated science and technology to construct structures that can prevent a river from flooding. Examples of hard engineering projects include (Jackson):

- Artificial levees that act as embankments, extend the channel’s height and increase its discharge;
- Wing dykes that are slats placed in pairs on either side of the channel behind which sediment builds up narrowing the channel and forcing water
to flow faster. This way, the quick pace at which water flows away from an area at risk helps reduce the risk of water accumulation;

- Straight routes across meanders help the river to flow faster and avoid flooding;

- Diversion spillways that are artificial river channels, move water away from an area at risk of flooding, either further downstream into the same river, or into another river if possible.

Although usually successful at controlling flooding, hard engineering projects bring their own impacts on the river, disrupting ecological systems in the drainage basin. They also require considerable funding, technology and up-keep that make them often too costly. However, it is important to consider all possible options that would be efficient for Khudoni case and incorporate cost benefit analysis of such projects.

Other possible options for infrastructure to provide flood mitigation benefits can be considered to provide more flood storage and ensure this additional storage is large enough and appropriately located such that its benefits are maximized. However, it should be noted that no infrastructure can guarantee a complete flood prevention, as the maximum degree of flood mitigation a dam can provide depends on a number of factors such as, the storage capacity of reservoir and the discharge capacity of the spillway, flood event and catchment size, and water level in the dam at the beginning of the inundation. The extent of feasible mitigation generally reduces as the extent of the flooding event increases ("Management of Flooding Downstream of Dams").

Consequently, after all costs of possible flooding events are calculated for Khudoni dam, all mitigation measures are considered, and those that are feasible and relevant are taken into
account, emergency response plans should be developed ("Management of Flooding Downstream of Dams"). Flood response activities include community warning and information systems. Warning and informing the community regarding flood risks downstream of a dam should be based upon the best, accurate and most recent information made available by dam operators. For efficient emergency response, it is important to know the dam classification, the estimated period over which a there is a relatively high probability of dam failure, maximum level of water that a dam can store, time before the flood wave reaches critical downstream locations, and likely duration of the event. Only after such studies are performed, can it be concluded that the issue of flooding is covered in full extent and incorporated in cost benefit analysis of the project.

2.2. Seismic activities 2.2.1. Summary of the ESIA

In addition to natural seismic activities of the region, during the construction of high dams, there is a high risk of so called triggered seismic events, which usually become evident after the filling of the reservoir. Generally, earthquakes caused by induced seismicity are of medium power. Triggered seismic activities also create a risk of landslides, which can cause rapid change of the water level in the reservoir, wave creation, blockage of the gorges and flooding of the low-lying landforms, including the built environment.

2.2.2. Mitigation Approaches in the ESIA

As the only effective techniques of impact mitigation during a strong earthquake, the ESIA lists public awareness, correct action and rapid response from the government and from special services. It is also important to create local seismic monitoring system which will observe seismic activity, as well as identify the earthquake epicenter, strength and potential impact. The information should rapidly be provided to the relevant services and to the public, in order to
ensure a rapid response in case of a strong earthquake or to avoid panic in case of a small earthquake.

2.2.3. Analysis of the ESIA

In the proposed Khudoni HPP site natural earthquakes with magnitudes from 5 to 7 have been recorded. Although the ESIA states that the dam might cause additional earthquakes to the area it does not provide details of the peculiarities of the region that might determine the frequency, magnitude and impact of dam induced seismicity.

Reservoir impounding causes a significant increase in pore pressure and elastic stress, which is the tendency of an object to deform. Increased pore pressure decreases strength of the rocks and causes the formation of faults and fracture planes, crushing, and relative motion of individual mineral grains and cements, leading to an earthquake. Other factors that may affect the seismicity of a region include thermal stresses due to cool water entering warm rock, and the effect of pressure gradients (Gupta 1976:1-5). The surface load produced by a reservoir is 0.1 bars (unit of pressure equal to 100,000 Pascal) for each meter of water depth. Maximum depth of water in the Khudoni reservoir would be 211m which creates 21 bars of surface load, equal to the surface load of the world’s largest reservoirs. The ESIA doesn’t mention whether rapid or delayed response of seismicity is expected depending on the design of the dam. For example, Figure 1 shows that at Nurek, Manic-3, and Monitcello reservoirs, the seismicity increased significantly immediately after the first rapid increase in water level. These dams exhibit rapid response in seismicity which happens due to compaction induced changes in pore pressure. In contrast, the large earthquakes at Oroville, Karoba, Aswan and Koyna occurred many years after the reservoirs began to fill. Such delayed response is more likely due to the diffusion of pore pressure to depth along fault zones. It is important to investigate which pattern Khudoni dam is
expected to follow and how much effect rising depth of water will have on induced seismicity (Simpson 21-42).

![Figure 1. Examples of water levels and induced seismicity. Vertical scale is absolute water depth at the dam. The horizontal scale is the same for all curves, but the absolute positions have been shifted for clarity. Numbers above the water level curves are magnitudes of the largest earthquakes. Bars indicate times of prominent bursts of seismicity (Simpson).]

Although there are active faults identified at the reservoir site and earthquakes of magnitude as high as 7 have been recorded in Upper Svaneti region, it is considered to be a seismically inactive region, because of a very long interval between such incidents. Red dots on the map on Figure 2 indicate instrumentally monitored earthquakes since 1900, while yellow dots represent earthquakes mentioned in historical documents since 1900. The black circle indicates the area of the Khudoni reservoir. As it is vivid from the map, the region immediately surrounding the dam site, has been seismically inactive over the last 100 years (Geoportal of Natural Hazards and Risks in Georgia).
In contrast to what might intuitively think, largest induced earthquakes more often occur and have the greatest impact in areas of relatively low natural seismicity that. In active tectonic regions, the repeat times between natural earthquakes is relatively short and thus natural earthquakes play major role without much impact from a reservoir. In relatively aseismic regions, repeat times between the natural earthquakes may be thousands of years and the dam structure can increase probability of the maximum expected earthquake and thus significantly alter the risk estimate (Simpson 35-40). Also it should be noted, that the foreshock values - earthquakes that precede larger earthquakes in the same location, of the reservoir-associated earthquakes are higher than the aftershock values - smaller earthquakes that occur in the same area during the days to years following a larger event or "mainshock," and both these values are
higher than those for the natural earthquake sequences of the region (Gupta 1976:1-5). The altered risk must be calculated, quantified and incorporated into the ESIA.

Among the earthquakes associated with the impounding of the artificial lakes the Koyna dam associated earthquake in India in 1967 is the most memorable. The devastating earthquake killed 200 people, injured over 1,500, destroyed Koyna Nager township and more than 80% of the houses. Even the city of Bombay and its suburbs, 230 km away from the epicenter, was shaken. Since electricity from Koyna Hydroelectric Plant was no longer available, industry in the whole region was paralyzed and people were in complete panic. Before this major earthquake, tremors were not rare at Koyna reservoir since 1962, soon after impounding. Some of them were strong enough to even break windows. Earthquakes began to be felt in the region during 1963 and about five earthquakes occurred that were strong enough to cause damage locally. The 1967 earthquake, with magnitude of 6.5-7.5 estimated by different agencies, significantly damaged the dam itself and hindered its operation for a long time (Gupta 1976:45-60). This is only one example among many that makes suspect the ESIA’s assertion that triggered earthquakes are usually of medium power and not worth addressing. Consequently, this is not an acceptable conclusion and should be reconsidered.

The seismology of the site should be studied in detail in order to develop a list of possible scenarios of triggered earthquakes, from which expected risk can be calculated based on probabilities of each scenario. After the risk is calculated, the costs of the possible triggered earthquakes should be quantified as well. These costs include, health impacts, damage to structures, buildings and cultural heritage, and earthquake-caused landslides that will further

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7 Tremor is a shaking or vibrating movement of the earth but with a smaller intensity and with effects limited to trembling of the earth. While the word earthquake is used when the intensity of the seismic activity is high, and there is considerable damage of property and lives.
elevate the impact. It is important to have an estimate of these costs as insuring against them might have a significant impact on overall costs of the project.

The ESIA not only insufficiently evaluates the induced seismicity risks, but it does not propose any adequate mitigation plans either. Raising public awareness and being more alert to earthquakes is not a mitigation plan. The risk posed by triggered earthquakes can be mitigated by careful control of the activity responsible for the triggering. Thus, the first step is to identify exactly which stage of dam construction or operation would influence the seismicity of the region. At some reservoir sites it appears that the rate at which the water level changes triggers earthquakes. If this turns out to be the case at Khudoni reservoir, gradual, carefully controlled changes in the water level may relieve excess pressures before critical levels are reached, decreasing the temporary stress change (Simpson 21-42).

As already alluded to, dams themselves are vulnerable to earthquakes. As a result of above mentioned induced earthquake, the Koyna Dam developed extensive cracking near the top that could probably be avoided by proper design and construction of the dam. Therefore the dam design is the most significant method, and arguably the only way to mitigate the inherent risk of the dam. Yet, there is no publicly available report that reveals the details of the Khudoni Dam design in terms of its earthquake resistance. The failure of the dam as a result of an earthquake would cause even larger and more devastating impact on the environment and the community than the earthquake itself. An independent and publicly available expert review of the dam design should be performed in order to verify whether the dam is designed according to the international seismic criteria. Furthermore, the effect of sudden failure of the Khudoni dam in case of an earthquake should be calculated.
According to the International Commission on Large Dams (ICOLD) Bulletin ("Bulletin 72"), large dams have to be able to withstand the effects of the Maximum Credible Earthquake (MCE), defined as “the strongest earthquake that could occur in the region of a dam, with a return period of several thousand years” (Wieland). The designer must take into account the possible impact on the dam’s foundation caused by any such earthquake at any distance from the dam site, especially when a potentially active fault crosses the dam site, as it does in case of the Khudoni dam.

According to Dr. Martin Wieland, a chairman of ICOLD Committee (Wieland), as a general guideline, the following minimum seismic requirements should be observed:

1. Seismic hazard study should be performed to determine design earthquakes;

2. All non safety-relevant elements of dam such as local seismic building codes should be used and the seismic design criteria should not be less than those given in building codes;

3. The Peak Ground Accelerations (PGA) for temporary structures and the construction phase should be of the order of 50% of the PGA of the design earthquake of the seismic building code.

However, it has to be kept in mind that each dam is a unique structure and that the experience gained from the seismic behavior of other dams has limited value. Therefore, observations have to be combined with sophisticated analyses and understanding of the project site that should reflect reality as close as possible.

Given the bad state of repair of the existing infrastructure and the high potential risk of landslides in the reservoir area, a complete risk assessment for the Khudoni HPP related to both potential geohazards, stability of natural slopes in the reservoir area, and stability of the dam
foundation is necessary. A thorough risk assessment will identify the potential risks that can then be ranked according to the priorities. Mitigation measures should be developed until acceptable levels of risk are obtained.

2.3. Water Quality

2.3.1. Summary of the ESIA

The underground activities involved in the construction of the Khudoni Dam include several potential risks, such as:

- The change of groundwater capacity – decrease or increase – in the substrate nearby the construction
- Spill of oil or other toxic substances might cause groundwater contamination that can later lead to reservoir pollution
- Groundwater pollution can also be caused indirectly – by the rainwater and snowmelt infiltrating from polluted soils.
- Groundwater contamination can also be caused by the artificial hydraulic connection of their horizons with the surface waters.

