Contents

The Final Report for Monitoring of Efficiency of Activities Carried out in the Course of Operating Paravani HPP to avoid/mitigate the Impact on the Ichthyo-Fauna

(fish population)

1. Introduction

According to the Aquatic Monitoring Plan of Paravani HPP project and the agreement signed with the Paravani HPP administration, experts of nonprofit organization "Independent Commission for Environmental Impact Assessment" have monitored an efficiency of activities carried out in the course of operating Paravani HPP to avoid/mitigate the impact on the ichthyofauna.

This document is a report for the works carried out according to the Aquatic Monitoring Plan of Paravani HPP project and the agreement signed between the Paravani HPP administration and nonprofit organization "Independent Commission for Environmental Impact Assessment".

Works under the Aquatic Monitoring Plan of Paravani HPP project included the desk (the study of existing literature) and field (research assessment of the current situation) studies.

According to the Aquatic Monitoring Plan of Paravani HPP project, the general aim of monitoring an efficiency of activities carried out in the course of operating Paravani HPP to avoid/mitigate the impact on the ichthyofauna is to timely reveal any changes in condition of fish populations inhabiting in the impact area of this project and ecological status of their living environment.
To reach this aim, the main goal of field surveys, implemented according to the Aquatic Monitoring Plan of Paravani HPP project, was:

- To assess the condition of fish populations in selected control areas of Paravani riverbed down the weir.

Field surveys included the following tasks:

- Monitoring fish species composition and relative abundance in the river Paravani downstream and upstream the weir, in the confluence area of the river Paravani and the Mtkvari River, upstream and downstream the Mtkvari River;
- Monitoring size/age distribution of fish species;

- Determination of the Condition factor of caught fish.

Ichthyofauna monitoring results should have been interpreted in accordance with the water quality analysis, monitoring of ecological status of macro invertebrates and the visual observation results of riparian vegetation condition in control areas.

Field studies also included determination of effectiveness of the fish passage operating in Paravani HPP, in different words, fish migration intensity downstream and upstream the fish passage.

Field survey area provided by the Monitoring Plan

Field survey area included area downstream the weir before the Mtkvari River confluence (above 50 meters) and the River Mtkvari stream of 150 meters upstream and downstream the confluence area of the Paravani River and the River Mtkvari.

200 meter stretch of the River Paravani from the River Khandostskali (sometimes, mentioned as the river Tchobareti) was the control area to compare with the information received from the study areas in the HPP impact area.

Coordinates for monitoring areas:

- Point 1.: 37162985E – 4590715.50N
- Point 2.: 356885.26E – 4593539.50N
- Point 3.: 356383.05E – 4593599.96N

- Point 4.: 356970.26E – 4592716.67N

The field surveys schedule provided by the Monitoring Plan:

According to the Aquatic Monitoring Plan, the field surveys were carried out in the following timeframes:

- April - May (April 15 – May 18 and 3 – 5)
- June (June 5 – 9)
- September (September 12 – 16)
- October - November (October 28 - November 2)

Timeframes determined by the Aquatic Monitoring Plan can be justified with the prescribed hydro-meteorological conditions which allow us to cover all the hydrological periods typical to the river and also, ichthyofauna cycles of spawning, condition factor and wintering.

2. Study methodology provided by the Monitoring Plan

The Monitoring Plan included two phases of study works.

Phase 1 – desk researches, which included review of existing information on the River Paravani and its ichthyofauna. Also, it was included to review and study the field surveys methodology provided by the Aquatic Monitoring Plan.

Phase 2 – Implementation of the field surveys

2.1 The first phase of study – desk researches.

2.1.1. Important information on natural conditions in project impact area to carry out monitoring

2.1.1.1. Important factors of environment

Average temperatures of the ambient air in the study areas (Source: Sustainable Use of Water Resources in Georgia. Akvaplan-niva AS report number 4538-01)

Months	1	2	3	4	5	6	7	8	9	10	11	12
Average temperature, °C	-7.2	-5.2	-2.0	4.7	10.2	13.2	16.0	16.4	12.4	7.4	1.6	-4.0

Water average temperatures in the River Paravani (Source: Sustainable Use of Water Resources in Georgia. Akvaplan-niva AS report number 4538-01)

Months	1	2	3	4	5	6	7	8	9	10	11	12
Average temperature, °C	1,2	1,5	3	6,7	11,6	15,6	19,0	19,0	14,8	9,2	5,0	2,3

*2.1.1.2. Information on Species Composition of Ichthyofauna **Fish species registered in the study area***

According to researcher G. Barachi, in the Paravani river section of flowing out from the lake and flowing into the Saghamos Tba, the following species can be found: Khramulya, Chub, Mursa, Riffle Minnow and Trout (Барач, Г. П. 1941. "Рыбы Пресних Вод." In Фауна Грузии, 288. Тбилиси: Академия наук Грузинской ССР).

№	Latin Name	English Name
1	Carassius auratus gibelio	Crucian
2	Romanogobio persus	Kura gudgeon
3	Capoeta capoeta	Khramulya
4	Squalius cephalus orientalis	Chub

5	Alburnoides bipunctatus	Riffle Minnow
6	Coregonus albula	European cisco
7	Luciobarbus mursa	Mursa
8	Salmo trutta	Brown trout

Source: Tatia Kuljanishvili "Fish diversity of the Paravani and Saghamos tba, population structure and dynamics", Master's thesis, Ilia State University, Tbilisi, 2016.

„Monitoring (Japoshvili 2009) of the lake Paravani in 2007 showed, that dominant species are the introduced European Coregonus Albula (75% of the total catches) and Crucian (Carassius gibelio (Linnaeus, 1758)) (15-20% of the total catches). Only 5-10 % of the local species are left, these are: Riffle Minnow, Rutilus rutilus (Linnaeus, 1758), Khramulya, Chub, Kura Gudgeon (Romanogobio persus (Gunther, 1899)), Mursa, in very small quantities – Lake Trout and Carp (Japoshvili 2009)" (Tatia Kuljanishvili "Fish Diversity of the Lake Paravani, population structure and dynamics")

№	Latin Name	English Name
1	Carassius auratus gibelio	Crucian
2	Barbus lacerta cyri	Kura barbel
3	Romanogobio persus	Kura gudgeon
4	Capoeta capoeta	Khramulya
5	Squalius cephalus orientalis	Chub
6	Alburnoides bipunctatus	Riffle Minnow
7	Oxynoemacheilus brandtii	Kura loach
8	Luciobarbus mursa	Mursa
9	Ponticola constructor	Caucasian Goby
10	Salmo trutta	Brown trout

Source: Pipoyan S.K., Eghoyan K.A., Arakelyan A.S. Species Composition of fishes of middle streams of Paravani river and lake Sagamo (South Georgia).

According to the Article Authors' (Pipoyan S.K., Eghoyan K.A., Arakelyan A.S) conclusions, 8 species of fish community were ascertained in the Saghamos Tba and the middle stream of the River Paravani, among them: 6 species (Crucian, Riffle Minnow, Chub, Gudgeon, Khramulya and also, Trout) were ascertained in the Saghamos Tba, 7 species (Crucian, Riffle Minnow, Kura Barbel, Khramulya, Gudgeon, Kura Loach and Trout).

According to the researchers, Crucian was ascertained for the first time ever in the study area. According to the researchers' data, the basic species of the River Paravani are Riffle Minnow, Kura Barbel and Khramulya.

Researchers (Pipoyan S.K., Eghoyan K.A., Arakelyan A.S. Species Composition of fishes of middle streams of Paravani river and lake Sagamo (South Georgia)) consider, it is possible in the River Paravani (due to fisheries) to ascertain such introduced species like Rainbow Trout (Oncorhynchus mykiss) and Coregonus albula. Them apart, article authors do not rule out existence of Cyprinidae and Gobiidae fishes.

In addition to the listed species of fish, for the experts of the nonprofit organization "Independent Commission for Environmental Impact Assessment" is known existence of the following species in fisheries of the River Paravani: Brown trout (Salmo trutta), Brook trout (Salvelinus fontinalis), Arctic char (Salvelinus alpinus), hybrid: Salvelinus fontinalis x Salvelinus alpinus. In case of escaping from the fisheries, these species can be discovered in the River Paravani.
Other new information about the River Paravani does not exist and fish species composition and relative abundance are unknown.

2.1.1.3. Main characteristics of living cycle for fish species described by the researchers in the monitoring area

№	Latin Name	Environmental Conditions	Spawning Period	Food
1	Carassius auratus gibelio	Typical habitat includes the quiet backwaters of streams and pools, especially those with submerged aquatic vegetation. This fish species is tolerant of high levels of turbidity, temperature fluctuations, and low levels of dissolved oxygen.	May - June 14 - 16°C	Insect larvae, Algae
2	Barbus lacerta cyri	Mountain and piedmont zones in streams and small rivers with fast, clear, and well oxygenated water and gravel substrate. In lowlands usually most common in small streams and absent from large rivers.	May – Middle August 15 - 18°C	Larva – Benthos, Plankton Adult fish – Animal Benthos
3	Romanogobio persus	Fast flowing stretches of rivers and streams with gravel and rocky substrate.	May - June	Plankton, Benthos
4	Capoeta capoeta	Inhabits a very wide range of	May - August	Algae

		rivers, streams and lakes including reservoirs. From lakes and reservoirs migrate to rivers to spawn.		
5	Squalius cephalus orientalis	Most abundant in small rivers and large streams of barbel zone with riffles and pools. Found along shores of slow-flowing lowland rivers, even in very small mountain streams, and in large lake, undertaking spawning migration to inflowing streams. Adults are solitary while juveniles occur in groups. Feeding larvae and juveniles live in very shallow shoreline habitats.	April - July	Benthos, Algae
6	Alburnoides bipunctatus	Inhabit streams and rivers in foothills with well oxygenated, fast-flowing water. All age classes occur in open water of streams and small rivers. Found also in rivers with very calm waters. Spawn in small groups and lay eggs deep into gravel with swift current.	May - June	Plankton, Benthos, Algae
7	Oxynoemacheilus brandtii	Fast to very fast flowing streams and rivers with gravel or rocky substrate. Usually most common in riffles and rapids in the middle of the river.	May - July	Plankton, Small form of benthos, Algae
8	Luciobarbus mursa	Inhabits a wide range of streams and rivers with fast to moderately fast running water. Also inhabits lakes and reservoirs from which it migrates to rivers and streams to spawn.	May - June	Animal benthos, Plant detritus
9	Ponticola constructor	Freshwater, in a wide variety of	May - June	Benthos,