The impact on surface water could include:

- Surface waters will be contaminated during the Khudoni Dam’s construction process
- Chemical pollution of surface water (principally by hydrocarbons) could result from the runoff of spilled fuels and lubricants into the river or by the solid or liquid wastes produced at or near the construction sites.
2.3.2 Mitigation Approaches in the ESIA

- Waste water should not change the composition of the surface water and should not exceed normal concentration.
- Water contaminated by mineral or organic chemicals should not end up in the surface water.
- Spills of the hazardous materials should immediately be reported to the relevant authority.
- All methods of water quality protection should be studied, especially construction waste and drainage water treatment processes.
- In case of nonexistent water treatment plants, waste water should be cleaned by mobile water treatment technology before disposal into the river.
- Specialist should be hired to continuously monitor implementation of preventive activities and perform laboratory analysis of water.

2.3.3. Analysis of the ESIA

The ESIA mostly focuses on water quality issues caused by on-site construction work and subsequent accidental contamination of the water. However, there is much more potential harm throughout the life cycle of the reservoir that needs to be considered. When flowing water is suddenly stilled, it undergoes chemical, thermal and physical changes that can pose a serious threat of contaminating the river downstream. The extent of deterioration in water quality is in general related to the retention time of the reservoir, which is its storage capacity in relation to the rates of water inflow and outflow.
A dam causes warming or cooling of its originally free-flowing river; water released from the depth of a reservoir behind a high dam is usually comparatively cooler in summer and warmer in winter than the original river water, while water from outlets near the top of a reservoir will tend to be warmer than original river water all year round. This affects the amount of dissolved oxygen (DO) and suspended solids, consequently altering chemical reactions that take place in water. Reservoirs also trap most of the nutrients carried by the river, which leads to algae proliferating near the surface of highly nutrient-enriched reservoirs in warm temperatures. As algae consume the reservoir nutrients and produce large amounts of oxygen, water releases from the surface layer of a reservoir in summer will tend to be warm, nutrient-depleted, high in DO, and thick with algae, giving water an unpleasant smell and taste, clogging water supply pathways and making water unusable (McCully 2001:36-41).

Dams usually lead to increased rates of evaporation, as they increase the surface area of water exposed to the sun. The evaporated water is generally lost to the river downstream, thereby increasing its salt (NaCl) concentration. For example, the increased salinity of the Colorado River results from the fact that one third of the river's flow evaporates from reservoirs behind the Hoover Dam and the other dams on the river, costing the water users of southern California millions of dollars annually as high salt concentrations poison aquatic organisms and corrode pipes and machinery. The salinity of the water at Imperial Dam, just north of the Mexican border, increased from an average of 785 parts per million (ppm) NaCl between 1941 and 1969, to over 900 ppm in 1990 and is predicted to exceed 1,200 ppm after 2000 (McCully 2001:36-41). For comparative purposes, the US standard for drinking water is 500 ppm NaCl.

Scientific evidence largely confirms the anticipated impact of large reservoirs on water quality. Studies performed on different points of Fox River, Illinois (Santucci 2005) showed that
DO and pH varied on a daily basis at all stations, but the magnitude of the daily oxygen fluctuations was higher at stations in impounded reaches than at those in free-flowing reaches. DO ranged from 2.5 to 18 mg/L in impounded areas and from 5 to 10 mg/L in free-flowing areas. Substandard DO and pH were recorded in 8 of 11 impounded areas, while DO and pH in all free-flowing reaches met the standard levels. Substandard water quality conditions were common in the Fox River. Total phosphorus (TP) and total nitrogen (TN) of the impounded areas were extremely elevated above recommended guidelines at almost all stations in the impounded areas. High nutrient concentrations led to the development of excessive algal blooms and the elevation of turbidity measures above recommended guidelines (Santucci 2005).

Study of the impact of dam construction and operation on water quality and water self-purification capacity of different river segments was performed for Manwan and Dachaoshan Dams on the Lancang River in China (Yang 2009:1763-1780). For this study, the long-term series of water quality and river flow data over 20 years were analyzed. The results showed that from pre-dam period to the first 7 years after the Manwan Dam had been completed, the water quality of Manwan Reservoir became worse due to the accumulation of pollutants; over the next 5 years the water quality improved due to the self-purification of the reservoir water. However, the self-purification capacity of the river decreased over time, having a strongly negative net effect on water quality in the reservoir as well as in the river below the dam. This study also concluded that temporal and spatial characteristics of dam are crucial in determining the overall impact of the dam on water quality.

Based on such studies from different parts of the world, it is clear that the effects of reservoirs on water quality depend on range of different variables. It is highly recommended to

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8 Self-purification is the ability of a body of water to rid itself of pollutants, the process in which aquatic environment restores balance by undergoing physical and chemical processes based on biological, hydraulic and morphological characteristics of the river.
S. Mgaloblishvili

develop a model for Khudoni Reservoir that will both (1) estimate changes in water quality throughout the life cycle of the dam and (2) enable precise cost calculation. Impacts of poor water quality on aquatic habitat, human health and recreational opportunities of the area will be discussed below, but the costs are far from negligible.

For example, along the Neversink River in southeastern New York, the studies showed that poor water-quality indicators such as pH and aluminum concentration, as well as, decreased flows and lowered water temperatures below the reservoir affected macroinvertebrate assemblages disrupting their downstream continuum (Santucci 2005). Excessive growth of aquatic plants in nutrient-enriched reservoirs can also incur significant costs as up to 6 times more water can be lost through evaporation and transpiration in weed-covered reservoirs than in open waters. Furthermore, floating plants can obstruct boats, block out light for other aquatic organisms, congest turbines and provide a favorable habitat for mosquitoes and snails that host the schistosomiasis parasite and consequently spread an infectious disease that causes chronic ill-health (McCully 43-49). For example, heavily contaminated water flows from the impoundments on Amu Darya and Syr Darya Rivers in Central Asia has had a catastrophic effect on the health of the 3.5 million people living near the sea. The incidents of typhoid fever, hepatitis, kidney disease and chronic gastritis have increased by as much as 60-fold. According to the medical research center of the town of Muynak, Uzbekistan, nearly 70% of the population showed 'precancerous conditions' after the impoundment of their major river, and life expectancy plummeted from 64 years in pre-dammed conditions to 57 years after (McCully 2001:43-49).

Accumulation of Mercury in reservoir fish presents another health issue, a persistent problem about which international community has only recently become alert (McCully 36-41). A harmless, naturally occurring, inorganic chemical mercury is transformed into a central nervous
system toxin – methylmercury by bacteria feeding on the decomposing matter under a reservoir. Extremely harmful methylmercury is then absorbed by organisms at the bottom of the aquatic food chain and finds its way to the top, increasingly concentrating in the bodies of the creatures consuming contaminated prey. This process called bioaccumulation, leads to the levels of methylmercury being several times higher in the tissues of large fish at the top trophic levels, than in the small organisms at the bottom. The best researched case of reservoir methylmercury is at the La Grande hydrocomplex in Quebec, part of the huge James Bay Project. Ten years after the La Grande 2 Reservoir was first impounded, methylmercury levels in predatory fish called were documented to have risen to about six times their pre-reservoir level and kept increasing. Consequently, mercury levels in the bodies of local native people reached dangers levels, as fish are a major part of their diet. By 1984, only six years after La Grande 2 Dam was completed, 64% of the local people showed blood mercury levels far exceeding the World Health Organization maximum tolerance (McCully 2001:36-41).

As the scope of water quality issues that should be covered by ESIA increases, so should the mitigation measures. The most common mitigation measure taken in the US is to release more water from the reservoir, even though compromising the ability to maximize power or water storage. These large 'flushing flows' are intended to wash away harmful accumulations of boulders and gravel and increase downstream DO levels in ‘instream flows’. Recently the generation of instream flows has become an obligation for many privately owned dams in the US in order to get their dam license approvals by the US Federal Energy Regulatory Commission. The fact that that such regulation was passed even though it causes the average 8% loss in power
Increasing DO levels can be achieved by different methods such as artificially aerating the water passing through turbines. Although generally regarded as the cheapest form of mitigation and generally being effective, deciding exactly what DO level is the most beneficial and how to trade-off the costs and benefits of such mitigation measures can be hard (McCully 49-54).

Another form of mitigating the effects of a dam on downstream water quality is to regulate the temperature of releases by withdrawing water from different levels of the reservoir. Although this method is not effective in all cases, around a hundred federal dams in the US are able to make such 'selective withdrawals' (McCully 2001:49-54).

Since most of the mitigation measures are costly and can decrease the profitability of the project, it is crucial to identify precisely which aspects of the Khudoni Dam’s operation pose the greatest threat to the water quality of the Enguri River and benefits of which mitigation measures outweigh the costs. After such analysis is made plans should be made to pursue such mitigation measures and incorporate relevant infrastructure changes in construction works.

2.4 Local Climate

2.4.1. Summary of the ESIA

The reservoir will have a cooling effect on the environment during the warm season for 7 months (April through October), and warming effect during the cold season for 4 months (November through February). The former is relatively longer cooling period probably due to residual ice filling the reservoir. As a result of cooling and warming periods, the partial pressure
and relative humidity of the water vapor almost always increases. The impact can reach as far as 10-15 km from the dam. However, no significant impact on local climate is expected.

2.4.2 Mitigation Approaches in ESIA

Since cooling and warming effects of the reservoir meaningfully depends on the surface temperature change of the water, it should be regularly monitored and controlled as found to be feasible. To regulate the intensified wind pattern, forest cover around the reservoir has to be increased.

2.4.3. Analysis of the ESIA

Eastern Georgia is characterized by a dry climate that varies significantly with elevation, forming a gradient of climatic belts from the sea to the summits. The upper Enguri watershed experiences cool and wet summers, long winters with high snow fall, and total annual precipitation ranging from 1,400 to 1,800 mm.

The study of the Khudoni reservoir’s impact on climate should involve three main issues: microclimate, connection between the reservoir and different weather events and the risk associated with reservoir’s cumulative effect on climate (Peiqun 2013).

Although the ESIA starts by listing the impacts of the reservoir on local climate, it ends by stating that the influence in negligible, without going into details of what consequences might follow, what costs might be incurred on the environment and society and how the peculiarities of the dam as well as the region can further aggravate the damage.

As stated in the ESIA, dams have reverse impacts on climate in different seasons. In the summer, the lake and water surface temperatures are lower than over their surrounding land surfaces. As a result, the waters absorb heat, and the exchange of energy from the neighboring areas to the waters is enhanced in comparison to the energy exchange with natural stream flow.
In the winter, the process is reversed, and the lakes and reservoirs become heat emitters. An enhanced energy exchange between the reservoir and the neighboring areas could make the atmospheric structure unstable and subjecting weather to a high degree of variability. Atmospheric stability is a measure of the atmosphere's tendency to encourage or deter vertical motion, which is directly correlated to different types of weather systems and their severity (Peiqun 2013). What the ESIA does not mention is that this could result in a changed precipitation pattern and a changed geographical distribution of precipitation. The most concerning impact of large reservoirs on local climate is a triggering of unusual and extreme precipitation patterns, the probability that is fully omitted from the ESIA, and only slightly implied in its description of increased humidity. A research consortium of a number of US universities and research institutionsinvestigating how large dams can affect local climates say “dams have the clear potential to drastically alter local rainfall in some regions” (Hossain 2009). These researchers were first to publish a study with documented evidence that climate around artificial reservoirs is clearly different from the climate around natural lakes and wetlands. The research team looked at 30 years of climate data spanning from 1979-2009 and collected hourly on a continuous basis over North America. This was achieved by a technique called reanalysis that aims to recreate the gold standard record of weather conditions everywhere in a domain by using as much information in hindsight as possible. Based on theoretical reasoning supported by weather records from monitored sites, the study reports that “if a dam's reservoir is large enough its water evaporates more rapidly and the expanded distribution of water vapor creates an altered climate” (Hossain 2009).