		flowing waters from cold hill to foot hill streams. Males guard eggs in gravel or rocky cavities.		Plankton
10	Salmo trutta	Cold streams, rivers and lakes. Spawns in rivers and streams with swift water. Lacustrine populations migrate to tributaries and lake outlets, rarely spawning on stone, wave-washed lake shores. Spawning sites usually characterised by downward movement of water into gravel.	September – February Mainly, October - November <10°C	Crustacea, Insects, Fishes

(Source: Elanidze R.F., 1983, Ichthyofauna of rivers and lakes of Georgia, Ed/Metsniereba, Tbilisi)

2.1.1.4. Recommended Speed of Water Flow for the Different Species of Fish

Fish Species	Water flow speed m/sec.		
	Attractive water flow for fish	Abducting water flow of fish	
	Adult Fish	Young Fish	Adult Fish
Salmo trutta	0,8….1,1	0,25….0,35	1,1….1,6
Barbus lacerta cyri	0,75…1,0	0,2…0,3	1,0…1,5
Squalius cephalus orientalis	0,7…0,95	0,2…0,25	0,95…1,4
Alburnoides bipunctatus	0,5…0,7	0,15…0,25	0,9…1,2

(Source: Organization of fish migration cycle within fish-protective construction of hydroelectric complex. O. G. Vvedenskiy Volga State University of Technology Bulletin, Number 2014. 4 (24), ISSN 2306-2827)

2.1.1.5. Fish Passage Characteristics in Paravani HPP

The fish passage has latitudinal units divided by two channels. During full working, the last 7 basins of the first channel and the last 5 basins of the second channel are fully covered by water. There are 5-15cm. high rocks the bottom of the channels. Each unit has two holes for fish movement at the

different sides of unit walls. The fish passage parameters (meet the standard requirements of fish pass) are the following:

Basin			Underwater hole		Cut		Discharging the water through the fish passage	Maximum difference between water levels
L(m)	W(m)	H(m)	W(m)	H(m)	L(m)	H(m)	Q(m^3/sec)	ΔH (m)
1,8	1,2	0,6	0,25	0,25	0,25	0,25	0,12	0,2

The fish passage channel:

	Channel 1	Channel 2
Number of basins	77	26
Length, cm.	118	106
Average length of basins, cm	140	150
Height in the upper part, cm	70	77
Height in the lower part, cm	80	88
Length of septum, cm	30	30
Sizes of hole, cm	25x25	25x25
Water flow speed in the basin, m/sec	0,7	0,7
Water average level during full working, cm (except underwater section/basin)	55	63

2.2. The field surveys methodology

According to the Aquatic Monitoring Plan, the following activities were determined: water quality monitoring (The Aquatic Monitoring Plan of the Paravani HPP Project, article 7), review of water habitats (The Aquatic Monitoring Plan of the Paravani HPP Project, article 8), monitoring of ecological status of macro invertebrates (The Aquatic Monitoring Plan of the Paravani HPP Project, article 9), monitoring of ecological status of ichthyofauna (The Aquatic Monitoring Plan of the Paravani HPP Project, article 10), monitoring of effectiveness of the fish passage (The Aquatic Monitoring Plan of the Paravani HPP Project, article 11) and the methodology of the mentioned studies. The Aquatic Monitoring Plan also covered interviews with the local amateur fishermen. They were interviewed by the relevant questionnaires developed according to the Aquatic Monitoring Plan.

3. Results of the Field Surveys

3.1. Water Quality

According to the Aquatic Monitoring plan, the water quality was analyzed according to the following parameters: pH factor, TSS/turbidity, color, overall nitrogen, overall phosphorus, chemical consumption of oxygen, biological consumption of oxygen, conductivity/TDS.

Samples were taken into the appropriate pottery. While taking, storaging and transporting the samples, the procedures provided by the following sources were taken into the account: 1. Water Quality Monitoring. A practical guide to the design and implementation of freshwater quality studies and monitoring programmes - Edited by Jamie Bartram and Richard Ballance, Published on behalf of United Nations Environment Programme; 2. Water Quality Assessments - A Guide to Use of Biota, Sediments and Water in Environmental Monitoring - Second Edition, Edited by Deborah Chapman, Published on behalf of United Nations Educational, Scientific and Cultural Organization; World Health Organization United Nations Environment Programme). Appropriate containers and preservation methods were used to avoid risks of contamination of the sample and/or losses of analytes of interest during storage and transit prior to analysis.

Samples for analysis were transferred to the authorized laboratory (LELP Ivane Javakhishvili Tbilisi State University, Caucasian Aleksandre Tvalchrelidze Institute of Mineral Resources Analytical Centre).

Results of the water quality analysis for all the stages of the field surveys:

Indicators of water quality

Customer: ltd "Independent commission of evaluation of influence on environmental"

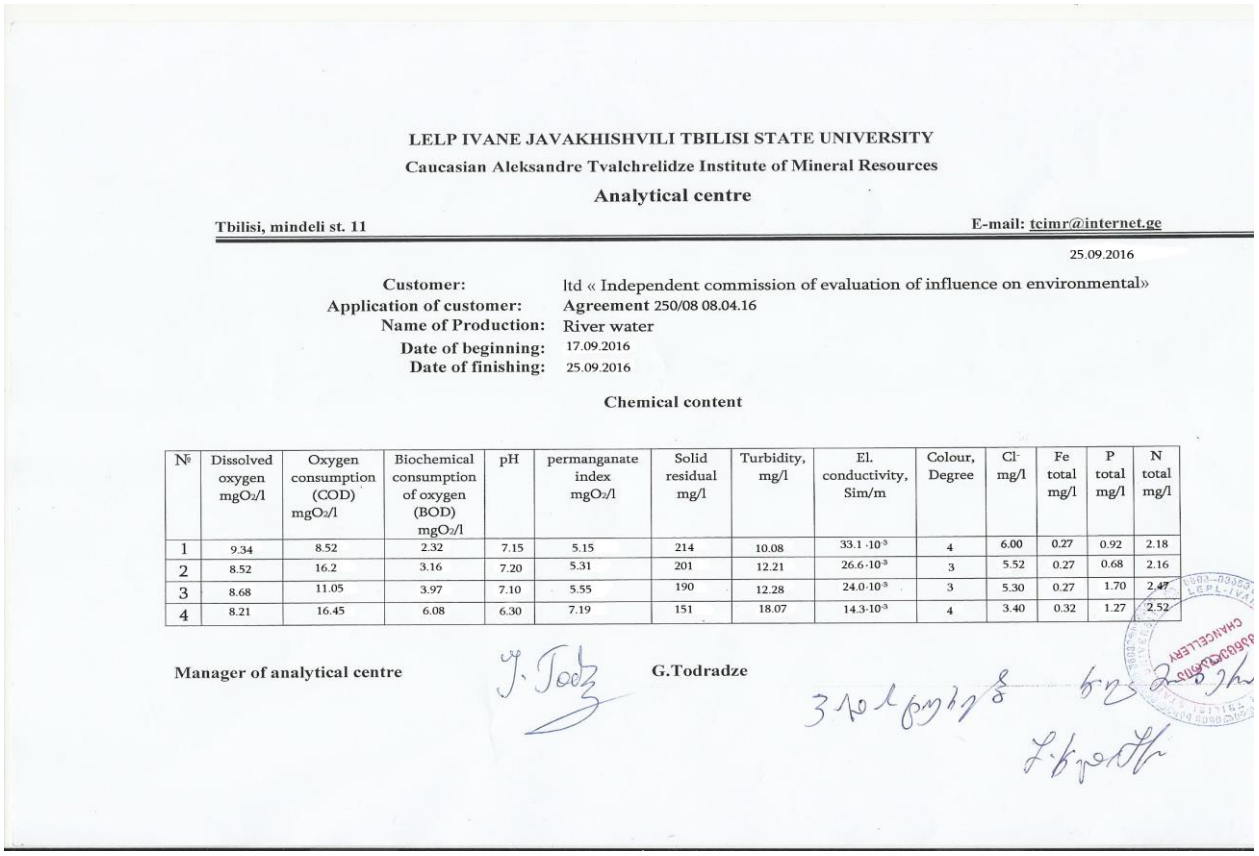
Name of Production: River water

Analysis time:
Date of beginning: 16.04.2016
Date of finishing: 25.04.2016

Chemical content, %

№	Name of sample	Dissolved oxygen mgO_2/l	Oxygen consumption (COD) mgO_2/l	Biochemical consumption of oxygen (BOD) mgO_2/l	PH	Permanganate index mgO_2/l	Solid residual mg/l	Turbidity, mg/l	NH_4^+ mg/l	Hardness mgeq/l	Cl^- mg/l	Fe mg/l
1	Confluence of river Paravani	10.09	7.5 (<30)	-								
2	R.Paravani, above hydro power station	9.20	-	4.53								
3	R.Paravani, lower hydro power station	9.22	-	2.92								
4	R.Paravani	-	-	-	5.75	7.98	149.0	8.88	<0.1	1.57	7.80	0.15
5	R.Mtkvari	-	-	-	5.95	7.95	159.0	8.59	<0.1	1.46	8.17	0.18