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10 Researchers at Tennessee Tech University, Purdue University, the University of Colorado and the University of Georgia, Pacific Northwest National Laboratory and Hellenic Center for Marine Research
Although it cannot be guaranteed that evaporated water will return back to the target region due to advection effects, a considerable amount will most likely find its way back to the vicinity of the reservoir system. The extent of evaporation-precipitation feedback varies according to geographical location, season of the year and the area considered (Kunstmann 2011).

In order to estimate costs and damage caused by increased humidity, the ESIA should anticipate possible results of triggered precipitation and extreme weather. According to the study mentioned above (Hossain 2009), there is a substantial evidence of more thunderstorms in the vicinity of a large dam compared with before the dam was built. In addition large dams lead to longer periods without precipitation followed by flood-inducing downpours. As Hossain (2009) describes, there has been a significant increase in extreme precipitation events (rainfall heavier that 99% of historic rainfalls in the area) around large dams; specifically, 99th-percentile rainstorms in the region have increased by 4% per year after a mega dam was built.

The possibility of similar drastic changes in climate cannot be discarded as negligible without further consideration. Different climates are affected differently and the ESIA should have provided a reasonable estimation of possible triggered weather events. Once such a study is done, the costs should be estimated and incorporated in the cost-benefit analysis. In Upper Svaneti people live off the land; agriculture is essential not only as a source of income but also as a means of subsistence. Thus, changes in weather patterns can considerably impact people’s livelihoods. In particular, the possibility of longer periods of drought followed by intense downpours poses a dangerous and potentially costly threat to the region. Also, an increase in annual precipitation variability may cause runoff in the upper reaches to fluctuate, leading to greater variation in reservoir water levels, thereby further exacerbating the region’s instability and hindering safe operation. Finally, although unlikely, an increase in the frequency and
intensity of extreme climate events may lead to intensified eutrophication of water bodies, thus increasing the vulnerability of natural ecosystems (Peiqu 2013).

Irregular hydrometeorological variables such as evaporation, precipitation and humidity in the post-dam period, are often followed by changes in temperature and wind speed (Kunstmann 2011). The best and most reliable practice for identifying the root causes of such alterations, is to directly monitor and carefully investigate key variations in the local climate after the construction of a dam in comparison to the pre-dam era. Since the Khudoni Dam has not yet been constructed, and the aim of the ESIA is to forecast the possible impacts, it might be reasonable to do such study on another big dam in the region.

Enguri Dam can serve as the best example. Enguri Dam is also located in upper Svaneti, and it is the world's second highest concrete arch dam with a height of 271.5 meters, a little higher than Khudoni Dam. Locals are concerned that the construction of the Enguri Reservoir has made the climate more humid, making life more difficult. “Fruit is rotting before ripening; we even cannot dry our clothes,” they say. Locals also fear that the construction of the second reservoir will make their lives even more unbearable and trigger negative impacts on their health. A doctor in Khaishi confirms these allegations, saying that cases of cardiovascular and pulmonary diseases are much more recurrent in Khaishi than other villages located in similar distances from the Enguri Reservoir. Since many variables, such as climate, biomes, or the size of the dam are similar for the two projects, monitoring how climate has changed in the vicinity of Enguri Dam since its construction, could give a reasonable estimate for similar impacts of Khudoni Dam.

Furthermore, changes in the post-dam era continue to occur over a long period of time since anthropogenic alterations keep happening continuously after the commissioning of the dam.
(Kunstmann 2011). The fact that Enguri Dam has been functioning since 1987 gives enough time interval to compare how different factors might have contributed to the climate alterations over time.

In the late 1990s, the Institute of Hydrometeorology (IHM), a department of the Georgian Academy of Sciences) developed a research program on the influence of Enguri reservoir on local climate. The research was based on data (1) from the former meteorological stations and (2) measurements in the lake area. The results show no reservoir effect at a large scale either in summer or in winter. However, a significant elevation of average temperature above the reservoir (measured 2 m above water level) and in immediate surroundings, up to 2 km from the shore, has been found. A similar follow-up study could be performed now to see how decades of the dam’s operation might have increased or decreased this effect.

Conducting such an assessment on the Enguri Dam as an example and an estimate for the Khudoni Dam, might be useful not only for understanding changes that occur over long periods of time, but for immediate changes as well. For example, many studies use the method of back trajectory analysis of precipitation recycling to identify the relative contribution of altered evaporation patterns to the local precipitation process. For example, using such a method, Kunstmann and Knoche (2011) reported up to an 8% contribution of evaporation from the impounded area in the Lake Volta region of West Africa to the total precipitation in the region.

Three Gorges Dam in China is one of the best studied examples in terms of its effect on local climate. After the impoundment, the reservoir area reported a 32% increase of high-temperature days and 21% decrease of low temperature days. Although the total number of annual drought as well as rainstorm days recorded was only slightly increased, the intensity of both was significantly higher than before. A notable increase was also observed in the
occurrence of hazy days. Regional climate modeling shows that the reservoir has potential of bringing down the air temperature by 1°C in the winter, and 1.5°C in the summer impacting areas within 20 km radius from the reservoir. Numerical modeling results also confirm the reservoir’s ability to affect temperature, humidity and wind variations within at least 10 km radius however, the extent of such effects is uncertain. The issue of whether any impact could expand and to the regional scale (within 100 km) remains controversial (Peiqun).

In its mitigation plans, the ESIA proposes increasing forest cover which seems unrealistic as considerably extensive deforestation is already planned to decrease the amount of vegetation that will be flooded as a result of damming the river. In addition, no further information is given on how, where and when reforestation programs would be achieved. In terms of mitigation, it is crucial to study and define the threshold values that may lead to the occurrence of unfavorable events in the reservoir area and enhance the weather observing network in the area. In this case, adaptation plans might be more reasonable to consider. The project’s drought resistance plan should be optimized and a study should be conducted that will examine how local biomes, vegetation and fauna will be impacted by estimated changes in weather, wind and precipitation patterns. Based on this assessment, adaptation plans should be developed that will propose ways to help those most vulnerable to possible changes. Climate change adaptation and disaster-risk management should become a part of the development planning for the reservoir area.

2.5 Emissions

2.5.1. Summary of the ESIA

Overall, CO₂ net emissions are forecasted to decrease by 16,735,881 tons over 20 years of operation by generating electricity from Khudoni HPP rather than from other sources, such as oil or natural gas. Yearly net emission of N₂O from the reservoir is estimated to be zero.
2.5.2 Mitigation Approaches in ESIA

mitigation needed for positive impact

2.5.3. Analysis of the ESIA

Hydroelectric dams produce significant amounts of carbon dioxide (CO\textsubscript{2}) and methane (CH\textsubscript{4}). Although the rate of greenhouse gas (GHG) emissions per unit of electric generation from hydropower is much lower than from fossil fuel technologies, hydroelectric generation still emits GHGs and the rate and amount of emissions varies considerably depending on different factors. Hydropower dams interfere with the carbon cycle, changing the storage of carbon in sediments and the form in which carbon is returned to the atmosphere (Hertwich). The estimates of how much the global GHG emissions would increase if hydropower emissions were included ranges from 0.5% to 3-4% (Mäkinen 2010). Either way, hydropower emissions are far above zero and simply asserting that the net level of emissions will decrease is insufficient for an accurate evaluation of costs.

World Commission on Dams (WCD) found that in order to fully understand the extent of GHG emissions from dams, they should be assessed in context of place, scale, time and other alternatives (“WCD”). Furthermore, it is not a common practice to blindly class any proposed new hydro project as "cleaner" in terms of GHG emissions than other alternatives without additional research (Li). WCD has been conducting long-term measurements of GHG emissions at 30 dam reservoirs worldwide, and has concluded that all sites have been emitting GHGs for decades. This is in contrast to the widespread assumption that such emissions are zero or negligable (“WCD”). Carbon emissions vary from dam to dam, says Philip Fearnside from Brazil's National Institute for Research in the Amazon in Manaus, "But we do know that there are enough
emissions to worry about. There are even times throughout the lifetime of a dam when it can produce more greenhouse gases than power plants running on fossil fuels” (Graham-Rowe 2005).

Best practices dictate that a plant’s emissions should be analyzed according to a life cycle analysis (LCA) approach which evaluates emissions from the entire life cycle of the plant. Intergovernmental Panel on Climate Change (IPCC) recommends calculating GHG emissions from a facility over a 100-year interval, to cover all effects from the whole watershed (Steinhurst 2012). Thus, to cover the issue fully, the ESIA should present a detailed life cycle estimation of GHG emissions, which should be constantly monitored and reassessed after the dam starts to function.

Life cycle emissions for hydropower include both indirect and direct emissions. Table 1 below lists all direct and indirect sources of GHG emissions from dams.

<table>
<thead>
<tr>
<th>Sources of Direct Emissions</th>
<th>Sources of Indirect Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility operation</td>
<td>Development of infrastructure</td>
</tr>
<tr>
<td>Biomass decomposition</td>
<td>Construction works</td>
</tr>
<tr>
<td>Bubbling</td>
<td>Manufacturing of materials and equipment</td>
</tr>
<tr>
<td>Diffusive fluxes</td>
<td>Transportation of materials and workers</td>
</tr>
<tr>
<td>Degassing downstream</td>
<td>Waste disposal and decomposition</td>
</tr>
</tbody>
</table>

*Table 1 Sources of Direct and Indirect GHG Emissions from Dams*

The major indirect sources of GHG emissions for hydropower include cement and steel production, and the use of diesel and electricity. Biomass decomposition is the biggest direct source of GHG emissions for hydropower, as well as the largest source of uncertainty in the GHG emission estimates since the rate of decomposition is highly dependent on the climate zone.
and the specifics of the flooded biome (Steinhurst 2012). Decay of biomass in the soil and vegetation of newly flooded lands by the facility’s reservoir emits GHGs that diffuse up through the reservoir into the atmosphere (Li).

World Bank provides a step-by-step guide on how to estimate emissions from flooded biomass in different climatic zones. Although this method still leaves the room for substantial uncertainties, it is extremely useful for creating a range of potential emissions (Liden 2013:49-50):

1. Identify the reservoir’s exact location (coordinates) and define its climatic zone (tropical, temperate, or boreal)
2. Identify the size of the reservoir area at Full Supply Level (FSL)
3. Identify type of forests/vegetation in the area of the reservoir
4. Identify the type of land uses by the reservoir area at FSL. Note percentage of forests, non-vegetated land (agriculture or grasslands), and water bodies. If such information cannot be obtained, assume 90% forested areas and 10% water bodies for dry ecological zones, and 80% forested areas and 20% water bodies for wet ecological zones (however, the uncertainty of the method will increase)
5. Identify the type of soils in the reservoir area
6. Use Agriculture, Forestry, and Other Land Use (AFOLU), common name for the 2006 IPCC Guidelines for National Greenhouse Gas Inventories) Table 4.12 (provided below) to estimate above-ground biomass for already identified forest type. Apply percentage of forested/vegetated area to calculate total biomass for reservoir area
7. Use AFOLU Table 4.3 (provided below) to first estimate the fraction of carbon in above-ground biomass, and then calculate amount of carbon in total above-ground biomass for the reservoir area.