Manager of analytical centre L. Akhalkatsi **G.Todradze**



LELP IVANE JAVAKHISHVILI TBILISI STATE UNIVERSITY

Caucasian Aleksandre Tvalchrelidze Institute of Mineral Resources

Analytical centre

Tbilisi, mindeli st. 11 E-mail: tcimr@internet.ge

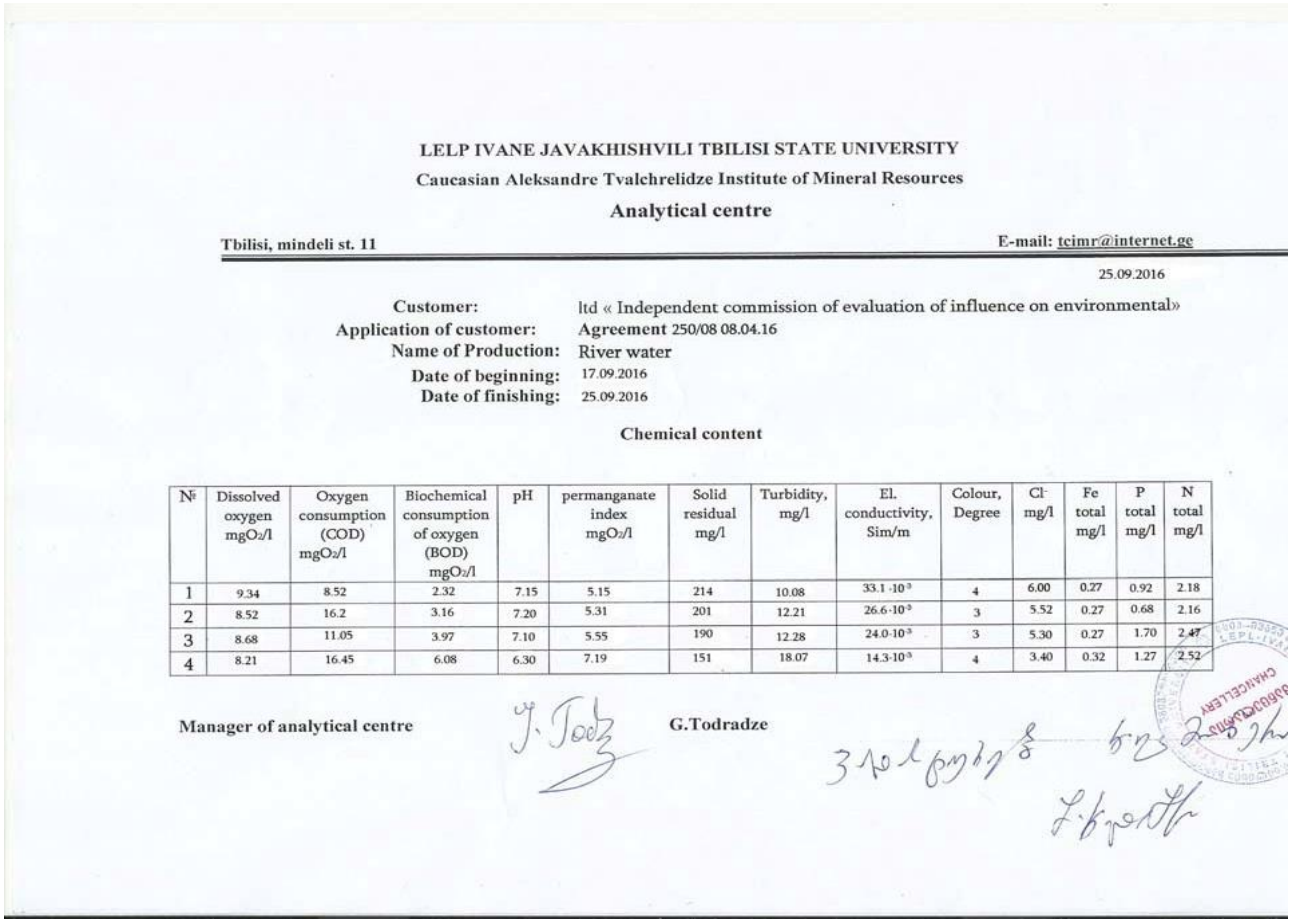
25.09.2016

Customer: ltd « Independent commission of evaluation of influence on environmental»
Application of customer: Agreement 250/08 08.04.16
Name of Production: River water
Date of beginning: 17.09.2016
Date of finishing: 25.09.2016

Chemical content

№	Dissolved oxygen mgO_2/l	Oxygen consumption (COD) mgO_2/l	Biochemical consumption of oxygen (BOD) mgO_2/l	pH	permanganate index mgO_2/l	Solid residual mg/l	Turbidity, mg/l	El. conductivity, Sim/m	Colour, Degree	Cl^- mg/l	Fe total mg/l	P total mg/l	N total mg/l
1	9.34	8.52	2.32	7.15	5.15	214	10.08	$33.1 \cdot 10^{-3}$	4	6.00	0.27	0.92	2.18
2	8.52	16.2	3.16	7.20	5.31	201	12.21	$26.6 \cdot 10^{-3}$	3	5.52	0.27	0.68	2.16
3	8.68	11.05	3.97	7.10	5.55	190	12.28	$24.0 \cdot 10^{-3}$	3	5.30	0.27	1.70	2.47
4	8.21	16.45	6.08	6.30	7.19	151	18.07	$14.3 \cdot 10^{-3}$	4	3.40	0.32	1.27	2.52