8. Use AFOLU Table 2.2 (provided below) to first estimate fraction of carbon in litter, and then apply percentage of forested/vegetated area to calculate amount of carbon in total litter for reservoir area.

9. Use AFOLU Table 2.3 (provided below) to first estimate the fraction of carbon in soil, and then apply total reservoir area to calculate amount of carbon in total soil for reservoir area.

10. Add the total amount of carbon in the reservoir area from biomass, litter, and soil and assume that 50% will decompose. This will give you an estimate for the total amount of carbon stock to be emitted from the reservoir during its life span.

11. The estimate of how much of the total amount of available carbon stock will be emitted as CO₂ and how much will be emitted as CH₄, depends on climatic zone. For tropical zone assume CH₄/ CO₂ = 7%, and for temperate and boreal zones assume CH₄/ CO₂ = 1.5%

12. Multiply the total amount of available carbon stock by 44/12 to estimate how much will be emitted as CO₂.

13. Multiply the total amount of available carbon stock by 16/12 to estimate how much will be emitted as CH₄.

14. To put both emissions in same units (CO₂ equivalents) multiply the amount of CH₄ by 25 and add to the total emitted CO₂.
15. Since all calculations were made for the life cycle of the plant, divide the total amount of emitted CO₂ equivalents calculated in step (14) by 100 years to get an average annual rate of emission by flooded biomass.

<table>
<thead>
<tr>
<th>Climate domain</th>
<th>Ecological zone</th>
<th>Above-ground biomass in natural forests (tonnes d.m. ha⁻¹)</th>
<th>Above-ground biomass in forest plantations (tonnes d.m. ha⁻¹)</th>
<th>Above-ground net biomass growth in natural forests (tonnes d.m. ha⁻¹ yr⁻¹)</th>
<th>Above-ground net biomass growth in forest plantations (tonnes d.m. ha⁻¹ yr⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tropical</td>
<td>Tropical rain forest</td>
<td>300</td>
<td>150</td>
<td>7.0</td>
<td>15.0</td>
</tr>
<tr>
<td></td>
<td>Tropical moist deciduous forest</td>
<td>180</td>
<td>120</td>
<td>5.0</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>Tropical dry forest</td>
<td>130</td>
<td>60</td>
<td>2.4</td>
<td>8.0</td>
</tr>
<tr>
<td></td>
<td>Tropical shrubland</td>
<td>70</td>
<td>30</td>
<td>1.0</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>Tropical mountain systems</td>
<td>140</td>
<td>90</td>
<td>1.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Sub-tropical</td>
<td>Subtropical humid forest</td>
<td>320</td>
<td>140</td>
<td>5.0</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>Subtropical dry forest</td>
<td>130</td>
<td>60</td>
<td>2.4</td>
<td>8.0</td>
</tr>
<tr>
<td></td>
<td>Subtropical steppe</td>
<td>70</td>
<td>30</td>
<td>1.0</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>Subtropical mountain systems</td>
<td>140</td>
<td>90</td>
<td>1.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Temperate</td>
<td>Temperate oceanic forest</td>
<td>180</td>
<td>160</td>
<td>4.4</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td>Temperate continental forest</td>
<td>120</td>
<td>100</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>Temperate mountain systems</td>
<td>100</td>
<td>100</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Boreal</td>
<td>Boreal coniferous forest</td>
<td>30</td>
<td>40</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Boreal mixed woodland</td>
<td>15</td>
<td>35</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>Boreal mountain systems</td>
<td>30</td>
<td>30</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

### Table 1.5
Carbon Fraction of Above-Ground Forest Biomass

<table>
<thead>
<tr>
<th>Domain</th>
<th>Part of tree</th>
<th>Carbon fraction, (CF) [tonne C (tonne d.m.)⁻¹]</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default value</td>
<td>All</td>
<td>0.47</td>
<td>McGroddy et al., 2004</td>
</tr>
<tr>
<td>Tropical and Subtropical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>wood</td>
<td>All</td>
<td>0.47</td>
<td>Feldpausch et al., 2004</td>
</tr>
<tr>
<td>wood, tree d &lt; 10 cm</td>
<td>0.46</td>
<td>Hughes et al., 2000</td>
<td></td>
</tr>
<tr>
<td>wood, tree d ≥ 10 cm</td>
<td>0.49</td>
<td>Hughes et al., 2000</td>
<td></td>
</tr>
<tr>
<td>foliage</td>
<td>0.47</td>
<td>Feldpausch et al., 2004</td>
<td></td>
</tr>
<tr>
<td>foliage, tree d &lt; 10 cm</td>
<td>0.43</td>
<td>Hughes et al., 2000</td>
<td></td>
</tr>
<tr>
<td>foliage, tree d ≥ 10 cm</td>
<td>0.46</td>
<td>Hughes et al., 2000</td>
<td></td>
</tr>
<tr>
<td>Temperate and Boreal</td>
<td>All</td>
<td>0.47 (0.47 - 0.49)</td>
<td>Andreass and Merlet, 2003; Greysoo et al., 2002; Matthews, 1995; McGroddy et al., 2004</td>
</tr>
<tr>
<td>boreal</td>
<td>0.48 (0.46 - 0.50)</td>
<td>Lambein and Swidge, 2003</td>
<td></td>
</tr>
<tr>
<td>conifer</td>
<td>0.51 (0.47 - 0.55)</td>
<td>Lambein and Swidge, 2003</td>
<td></td>
</tr>
</tbody>
</table>


### Table 2.2
Tier 1 Default Values for Litter and Dead Wood Carbon Stocks

<table>
<thead>
<tr>
<th>Climate</th>
<th>Broadleaf deciduous</th>
<th>Needleleaf evergreen</th>
<th>Broadleaf deciduous</th>
<th>Needleleaf evergreen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Litter carbon stocks of mature forests (tonnes C ha⁻¹)</td>
<td>Dead wood carbon stocks of mature forests (tonnes C ha⁻¹)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boreal, dry</td>
<td>25 (10 - 58)</td>
<td>31 (6 - 86)</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Boreal, moist</td>
<td>39 (11 - 117)</td>
<td>55 (7 - 123)</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Cold Temperate, dry</td>
<td>28 (23 - 33)</td>
<td>27 (17 - 42)</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Cold temperate, moist</td>
<td>16 (5 - 31)</td>
<td>26 (10 - 48)</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Warm Temperate, dry</td>
<td>28.2 (23.4 - 33.0)</td>
<td>20.3 (17.3 - 21.1)</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Warm temperate, moist</td>
<td>13 (2 - 31)</td>
<td>22 (6 - 42)</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Subtropical</td>
<td>2.8 (2 - 3)</td>
<td>4.1</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>Tropical</td>
<td>2.1 (1 - 3)</td>
<td>5.2</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

55
Biogenic GHG emissions resulting from hydropower include CO₂, CH₄ and N₂O (nitrous oxide). Biogenic CO₂ and CH₄ are produced by the oxidation of organic carbon from biomass or detritus, organic carbon matter in soil, or sediments. Although the ESIA only focuses on CO₂ emission, not even mentioning CH₄, the principal concern from climate perspective is methane formation, because it has higher Global Warming Potential. Scientists from the National Institute for Space Research of Brazil reveal that large reservoirs around the world are “one of the single most important contributors to global warming, releasing 104 million metric tons of methane each year” due to rotting vegetation (“International Rivers”). The same team found that CH₄ emitted from the reservoirs of Brazil and India constitute one fifth of both countries’ share in global warming. About 10% of biogenic CH₄ emission factors from hydropower are larger than CO₂ emissions from natural gas based plants and biogenic emissions have potential of being more important than life cycle GHG emissions from fossil fuel combustion (Hertwich).
Reservoirs have recently been estimated to contribute an additional 30% to existing global CH\textsubscript{4} emissions from anthropogenic sources. While the ESIA estimates N\textsubscript{2}O emissions to be zero, N\textsubscript{2}O forms as part of denitrification of nitrogen bound in organic matter, and although N\textsubscript{2}O emissions are of relatively minor concern, they are hardly ever equal to 0.

It is important to conduct an LCA for Khudoni HPP and present a detailed report of estimated emissions from all direct and indirect sources. While doing so, specific variables should be taken into account. Variables that impact emissions rate include: temperature and climate, water residence time, reservoir shape and volume, and amount and type of vegetation flooded, depth, geographic location and reservoir age (Steinhurst 2012). The ESIA provides no publicly available analysis of the particular characteristics of the region and of the reservoir that would be critical in constructing a plausible estimate of the project’s emissions.

Recent studies have shown that in some cases, during the first several years after reservoir creation, GHG emissions may be higher than emissions for some fossil fuel sources. As reservoir ages and the amount of decomposable organic matter decreases, GHG emissions from reservoir surfaces will tend to decline (Roland). Thus, it should be considered that the GHG emissions will tend to alternate with the growing reservoir age and changing amount or type of vegetation. Research done at Hydro-Québec’s Eastmain 1 reservoir showed that net GHG emission rates for within one year of reservoir creation increased from 3,200 to 500,000 tons of carbon, followed by a 156-fold increase over following three years in comparison to pre-flooded conditions, which is more GHG emissions than a natural gas combined-cycle facility produces each year (Steinhurst 2012). A proper assessment also has to address variations in spatial features, weather and seasonal effects through measurements that extend over seasons.
According to Edgar Hertwich, a Professor of Energy and Process Engineering and director of the Industrial Ecology Program at Norwegian University of Science and Technology, the ESIA needs to separately address a number of direct emission sources which are either completely ignored or insufficiently addressed by the Khudoni ESIA (Hertwich):

1) Diffusion of CO$_2$, CH$_4$ and N$_2$O across the air-water interface, depending on wind speed, rainfall, temperature and relative gas concentrations.

2) Methane produced through anaerobic digestion in sediments leading to bubbling, which depends on temperature, hydrostatic pressure, and drowned soil and vegetation type.

3) Downstream emissions which are often neglected and underestimated.

International good practice proposes several ways of estimating emissions from each source separately. Two different methods and technologies can be used to calculate emissions from terrestrial ecosystems (Gondelfum 2006):

1. An open-bottom chamber is placed over a small area of soil surface and the gas emitted into the chamber is measured. The chamber has to be static and closed and has to be equipped with a butyl rubber stopper. At the soil-air interference, GHG fluxes will be measured with such chamber, followed by gas sampling with a syringe and needle and gas chromatography analysis.

2. Soil samples are collected from the study area and taken to the laboratory, where they are placed in incubators under controlled temperature and moisture conditions. Air samples are drawn from the incubator over a given period of time and analyzed on a gas chromatograph for different GHG concentrations. The changed gas concentrations in the air samples over given period of time will be flux of that gas.
To calculate emissions from aquatic ecosystems, similar process can be used: a chamber with air enclosed in it can be put on a water surface to float. As in case of chambers used on terrestrial ecosystems, fluxes from aquatic ecosystems will then be calculated by monitoring the change of the concentration of the gas in the chamber (Gondelfum 2006).

Bubbling can be measured by installing bubble collectors below wind-wave influence. Degassing\textsuperscript{11} of water passing through spillways and turbines can be estimated by taking the samples of water directly at the entrance of the inlets and comparing the concentration of gases to the concentration of gases from a sample of water taken from ports in the conduits leading to the outlets. GHG concentrations can be determined by gas chromatographic analysis, and the difference between the concentrations will be the flux (Gondelfum 2006).

To define the magnitude of GHG fluxes for a given reservoir, gross and net GHG emissions have to be assessed and calculated. Gross emissions are those measured at the water-air surface, while net emissions are gross emissions minus pre-impoundment natural emissions. So, to quantify the net GHG emissions from a reservoir, emissions have to be studied before, during and after the reservoir’s construction. True net GHG emissions are obtained by the difference between pre- and post-reservoir emissions from the whole river basin plus emissions from the construction phase. Since we are trying to forecast emissions from the dam that is not constructed yet, the best we can do is to use the proposed Khudoni Dam site for calculating pre-impoundment natural emissions, and use the Enguri Dam site for calculating gross emissions. Difference between the two can give us a reasonable estimate for Khudoni Dam net emissions.

To simplify the process of accounting for the indirect sources of GHG emissions, the Economic Input-Output Life Cycle Assessment (EIO-LCA) method can be used. EIO-LCA estimates the materials and energy resources required for, and the environmental emissions

\textsuperscript{11} Emission that happens on discharge from low-level outlets induced by dramatic pressure change
resulting from activities involved in dam constructions. The EIO-LCA method was theorized and developed by economist Wassily Leontief in the 1970s, who received the Nobel Prize in Economics for his input-output work in the 1930s. EIO-LCA approach consists of a matrix of economic data (the inputs from all sectors of the economy into all other sectors and the distribution of each sector’s output) and a matrix of sector level environmental coefficients. For LCA analysis, 1 kWh of net electricity produced is used as the functional unit. GHG emissions are normalized to a CO$_2$ equivalent per kWh of net electricity produced based on the guidelines of IPCC for 100-year Global Warming Potentials. Economic activities involved in hydro projects are usually divided into four categories: (1) civil works (diversion, channel, spill way, erection, and commissioning), (2) electromechanical equipment (control structures, transformer, and switchyard and station auxiliaries), (3) operation and maintenance (O&M), and (4) decommissioning. Results from using the EIO-LCA online tool (www.eiolca.net) provide guidance on the relative impacts of different types of products, materials, services, or industries with respect to resource use and GHG emissions throughout the life cycle of a plant.

The ESIA proposes no plans to reduce GHG emissions, since net emissions will already be lower than before the project implementation. Even if after taking into account all of the above mentioned factors, the ESIA’s estimated emission turn out to be accurate, the achievable ways to further reduce the emissions should still be examined and incorporated to the greatest degree possible.

Issues such as site selection in terms of topography and type and density of vegetation are important considerations. Clearing the land of biomass prior to impoundment and managing the land areas surrounding a reservoir can significantly influence the amount of organic material in a reservoir – and thus what is available for GHG generation. Dam design features such as turbine...
inlet and spillway designs present another aspect that offers a variety of possibilities to minimize greenhouse gas emissions (Mäkinen 2010).

After the dam construction, a variety of management options can be used to reduce the level of emissions. For example, the amount of organic material flowing into a reservoir from upstream areas can be controlled by managing land and physically capturing floating biomass. Controlling water levels in a reservoir can also impact level of emissions, as water level fluctuations affect both the rate at which GHGs are released through bubbling and the size of drawdown areas (fertile ground for seasonal vegetation which, over time, becomes flooded and results in decomposition unless cleared) (Mäkinen 2010).

The ESIA should first provide a detailed report of short and long term estimated emissions of all possible GHGs from Khudoni HPP taking into account different variables and then should propose a plan to maximize the emissions reduction throughout the reservoir’s lifetime. It is also important to compare emissions from Khudoni to emissions from all other possible sources of energy, not only from oil and natural gas. Although hydropower emissions might be lower than those of fossil fuels, there might be other “cleaner” sources of energy, development of which might be feasible for the country.

2.6. Fish

2.6.1. Summary of the ESIA

Anadromous migrations in Enguri river have been limited since 1978 when Enguri HPP was constructed, thus, Khudoni construction and exploitation cannot cause any additional significant negative impact on anadromous ictiofauna of Enguri river, which includes, Black Sea Trout (Salmon labrax, pallas), Beluga (Huso huso, Linnaeus), Star Sturgeon (Acipenser stellatus,
The ictofauna within the project’s area of influence is represented predominantly by trout, thus the dam will mostly impact the trout populations in the following ways:

1. Fragmentation of trout’s habitat

2. The temporary decline in water supply below the dam will limit the trout’s food supply

3. There is a risk of water contamination by the increased sedimentation, runoff from construction sites, and waste water disposal, which will negatively impact the trout’s habitat

4. Disrupted river flow, increased turbidity and noise will limit the mobility of the fish and create disturbance

**2.7.2 Mitigation Approaches in ESIA**

Two technologies that help fish survive in dammed rivers, fishway (or fish ladder) and fish nest, fundamentally differ from each other both, constructively and functionally. Fishway’s function is to pass fish in dams, while fish nest is supposed to hinder fish from getting into the turbines of hydroelectric power stations.

The constructional peculiarities Khudoni dam exclude the possibility of fishway. There is no case in history of fishways being constructed in such narrow gorges as Enguri river gorge is, and on such a high dam as Khudoni is. Generally, to lift fish on a 10 meter high dam, there should be 250 meters long stair like and 300 meters long channel like fishway. In case of Khudoni dam, the stair like and channel like fishways would have to be minimum 5.5 and 6.5 km long respectively, which is impossible. There exists another construction that enables fish to pass through the dam, called fish elevator. However, in this case fish elevator wouldn’t be effective either, because in Enguri River there are no more anadromous migrations happening, Trout left
on the upper part of Enguri Dam does not migrate for reproduction, while the very small number of Trout left on the lower part of the dam cannot justify the usage of such expensive and complicated construction as fish lift is.

Fish nest is important not only to stop fish from entering the turbines, but also to avoid turbines’ contamination that can seriously harm their function. Experts think that construction of a metal nest of the size 5X5 mm is absolutely necessary.

- No works should be performed in the river during the reproduction period of Trout, specifically during September-October-November.
- Before the start of any work, the river-bed should be blocked
- Temporary drainage system should be established at roadsides to avoid discharge of muddy water from construction sites into the river
- The risk of oil spills should be minimized
- Discharge of water into the river without proper treatment should be prohibited.

2.6.3. Analysis of the ESIA

The ESIA mostly focuses on migratory species of the river and concludes that since the Enguri Dam already created obstacles to migratory fish, the Khudoni Dam cannot aggravate the problem further. The net effect of additional dam is neglected and it is blindly assumed that when problem is created by one dam, no additional dam can further impact the issue, which is a very naïve assumption.

Anadromous fish are born in freshwater, migrate to the ocean to mature and then return to rivers to spawn. Dams block critical fish migration routes between the river's downstream floodplains and upstream tributaries. A study done on Mekong River in China uses a simple
ecological model of fish migration to estimate fish biomass loss in various damming scenarios. The results of the study show that the impact of the damming of the river on migratory fish is meaningfully determined by the location and number of the dams, as well as characteristics of each dam. According to the model developed by the scientists, the number of endangered species in the Mekong River would increase by 5% with each additional dam (Ziv 2012).

The annual run of adult salmon and steelhead trout in the huge Columbia River basin is estimated to have averaged between 10 and 16 million fish in the 19th century. Today, only some 1.5 million salmon and steelhead enter the Columbia each year, the fact that is attributed significantly to the 130 dams in the basin. The number has been decreasing gradually with the number of dams growing, rather than 15 million salmon and steelhead disappearing all together after the construction of the first dam (McCully 2001).

Before stating that the Khudoni Dam will not cause any additional effect on anadromous fish, the ESIA should consider differences in Khudoni and Enguri Dams, such as, location and size. Even if the major effect was actually caused by the Enguri Dam, additional impact from Khudoni Dam cannot be neglected and should be further studied before final costs of endangered aquatic species is calculated.

Impacts of the dam on non-migratory fish species is also worth paying attention to and should be incorporated in the report. The long-term effects of impoundments on populations of non-migratory fish depend on a large number of factors, including habits of the particular species affected, the drawdown regime of the reservoir, and the climate of the region. For example, in temperate and tropical regions many species spawn in nests in the shallow water near the shore that may be left bare when the water level decreases after the dam is built without leaving a chance to the young to survive. Fish can also be killed if because of variations in weather, the
anoxic water from the bottom of the reservoir is mixed with the surface water. The impoundment of a river also often leads to changes in the kinds and numbers of fish parasites, significantly increasing the level of infestation (Baxter 1977).

Although the impoundment is not likely to be disastrous to most fish populations of the river, the population composition of the species may be changed to a considerable degree. The construction of a dam usually leads to variations in water level downstream. These variations can cause considerable decrease of diversity of benthic organisms. Another danger for fish and other aquatic animals below dams is gas-bubble disease. The pressure created when air and water are mixed in a turbine, may be great enough to force gas into solution. Or, when water is forced over a spillway into a deep basin, air bubbles may be carried to a depth where the hydrostatic pressure may be great enough to force gas into solution. Result is water supersaturated with gases, which, if ingested by a fish, might be stored in various parts of its body and cause, injury or even death depending on the size and location of the fish. Although the degree of supersaturation that can cause gas-bubble disease depends on the age and species of the fish, in some cases as little as 18% of supersaturation may be sufficient (Baxter 1977).

Knowing that dams cause water quality problems, it is easy to assume that contaminated or poor quality water will have adverse effects on fish. Furthermore, if dams are lowering fish numbers, than chances are they are also having a negative effect on other aquatic forms of life.

For example, cold discharges and highly variable flows from Center Hill Dam in Tennessee, have created an environment that can be tolerated by only a few species of aquatic invertebrates. Multiple studies have confirmed that invertebrate populations of the water increase in diversity.

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12 The Broken Bow Dam on the Mountain Fork River in Oklahoma was built in 1961 and the results received prior to this included 84 species of fish. Results received after the dam was built are from 1971 and the fish population included only 65 different species (Miller 2004). Results taken from 1964 before The Beaver Dam on the White River in Arkansas was built showed 23,535 individual fish and 62 different species recorded. Results were then taken after the dam was built in both 1968 and 1969. In 1968 there were 1,193 individual fish and 18 species. Then in 1969 there were only 527 individual fish, yet 21 species recorded (Quinn 2003).
in direct proportion to distance from the dams ("FINAL ENVIRONMENTAL IMPACT STATEMENT" 2007). The study conducted in 2002 that involved 40 different dams in the Fox River in Illinois showed an average of 70 different species of fish before the dams were built and only 40 afterwards ("Fox River Ecosystem Partnership" 2002). Figure 3 demonstrates the relationship revealed between dams and fish species. The more dams there are, the fewer is the number of fish species. This relationship further proves that the assumption that the Khudoni Dam cannot aggravate problems created by the Enguri Dam is flawed.

![Species richness vs. number of dams](image)

*Figure 3. Relationship between aquatic species richness and number of dams (Cumming 2005)*

There are diversity of methods employed worldwide for mitigating dams’ effects on fish and aquatic habitats. Variety of methods were tried at the Cumberland and Caney Fork Rivers in Tennessee, which before impoundment supported highly diverse fish and aquatic species. Once Center Hill Dam was constructed the seasonal flows, water temperature, and water quality changed radically, creating an environment that could not be tolerated by native species of fish and aquatic invertebrates. Presently, the fish communities in the Caney Fork River below the dam are composed of remnants of the pre-impoundment populations. A preliminary Physical
Habitat Simulation System (PHABSIM) was used to analyze the physical habitat for trout in the tailwater. The PHABSIM analyzed the availability of habitat of suitable depth, velocity, and substrate for trout. The results of this study indicate that the optimal minimum flow requirement for trout below Center Hill Dam is approximately 200 cubic feet per second (cfs) and thus quality and flow improvements would greatly improve the fishery and management options below Center Hill Dam. An Environmental Assessment further concluded that if the grouting, installing barriers (grout curtains) in dam foundations where the rock formations in the dam foundation is pervious and would lead to later seepage problems, was successful the minimum flow that sustained the trout fishery below the dam would be significantly diminished ("FINAL ENVIRONMENTAL IMPACT STATEMENT" 2007). Similar study should be performed in Enguri River to identify favorable conditions for trout survival. Before decision makers decide which mitigation measures to take for the Khudoni project, ideally, an ecosystem approach should be taken to establish an adequate knowledge of aquatic resources, including species distributions and requirements, ecological processes and functioning of ecosystems.