Manager of analytical centre G.Todradze



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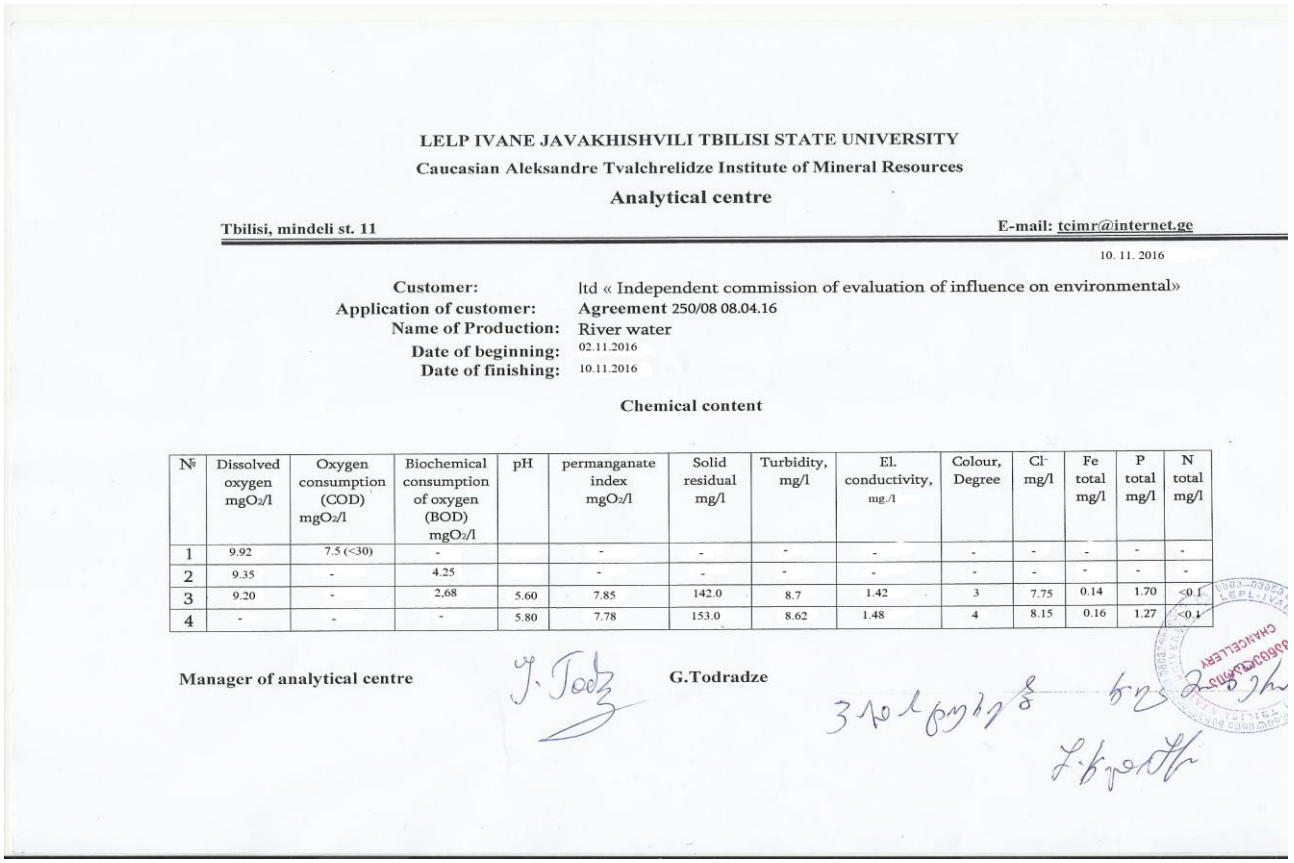
25.09.2016

Customer: ltd « Independent commission of evaluation of influence on environmental»
Application of customer: Agreement 250/08 08.04.16
Name of Production: River water
Date of beginning: 17.09.2016
Date of finishing: 25.09.2016

Chemical content

№	Dissolved oxygen mgO_2/l	Oxygen consumption (COD) mgO_2/l	Biochemical consumption of oxygen (BOD) mgO_2/l	pH	permanganate index mgO_2/l	Solid residual mg/l	Turbidity, mg/l	El. conductivity, Sim/m	Colour, Degree	Cl^- mg/l	Fe total mg/l	P total mg/l	N total mg/l
1	9.34	8.52	2.32	7.15	5.15	214	10.08	$33.1 \cdot 10^{-3}$	4	6.00	0.27	0.92	2.18
2	8.52	16.2	3.16	7.20	5.31	201	12.21	$26.6 \cdot 10^{-3}$	3	5.52	0.27	0.68	2.16
3	8.68	11.05	3.97	7.10	5.55	190	12.28	$24.0 \cdot 10^{-3}$	3	5.30	0.27	1.70	2.47
4	8.21	16.45	6.08	6.30	7.19	151	18.07	$14.3 \cdot 10^{-3}$	4	3.40	0.32	1.27	2.52

Manager of analytical centre G.Todradze



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Tbilisi, mindeli st. 11 E-mail: tcimr@internet.ge

10. 11. 2016

Customer: ltd « Independent commission of evaluation of influence on environmental»
Application of customer: Agreement 250/08 08.04.16
Name of Production: River water
Date of beginning: 02.11.2016
Date of finishing: 10.11.2016

Chemical content

№	Dissolved oxygen mgO_2/l	Oxygen consumption (COD) mgO_2/l	Biochemical consumption of oxygen (BOD) mgO_2/l	pH	permanganate index mgO_2/l	Solid residual mg/l	Turbidity, mg/l	El. conductivity, mg./l	Colour, Degree	Cl^- mg/l	Fe total mg/l	P total mg/l	N total mg/l
1	9.92	7.5 (<30)	-		-	-	-	-	-	-	-	-	-
2	9.35	-	4.25		-	-	-	-	-	-	-	-	-
3	9.20	-	2,68	5.60	7.85	142.0	8.7	1.42	3	7.75	0.14	1.70	<0.1
4	-	-	-	5.80	7.78	153.0	8.62	1.48	4	8.15	0.16	1.27	<0.1

Manager of analytical centre G.Todradze

On the second (June) and third (September) stages of the field surveys, water temperature was different during a day that was related to the meteorological conditions and weather of the study area.