In the same water body, it was found that from August to October of each year, oxygen in the water released during power generation is less than state water quality minimum of 6 mg/l and consequently, the trout fishery below Center Hill Dam is stressed. In 2004, various structural options were tried to address the lack of minimum flow for trout and seasonally stressed DO conditions. Although, the modification of the turbines in the hydropower plant by installing hub baffles and supplemental air supply lines to inject air into the turbines, were unsuccessful, in the fall of 2005 problem was solved. Hydropower generation discharges were blended with sluice gate releases. The sluice gate is an opening through the dam that provides about 1,200 cfs. Water from the sluice gate flows directly through the dam rather than through the generators, produces
a turbulent flow and raises DO levels enough to keep the trout fishery undamaged during cold season. As a result, the Caney Fork River’s potential to support trout survival was significantly increased (“FINAL ENVIRONMENTAL IMPACT STATEMENT” 2007).

Widely proposed methods for reducing the harmful effects of drawdown on the fish populations include the construction of sub-impoundments that retain water when the level in the main impoundment drops, the construction of floating nesting platforms, and a drawdown regime which avoids laying bare the littoral at the most critical times (Waldman 2013).

In order to compare which mitigation measures and constructions are economically efficient, all costs of lost fish populations should be calculated. In addition to the intrinsic value, fish are an important source food, recreation and sales in the region. Fishers play important role in resources conservation when they are organized. Also, loss of certain aquatic species that serve as food supply for species in upper trophic levels will initiate a chain reaction and impact the survival rates of other species as well. Once cost of losses is estimated and benefits from each possible construction are quantified, can economic feasibility be determined.

3. Summary and Analysis of Conclusions on Social Impact of Khudoni HPP.

Social and economic impact assessment includes the analysis of foreseen as well as unexpected positive and negative effects and social changes. Khudoni HPP will have short term as well as long term impacts during both construction and exploitation phases. Socio-economic impact will be quiet long term and it has to be discussed in a wider context – particularly, from the standpoint of increased energy independence and country’s energy demand.
3.1 Displacement

3.1.1. Summary of the ESIA

Construction of Khudoni HPP reservoir and infrastructure will severely impact local population: there will be significant losses of private lands, real estates, culture and source of income. The study was conducted to identify private properties and their owners in the area of project’s influence and to estimate the scale of potential impacts. The study concluded that following villages will be impacted: Khaishi, Idliani, Skrometi, Lalkhorali, Tobari, Lukhi, Tsvrimindi, Naki, Dakari, Shgedi, Lajra, Tsitskhvari and Lakhani. People in Khaishi, Dakari and Tobari will be resettled fully, while only several houses will be displaced from other villages. Total of 184 houselods (769 individuals) will experience direct impact from the project. Total of 14 settlements, 224 houses will be influenced. Since the population of Khaishi mostly lives off the land, their source of income will be flooded. There will be social-cultural adaptation problems for the population at the new place, especially if this new place is the urban area where people will have to change their habits and sources of income.

3.1.2. Mitigation Approaches in ESIA

The project will be implemented according to the Georgian legislation on “Involuntary taking of the private property for public need.” Since this is not a case of mutual agreement, the process of involuntary resettlement needs a good planning to avoid worsening of life conditions of affected people.

In the international practice, in addition to compensation of losses, full rehabilitation of living conditions and sources of income for displaced families is usually demanded. Thus, socio-economic analysis of the impacted community, and development of relevant compensation-rehabilitation program is necessary. Since 2013 an agreement was signed between the GoG and
the investor company that obliges the investing company to prepare the final version of resettlement plan that will include reasonable compensation for the resettled families. In addition, the mitigation of complex social impacts on resettled villages as well as on villages that have to accept displaced families, the rehabilitation activities should not only maintain the socio-economic status of the villagers, but rather ensure significant improvement of living conditions. It is completely feasible to satisfy the needs of all affected families without majorly raising the costs of the project.

3.1.3. Analysis of the ESIA

This part of the ESIA deserves special and careful consideration, as the resettlement plans are the reason of major conflicts associated with the project. Elimination of possible flaws in this part can significantly lessen the resistance of the Svani people against the project. Every person has a right to adequate housing and security, and they are protected by human rights law from being unlawfully displaced from their homes and lands. However, every year numerous families are forcibly displaced to make way for mega-dams. It is true that in some exceptional cases land eviction may be necessary however, displacement caused by development projects should not occur in violation of human rights. Forcing people out of their lands often happens in undemocratic ways using threat and violence, leading to homelessness, loss of livelihoods, physical and psychological trauma, morbidity and vulnerability, and social disintegration. In addition, forced evictions are also inherently discriminatory, as usually it is the poor who are displaced.

First of all, since now we are considering livelihoods of hundreds of families, it is especially important to precisely define the impact areas. International practices also require the defining of impact areas for use in the ESIA. The ESIA refers to various terms: ‘Area of
Influence,’ ‘Project Area,’ and ‘around the project area,’ without ever defining what exactly each term means. Furthermore, the ESIA lists different categories of impacted settlements, without clarifying who is affected in what manner, and to what extent. The terminology used is unclear and no maps are provided to illustrate the impacted areas. Given that the areas of project impacts are unclear, the issue of direct and indirect influence remains vague. From the ESIA the reader cannot conclude who will be affected, in what manner, and where. This is of particular relevance in relation to the proposal of mitigation measures. Project’s area of influence should be defined and the terminology should be consistently and uniformly used in the ESIA.

The ESIA does not provide any distinction between groups of affected people according to the degree of impact from the project. Similar to the need to provide a clearly defined baseline with demographic and socio-economic-cultural details and maps of affected areas, in the impact description a categorization should be made for groups of potentially affected people, according to the type of impact. Some of the affected people would clearly fall into categories of physically or economically displaced ones. Others may fall into different categories based on the degree of loss. All of these affected groups have to be included in compensation framework and social development plan.

The Asian Development Bank (ADB) defines ‘Affected Persons’ as “those who stand to lose, as a consequence of the project, all or part of their physical and non-physical assets, including homes, communities, productive lands, resources such as forests, range lands, fishing areas, or important cultural sites, commercial properties, tenancy, income-earning opportunities, social and cultural networks and activities. Such impacts may be permanent or temporary” (ADB 1998:3). According to the World Bank, ‘direct impacts’ means “any consequence immediately related to the taking of land or to restrictions in the use of legally designated parks and protected
areas” (Bugalski 2013:9). Similar definitions should be developed for all terminology used in the ESIA.

Similarly, the numbers of households and names of villages are not precisely presented. No explanation is provided for why the villages are grouped the way they are. It is not clear whether groups of villages experiences similar type or level of impacts. The ESIA does not provide precise baseline data on affected households, and is thus unable to address precise impacts and mitigation. The social baseline is seriously flawed. Directly and indirectly affected areas and villages should be characterized by a baseline which includes demographic and socio-economic and cultural details. The baseline should also include information on:

- Demography of the population in the affected villages;
- Income/wage levels and economic vulnerability;
- Health of the affected people;
- Livelihood improvement needs and expectations;
- Identification of vulnerable groups;
- Dependency on land, water and ecosystems;
- Community based organizations and local institutions;
- Cultural identity, social structures and status;
- Mobility and linkages between affected villages and the outside world;
- Cultural practices of the communities; and
- Preferences of affected people for relocation sites and compensation.

These data would form the base for the resettlement policy and basic description for the resettlement action plan.
In April 2013, the World Bank published its new Policy on Involuntary Resettlement, Operational Policy (OP) 4.12 (Bugalski 2013), to minimize involuntary resettlement and to make any resettlement activities sustainable. OP 4.12 covers direct economic and social impacts of displacement, assuming that the improvement or at least restoration of living standards of displaced communities can only be achieved by properly assessing displacement. The consultation phase should be even more extensive when the investing company is the one building the resettlement plan, as is the case of Khudoni project.

For projects with significant displacement impacts, the World Bank policy requires resettlement to be treated as a separate project. Before such separation occurs, however, (1) the general welfare value of the project should be established, including all material and non-material impacts of the displacement; and (2) it has to be made sure that the project design minimizes displacement to the fullest extent possible (Bugalski 2013).

Human rights impact assessment should be conducted while the project is still being prepared and not after the start of the construction as it is planned for the Khudoni project. Such assessment should account for not only current assets, living standards, and incomes of affected people, but also for all economic, social or cultural opportunities they would have had in the future had they stayed at their current place of settlement. Otherwise the assessment will fail to fully capture the extent of displacement on local communities, and many risks will remain unaccounted for (Bugalski 2013). In addition, post-implementation, follow-up, periodic assessments should be planned to ensure that objectives made during the project preparation are properly fulfilled.
Compensation is the most sensitive part of the resettlement plans. Compensation of all short and long-term losses should be estimated for each affected family individually, and fully included in calculations of overall costs of the project.

In addition, especially vulnerable groups, who usually have harder time adjusting to changes and require special consideration, should be identified and treated accordingly. Indigenous peoples are frequently categorized as vulnerable peoples, not only because they are frequently poorer than other groups, but also because of their unique social and cultural circumstances. The ESIA presents arguments for the non-qualification of the Svani people of Khaishi villages as ‘Indigenous Peoples’, mainly based on their non-affiliation with the more remotely located Svans (upstream) and their closer ties to non-Svan areas in the south (downstream). The World Bank Group uses the term “indigenous people” in a generic sense and clearly states that there is no universal accepted definition. The Svani people living in Khaishi Village fit a number of characteristics of indigenous groups, including:

- Self-identification as members of a distinct cultural group, the identity also being recognized by others;
- Collective attachment to a geographically distinct area affected by the project;
- A unique and distinct language, culturally identifying the Svans;
- Customary cultural practices, days and events that are separate from others; and
- Social ties between Khaishi and surrounding project affected villages around and other villages in upper Svaneti.
The above characteristics can easily classify the Svani people as a unique community which may be referred to as an “ethnic nationality” group. The Svani people living in Khaishi cannot be separated out as not having an ethnic identity based on the arguments outlined in the ESIA. Thus displaced families can be characterized as vulnerable group and should be treated as such.

Once the social baseline study is completed and all relevant information is studied accordingly, all results must be communicated with the villagers. The communication with potentially affected people of the Khaishi community as well as the inhabitants of the upper Svaneti region has been incomplete and not transparent. Flaws in procedures for resettlement planning and lack of information sharing have resulted in significant distrust of the population in government and investor. The current situation therefore represents a high risk to the development of the project and is a potential source of conflict and hindrance to the project. After decades of uncertainty, the Khaishi population wants clarity on their fate. On several occasions during the site visit representatives of the population in Svaneti have expressed the expectation that the newly elected government will provide transparency on the future of the region. A window of opportunity thus exists, if timely and appropriate measures are taken to de-escalate the present situation.