Variation of water temperature depended on the time of measuring and also, on air circulation (wind), cloud cover and the flow speed and depth of the water column at the control point. It is important as the water temperature affects current physical, chemical and biological processes in the water bodies.

It is known that as the water temperature increases, the rate of chemical reactions generally increases together with the evaporation and volatilization of substances from the water. Increasing temperature also decreases the solubility of gases in the water (O2, CO2, N2 and etc.). The metabolic rate of aquatic organisms is also related to temperature, e.g., increased breathing intensity, which of course, is related to the oxygen consumption and increased decomposition of organic substances. Growth rates of different organisms also increase (this is most noticeable for bacteria and phytoplankton), leading to increased water turbidity, as the water temperature increases growth rates of the macrophytes and the algae also increase. This is most noticeable during dry seasons, particularly in shallow waters.

During spring (April-May) and later fall (October-November) field surveys, ambient and water temperature dropped, so daily variation of water temperature was less significant and noticeable.
Besides importance of the above mentioned climatic conditions, the results of analysis showed that data variation of water temperature, turbidity, pH and chemical oxygen demand had no considerable influence during the three phases of the survey. According to the chemical oxygen demand (COD) and maxima concentration norms the river was considered to be "clean."
The composition of biogenetic elements, inorganic forms of nitrogen, phosphorus on the study areas were lower than maxima concentration norms and equals their normative data in the surface waters.

3.2. Results of Aquatic Macro invertebrate Survey

During the second (June) and the third (September) stages of the field surveys, 25 quantitative and 30 qualitative samples were taken and analyzed. Materials from silty biotopes were taken by bottom scoop of Peterson System, and from stony biotopes by benthometer of Sadovski System. After processing the taken material, it was determined that the river control areas are inhabited by the following groups of zoobenhtos:

Hidrozoa. The representative of these hidrozoas is *Hydra viridis*, which we meet rarely and in little quantity only on the shoreline of stony biotopes.
Nematoda. All the materials were not processed because of technical reasons (according to the methodologies, some of the locations for analysis were inaccessible due to the boulders and physically inaccessible shorelines) that are why their quantity indicators were not taken into the consideration while determining biomass tonnage of total zoobenthos. We'll only remark that they are of enough quantity in the river (223 mg/m^2 - 260 mg/m^2).
Oligochaeta. oligochaetas are met in great quantity everywhere. 16 species of oligochaetas are registered in all, overwhelming majority of them are inhabited on the stony

biotopes of the shoreline, and a small part - on the silty biotopes.

Oligochaetas Biomass is 10288 mg/m^2. Oligochaetas take one of the most leading places. Hirudinae.

Hirudinae. Hirudinaes are registered at every station in the river (sched. 1). Quantity indicator of hirudinaes biomass is 1571 mg/m^2.

Quantity Accounting of Hirudinaes

Quantity / Control Area	copies./m^2	mg./m^2
1	186	744
2	223	930
3	37	260
4	28	4350
Average	118	1571

Ostracoda. Ostracodas are organisms of small size and weight, which are met on the silty biotope as well as on the stony biotope of the shoreline. Quantity Indicators - 325 egz/m^2, 33 mg/m^2.

Hidrocarina. Hidrocarinas are benthonic organisms of small size and weight, which are met rarely and in little quantity in the river. They were not registered on the stony biotope of the shoreline, and on the silty biotope they are met in little quantity - only a few copies were extracted - 37 copies/m^2.

Hidrocarins, because of their small size, weight and quantity don't have any practical importance in the zoobenthos.

Ephemeroptera. Ephemeropteras were not registered in the quantity materials, which were taken on the silty biotope, and on the stony biotope of the shoreline they are met of enough quantity.

It may be said that Ephemeropteras are benthonic organisms characteristic for only shoreline.

Chironomidae. Chironomidaes are spread everywhere, that's why they are registered in large quantities, especially in the shoreline where they are of most quantity - 50720 copies/m^2; 7960 mg/m^2

Quantity Accounting of Chironomidaes

Quantity / Control Area	copies./m^2	mg./m^2
1	2976	6659
2	5654	10230
3	5208	10379
4	7640	1680
Average	5369	7237

Trichoptera. Trichopteras were also registered on the stony biotope of the shoreline. Inhabitable environment of Trichopteras is cold waters where there is a stony biotope, that's why they were mainly found at the confluences of cold springs (sources) in the river.

Mollusca. Molluscas are spread everywhere where there is a silty biotope, and the plants are not found on the stony biotope of the shoreline.