The issue of miscommunication was raised during the meeting arranged by villagers to discuss the revival of Khudoni Dam construction. As Khaishi villager stated, “Politicians sit in their offices in Tbilisi and make decisions that will affect and completely change our lives here, why don’t they ask for our opinion? Why aren’t they interested what ails us and why?”

During the meeting villagers in opposition and even some supporters of the dam decided that its construction was unacceptable given that the decisions regarding the future of Khashi were made
by bureaucrats from Tbilisi without local input to the decision-making process. A special commission on Khudoni Dam construction was established during the meeting, which elaborated a first appeal to the President of Georgia. Its statement underlines that despite television and newspaper reports, no government representative had met with local people to explain the situation regarding the Dam’s construction and thus effectively limiting local villagers’ rights to participate in the decision-making process. The statement requested the President and relevant ministries to send representatives to the region and provide explanations of the process. Despite the number of requests from the local population to involve local stakeholders in the decision-making process, till now people’s concerns had not been shared.

Officials publicly declaring that the construction of the Khudoni Dam has already been decided, is also a form of pressure, since some locals believe their opinions will not be taken into consideration. The Prime Minister’s call for Svans “to address the Khudoni issue with understanding” is another example of pressure from officials. “Keep in mind that Khudoni needs to be constructed like many other hydro power plans,” the Prime Minister announced. That same evening, Energy Minister Kakha Kaladze gave a televised interview and promised that all Svans would receive appropriate compensation. “They talk to us resolutely, but our opinion is that the Khudoni Dam must not be built,” says local priest.

Moreover, police officers were mobilized in Khaishi for the September consultations. Locals say that they have not seen so many police officers in the village for years, they felt they were being frightened to come out and express their opinions. Now, locals associate all incidents in village with being forced to leave. For example, they claim that one of their neighbors was illegally fined for transporting wood to terrify them and make their lives unbearable if they refuse to leave.
Uncertainty is one of the most unbearable conditions for local people in this situation. Politicians keep making promises that people will get the “best deals” on individual basis, but no one has ever presented a detailed plan of resettlement. “Trans Electrica representatives talk about taking into consideration every person’s needs while making displacement plans, but no one has ever gone door to door in Khaishi village asking for people’s requirements. Decision-makers keep mentioning costs for displacement but, where are they getting the numbers from, when no research of actual needs has been performed yet?” says the representative of Green Alternative, an environmental non-governmental organization.

To address these issues following should be done:

- The investor needs to develop a communication and consultation strategy to address the issue of mistrust at the community and household levels. Timely disclosure of information on project plans, anticipated impacts and proposed mitigation and compensation measures should be prepared;

- In addition, the ministries of environment and energy should show their intention to assure transparency of decision-making processes;

- All necessary information has to be collected to produce a full-fledged Resettlement Policy Framework (RPF) as a necessary first step to the required RAP. The completed RPF should be part of the ESIA;

- Cultural authority (e.g., the Ministry of Culture) should address the issue of identifying Svans as unique ethnic group; and

- The context of conflict triggering historic issues needs to be studied as part of the social baseline and dealt with.
According to the OP 4.12 (Bugalski 2013), the access to information and participation and for affected people during the resettlement process is hugely important. It would be a violation of human rights to exclude affected people from having any control over the decision making process of their own fate. Moreover, needs, priorities and choices of impacted people have to be considered in order to ensure a sustainable resettlement. Particular attention must be paid to ensure that vulnerable and marginalized groups are able to fully participate in planning, decision-making and implementation processes. If done properly, resettlement activities would evolve into a genuine community-driven development initiative, and when people start feeling some degree of control in their hands, their resistance will hopefully decrease.

A clear example of how transparency can change the outcomes is the case of Aguamilpa and Zimapán hydroelectric dams in Mexico that caused the resettlement of 3000 people (Bugalski 2013). Although the project was already in negotiation, the team set out to implement “a new approach to resettlement – an approach based on creating an institutional capacity for consultation and participation.” In Aguamilpa, where the affected people were mostly Huichol Indians, the company’s first attempts to organize group meetings and discussions about resettlement were met with complete failure. However, after the project’s independent advisor recognized the need for a more culturally appropriate approach, and the company began house-to-house visits to the remote settlements, the Huicholes began contributing their ideas about good locations, proper housing designs, and special their special needs. The participation strategy in Zimapán was more sophisticated, because the strategy itself was negotiated locally. Community antagonism toward the first resettlement proposals had been so intense that people had repudiated their official leaders. This evolved into a “negotiating committee” that developed a protocol for all resettlement discussions. Institutional resistance and community stratification
made the participation strategy difficult to implement. It also proved challenging as the process went on to ensure that the voices of women were heard in negotiations with the company. However, the team managed to foster a process whereby affected people were able to select their resettlement land, design their own housing and negotiate fair compensation rates. As a result of the greater control that they had over resettlement planning and implementation, resettlement outcomes were largely successful. While this case illustrates that the up-front costs of participatory resettlement are higher – negotiation forces compensation rates up considerably – these costs must be weighed against the benefits gained from getting local buy-in. Aguamilpa and Zimapán are among the few large dams ever completed on time in Mexico, while many others have been delayed due to factious resettlement. At roughly the same time that Aguamilpa and Zimapán were being constructed, two other large dams were cancelled entirely because of resettlement protests that blossomed into armed confrontations and marches into Mexico City.

“The project’s ‘participatory stance’ led to happier people, not just among the resettlers but among the technical staff as well. During supervision we repeatedly met field engineers and supervisors who commented how relieved they were to be working on a project in which they didn’t feel surrounded by hostile, bitter people…Resettlement colonies in other projects we visited were often squalid places, mired in poverty and unhappiness” (Bugalski 2013:70).

According to the ADB, “[A]ffected people should be fully informed and closely consulted on resettlement and compensation options. Consultation with APs [Affected Peoples] is the starting point for all activities concerning resettlement. Participation in planning and managing resettlement helps to reduce their fears and gives APs an opportunity to participate in key decisions that will affect their lives. Resettlement implemented without consultation may lead to inappropriate strategies and eventual impoverishment.” (ADB 1998:39) Therefore, it is
essential to facilitate participatory processes with all affected people, not only those from one particular group. This is certainly one of the most important conditions for good planning and management of all kinds of projects, including hydropower dams.

Given the complexity of these matters, the best decision would be to hire an internationally experienced expert in RAP development to guide the process. Furthermore, an Advisory Group may be considered to overview the process and check the fulfillment of the core issues. Independent experts should be engaged to audit and verify compensation amounts or the adequacy of housing provided. An independent third party should be engaged to ensure that affected households and communities have an opportunity to freely choose between the options presented based on all relevant information.

Once a communication channel and a minimal level of trust have been established, the following steps are easier to project. Projects causing displacement should not rely primarily on compensation, but rather it is employed as simply one tool among an array of programs and investments that support affected people to improve their standard of living. These investments should support development initiatives that aim to expand access to resources and opportunities and enhance capabilities, and thus contribute to the realization of human rights.

3.2. Health & Safety

3.2.1. Summary of the ESIA

Change of local climate within 0.5-1.5 km from the Khudoni dam, might have effect on health of the people living in the mentioned area. Outside this territory, the impact of the reservoir on the climate will be negligible. According to the medicinal statistical analysis, occurrence of osteoarticular and connective tissue diseases is much higher (about 2.6 times) in population in Mestia, around Enguri HPP, in comparison to the rest of the region. Endocrine,
cardiovascular, respiratory diseases and cancer are also more common in Mestia than in any other part of Svaneti. Instances of cerebrovascular diseases in Mestia are 2.4 time higher than the average of the region. However, several factors contribute to this statistics:

- Instances are only recorded in statistics in hospitals after the visit of a patient. Population of Mestia has better access to the hospitals and free check-ups because of state programs;
- Because of very small population, even one occurrence of the disease increases the statistics significantly.

In case of lack of proper management, run-off from construction sites might become polluted by pathogenic microorganisms, various organic and inorganic substances. Contamination of water by household remains is a huge problem in Mestia. Sewage system exists only in borough Mestia and is non-existent in villages. Fecal masses are usually disposed of in rivers, creating problems during floods. This is reflected on the quality of drinking water, causing increase of diarrheas. Lack of garbage transportation and accommodation infrastructure creates further risks of contamination and creation and increase of various diseases.

3.2.2 Mitigation Approaches in ESIA

- All workers must go through medical examination before being hired;
- Sewage systems must be organized;
- Sanitary buildings, such as, baths and toilets, must be constructed; and
- Drinking water quality must be constantly monitored.

3.2.3. Analysis of the ESIA

In terms of health & safety the ESIA only considers spread of possible diseases as a result of dam construction, however there is an array of various safety issues that should be considered.
Health and safety issues are particularly acute in people indirectly affected by the project, due to various temporary and permanent activities, construction in particular. The following impact themes are not addressed adequately or are absent from the ESIA: transport and local community safety, mobility, threats of loss of access to resources, food security and quality of life. All possible impacts should be accordingly assessed and ranked in terms of severity. The management plans need to reflect the degree of impact predicted and the associated remedies.

A visit to Svaneti will make it obvious that even though the dam is far from being finished yet, the construction works have already had a devastating footprint on the village and the life of people there. In the spring of 2005, a huge mountain literally fell apart, trapping a river and resulting in the destruction of a bridge and the tunnel network. In order to get from Khaishi to Gagma Khaishi, another small village, people have to use a temporary bridge that, according to locals, will soon be washed away by the river. That creates quite a problem for the people of Khaishi and other villages to get access to hospital and other services. The dam’s foundation has also severely impacted the Enguri’s flow. According to local populations, placement of concrete was planned to continue along the dam’s hundreds of meters to retain the river’s waters. But it never happened and the river waters are splashing away the dam’s foundation. The Enguri River is disappearing under the bridge connecting Khaishi to Gagma Khaishi, caused in part by a 100 meter-deep underground tunnel. Last spring this tunnel cracked; this year people also expect the same. Local villager Tamaz Kvirikadze explained that while there is no flooding yet this season, the tunnel already has a problem with water turnover. During flooding, water splashes out of the tunnel and could potentially destroy village houses, as Khaishi is only 30 meters from the dam construction site.

Landslides are common in Khaishi now. After one such huge landslide, when land
masses and rock came down, blocking road entry to the village and destroying gardens along the banks of the Enguri, villagers gathered in front of the Sakrebulo building. An owner of one garden was devastated, as she witnessed five years of work destroyed in an instant. One woman shared her story about a landslide directly in front of her house. Upon hearing a terrible noise and seeing the mountain start to crumble, she immediately took her children and ran from the garden. Now, their house is inhabitable, and the family must seek refuge with relatives. Yet it is unclear where her family will live in the future and whether the GoG will provide any support.

The introduction of thousands of construction workers would affect the social network, cause disturbances and disrupt local communities. The safety, health and wellbeing of all employees should be guaranteed, and human and indigenous rights respected. Recognizing that dam safety is an issue throughout the operating life of the facility, the design and construction of the dam should be adequately supervised and safety measures adopted for the design, construction, operation and maintenance of the dam and related facilities.

3.3. Cultural Heritage

3.3.1. Summary of the ESIA

Important cultural heritage sites that will be flooded includes:

- St. George Church
- Cemetery
- Medieval century graves
- Settlements from classical period
- Treasures
- Ruins of ancient buildings.

3.3.2. Mitigation Approaches in ESIA
Detailed research will be done in the areas under risk before the start of the construction. Stationary archeological excavations will be performed on monuments. Khaishi church and cemetery will be relocated according to the Christian and local traditions.

3.3.3 Analysis of the ESIA

The construction of the Khudoni HPP will have enormous impact on existing and largely unstudied cultural heritages. Svani people have special ties with their culture and traditions and are extremely sensitive about the issue of flooded heritage. Locals of the Khaishi village in Svaneti continue to sign the pledge against the planned construction of the Khudoni hydro plant in their area. A group of more than two hundred locals gathered near the St George Church in their village in November to sign the paper and offer their pledges in front of an icon.

“I pledge to use my physical and mental abilities to prevent flooding of the Khaishi St George Church, the village and its cemetery, and sign the paper to attest to the validity of this pledge” - said all of residents. Khaishi residents stated they would not accept any amount of compensation for leaving their history behind.

The potential impact on cultural heritage has been stressed several times during the public hearings. According to the screening document “Loss of culturally significant sites (there are only few archaeological sites, but sites such as churches and burial sites are also important to people) will cause: impacts on the population’s feelings of place, history, culture and memories.”

The possible mitigation measures proposed by the ESIA in order to preserve the cultural heritage sites, like “complementary archaeological excavations and relocation of cultural monuments (Kaishi church and cemetery)” looks unlikely to be enough. Along with the impacts on tangible cultural heritage, the impacts on intangible cultural heritage, such as traditions and rituals should be considered. For communities that try to hang on to and maintain their ancient traditions, using
ancient customs as a part of everyday life, identifying themselves with their ancestors and forefathers, these types of impacts are very sensitive. The measures proposed are not enough, especially taking into account that indigenous peoples’ policy is applicable to Svans. As a mitigation measure to avoid disruption of social networks, development of an integrated development Project for the Svaneti Region has to be proposed and the deeper programs for preservation of Svaneti original way of livelihood will be required.

The ESIA estimates the project’s impact on tourism industry as beneficial, assuming that tourists will be drawn to the area to visit mega-dam site. However, the issue of destruction of already touristic sites and consequent economic loss is completely ignored. The Khudoni Dam region, highly prized by tourists, famous as it is for its ancient and contemporary history as well as for its magnificent views, is facing a significant change. Following the rise in the water level, it will have to somehow encourage tourism despite the loss of many sunken relics and the inevitable loss of charm due to the transformation of the landscape. In Upper Svaneti region, the local culture, along with the historical and religious sites, constitute significant assets for tourism.

The ESIA reports on several cultural properties and heritage sites, including a church and cemeteries, and other archaeological sensitive sites. The Khaishi Church of St. George and various cemeteries are stated as the most sensitive of the cultural heritage sites affected by the project. However, there is no information about other cemeteries. The ESIA does not point to precise communication, analysis or agreements with the authorities on the actions to be taken on the cultural heritage sites.

With respect to cultural heritage it is recommended to make a detailed description of all the cultural heritage sites and their precise location. These should be then dealt with in the
impacts assessment and mitigation chapter. How the issues of flooded archaeological sites, a church and several very old cemeteries will be dealt with is unclear from the ESIA.

In her report on the right to access and enjoy cultural heritage, the Special Rapporteur in the field of cultural rights has stressed that “States have the duty not to destroy, damage or alter cultural heritage, at least not without the free, prior and informed consent of concerned communities, and to take measures to preserve/safeguard cultural heritage from destruction or damage by third parties” ("Mandates of the Special Rapporteur” 2014:20). States should cooperate with affected communities and initiate cultural heritage mapping processes before completing cultural impact assessments. Attitudes of communities towards cultural heritage should be fully taken into consideration and relevant remedies should be offered to individuals who are concerned that their right to their cultural heritage is violated ("Mandates of the Special Rapporteur" 2014).

Cemeteries have to be dealt with on case by case basis and the communities have to be central in this along with the Clergy and authorities. An exhumation plan as part of the framework plan has to be made, with process and costs outlined. Importantly a participatory process has to be laid out to handle any excavation and relocation of burial sites. Outlining perceptions and cultural ties to burial sites and other locations of local cultural value, and acceptance towards transfer of these sites of cultural value has to be documented as part of the baseline. The community discussions and opinions have to be better documented in the baseline.

According to the WCD (Brandt 2000), the issues of Rights to a Cultural Heritage include: (1) the right to a cultural past; (2) the impact of heritage displacement on local communities; (3) the alienation of people from their cultural pasts; (4) the indifference of archaeologists to the needs of local people; and (5) the misuse of archaeology in “rescuing” the histories of displaced
people. The right to a cultural heritage is a basic tenet of human rights law, as implied in the Article 27 of the United Nations’ Universal Declaration of Human Rights (“The Universal Declaration of Human Rights”). The loss of the cultural heritage weakens local communities and diminishes the pool of knowledge and wisdom from which they draw strength and resilience.

As is clearly stated by the WCD (Brandt 2000), the magnitude of cultural loss from different parts of the world wherever large dams are constructed is staggering. The impact of large dams on cultural heritage is, long-term, far-reaching and irreversible. The impact of dams extends to the loss or damage of cultural heritage as a result of the construction of power lines, roads, railways, and workers’ towns. Erosion processes initiated by the construction of dams expose subsurface archaeological remains and make them vulnerable to damage.

As in case of involuntary resettlement, the involvement of direct and active participation of local communities in all stages of cultural heritage management (CHM) is a requirement for success. CHM should be integrated with development projects to benefit the local communities, especially marginalized, indigenous populations. CHM operations must begin as early as possible before construction, and a methodology to establish priorities and determine significance (Brandt 2000:6-8).

WCD advises all entities involved in project implementation to ask following questions during the design phase of the project (Brandt 2000:14-16); are communities being asked about the cultural meanings of their landscapes? Are they asked to explain which sites form a central core to their identities or how the loss of certain sites will influence their cultural well-being and their way of life? In the next phase, as mitigation plans for are being designed, should be asked; what kinds of information are most significant for your cultural and historical needs? How can your participation in mitigation efforts increase your capacity to maintain your own past and histories?
The failure to share power in dam planning and mitigation of impact on cultural heritages amplifies alienation of local communities from their cultural pasts. By removing local communities from meaningful roles in decision-making, developers are solving problems that might be irrelevant to those who are linked to those sites.

For example, the Three Gorges Dam in China triggered the relocation of temple dedicated to Zhang Fei which carried a special importance for the followers and worshippers. People were hugely disappointed with this relocated temple, which “no longer really looks like a temple”, as they say. They no longer enjoy themselves there so much, many things are lacking, but above all it is thought to be no longer as “effective”, having lost, inter alia and its auspicious surroundings. In the countryside, there are stories that tell of Zhang Fei’s displeasure and his refusal to be removed (Le Mentec 2006:5-8).

The choice of conservation measures depends on the condition and vulnerability of the site, the degree of present and potential threat, the cultural significance of the site, and its potential future use. To ensure the effective implementation of the conservation measures selected, projects should include components to strengthen the institutions responsible for safeguarding and managing cultural property (CP). It is crucial to support training, technical assistance, review and strengthen the legal framework. The project needs to: (1) take into account the presence of CP identified in its national inventory, (2) document any damage to such CP; and (3) incorporate measures to conserve and restore such property as appropriate. The project is then designed and implemented so as not to cause further damage to CP. Provision must be made for the prompt publication of technical reports and interpretive materials to the public. CHM must also include post-construction monitoring, assessment and rehabilitation plans (Brandt 2000:14-16).
V. Conclusion

The public increasingly perceives the Khudoni ESIA as a biased bureaucratic document. Because of this, the Khudoni has lost credibility amongst its target audience, namely the Georgian public. The community generally expects that an ESIA should be an objective scientific report while many consultants and project proponents view an ESIA as a supporting document prepared as part of the procedure for gaining approval for a project.

The goal of a completely objective research instrument like the ESIA is hard to reach when large investments, careers and businesses have already been committed. In this case, the Khudoni ESIA was carried out rather late in the planning process when project proponents already had committed considerable financial resources to a particular option at a designated site. The ESIA performed at this stage became another obstacle in the way. Naturally, developers wanted the document to emphasize the advantages of the project to the community and to downplay the disadvantages.

The analysis of the Khudoni ESIA has revealed a significant number of instances where project proponents leave vital information out or do not fully disclose results. Also, biases arise from the many value judgments that were made at every stage of the preparation of the ESIA. The scope of the Khudoni ESIA was solely decided by the developers, further increasing the source of bias.

The design of an ESIA study also requires judgments of what types of impacts will be significant and the collection of data requires decisions about the time period and area over which samples are collected, the species to be studied and the quantities of individual specimens to be collected, more generally the scale of study. Such decisions for Khudoni ESIA were not
made only on the basis of what might be considered by a scientist to be appropriate, but were also affected by considerations of cost, time availability and even likely outcomes.

Similarly, methods of analyzing data can vary in the sorts of results they produce and data they require and those preparing an ESIA will choose the methods using many criteria, apart from the 'purely scientific'. Data collected and the results of analyses can be interpreted in a number of ways. The Khudoni ESIA presents the most favorable interpretation that is available and is carefully worded to avoid any impression that anything is uncertain. More generally, the consultants have merely made their choices and judgments at the more favorable end of a range that is scientifically credible.

It is often argued by supporters of the system that the ESIA process avoids bias and distortion by subjecting the ESIA to public scrutiny when it is displayed and then it is assessed by government authorities. However, the Khudoni ESIA is not public yet and government authorities such as the Environment Ministry do not possess enough power to trigger significant changes in the system.

Nevertheless there are ways in which the ESIA can be made more transparent to the reader. Rather than attempting to appear objective an ESIA should incorporate discussion of assumptions, choice of methods and different interpretations that can be made of the studies. Unedited reports and raw data should also be made publicly available. The final ESIA should be subject to peer review.

The major factors preventing a more transparent and accessible ESIA and free discussion of likely impacts arise from the way the process is structured. Those who prepare the ESIA, or hire the consultants to do so, usually have much at stake, financially or politically. Consultants are dependent on the judgment of clients and that judgment is based on whether they are
perceived to be able to deliver what is beneficial to the client. Consultants with overdeveloped consciences, who do not put the client's priorities first, are less likely to be given work in the future.

Consultants could be more independent if they were not directly hired by project proponents. An independent panel with community representation could choose the consultants from tenders. Proponents would still pay the consultants. In this way a firm that compiled an ESIA leading to unfavorable results regarding a particular project would not be penalized for doing so by being denied ESIA work in the future.

Biases would still remain – biases will always remain whenever judgment is required - but there would be a better chance of objectivity. Also, it is more likely that consultants under such a system would be willing to make ESIA's more transparent to the public and to discuss uncertainties and unknowns.

At this stage, in order to regain the trust of the public, diminish the resistance to the project and make it fit in the interests of all parties involved, the developers need to:

- Improve above-mentioned weak points of the ESIA;
- Provide more detailed analysis of outlined issues;
- Carefully estimate all potential costs of the project;
- Ensure completely transparent planning process;
- Involve affected communities in decision-making;
- Discuss all possible mitigation and/or adaptation possibilities and their feasibility;
- Provide publicly available, cost-benefit analysis, along with the raw data; and
• Discuss all alternatives to the Khudoni HPP.

Although the Khudoni HPP would undoubtedly generate economic benefits, its implementation as it is currently proposed would constitute a violation of democracy, human rights and freedom of speech – all of which Georgia has struggled so hard to achieve over the last few decades. The Government of Georgia along with the investing company need to seriously reconsider the ESIA standards and implement relevant changes in the system if the Khudoni HPP is destined to see the light of the day.
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