Quantity / Control Area	copies./∂²	mg./∂²
1	1228	1153
2	149	186
3	13690	24775
4	0	0
Average	3767	6528

Amphipoda. Amphipodas, representatives of this group, are inhabited on the stony biotope of the shoreline among the plants. Their inhabitation density and biomass are high enough on the stony biotope of the shoreline; inhabitation density fluctuates between 1020 copies/m^2 and 1130 copies/m2, and biomass between 570 mg/m2 and 4620 mg/m^2. If we sum up the results we'll see that 13 groups of zoobenthos inhabit in the river. Among them 12 groups of are spread on the stony biotope of the shoreline, and 7 groups on the silty biotope.

These zoobenthos are typical for the region. The distribution after construction is the same as before construction which means that Paravani HEPP does not affect the distribution of zoobenthos.

Distribution of Zoobenthos according to Biotopes

N	Biotope / Zoobenthos Group	Stony	Silty
1	*Hidrozoa*	+	-
2	*Nematoda*	+	+
3	*Oligochaeta*	+	+
4	*Hirudinea*	+	+
5	*Ostracoda*	+	+
6	*Tardigrada*	+	-
7	*Hidrocarina*	+	+
8	*Chironomidae*	+	+
9	*Coleoptera*	+	-
10	*Trichoptera*	+	-
11	*Ephemeroptera*	+	-
12	*Mollusca*	-	+
13	*Amphipoda*	+	-
	In total:	12	7

Quantitative composition for food of separate rheophilic fish species inhabiting in the River Paravani

Feeding Object	Brown Trout	Barbel	Gudgeon	Chub	Khramulya	Riffle Minnow
Chlorophyta	-	+	+	-	-	-
Bacillariophyta	+	+	+	-	-	-
Plant Seeds	+	-	+	-	+	-
Ciliophora	-	+	+	-	-	-
Plathelmintes	-	-	+	+	+	-
Oligochaeta	+	+	+	-	+	+
Rotatoria	-	-	+	-	-	-
Nematoda	+	+	+	+	+	+
Arthropoda ov.	-	-	+	-	-	-

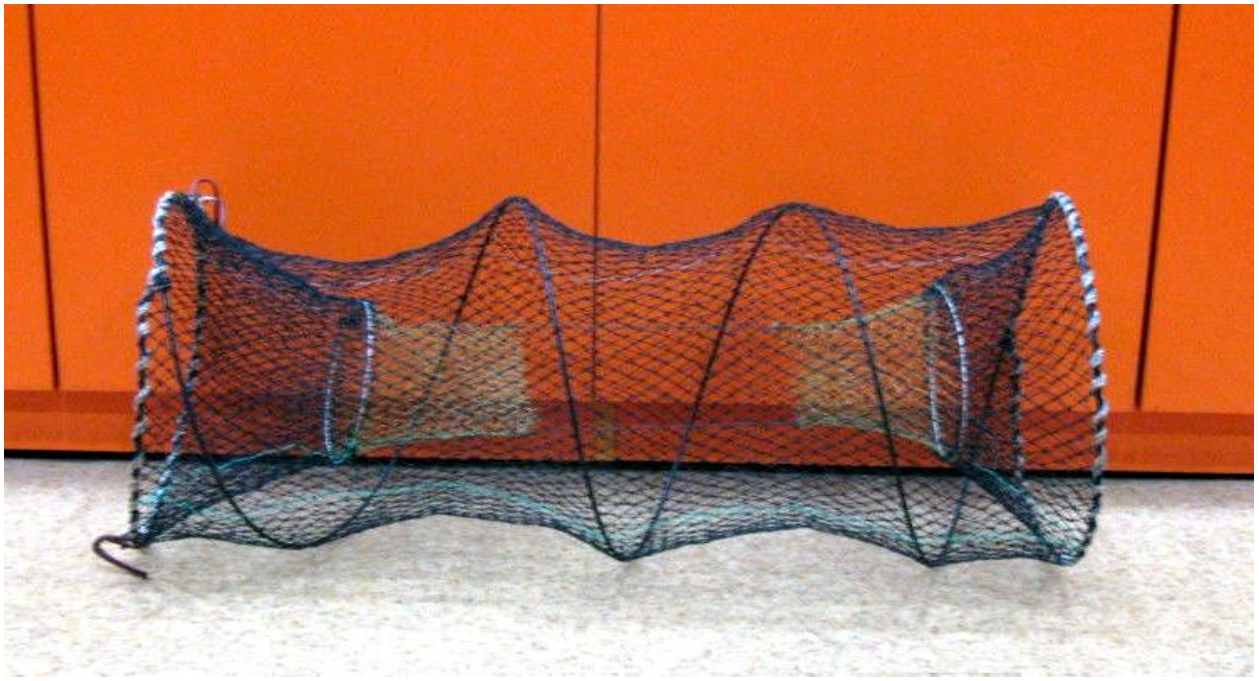
Arthropoda pup.	+	+	+	-	-	+
Myriapoda	-	-	-	-	-	+
Arachnida	+	+	-	-	-	-
Hydrocarina	+	-	+	-	-	-
Phyllopoda	+	-	-	-	-	-
Cladocera	-	+	+	-	+	-
Copepoda	-	+	+	-	-	-
Amphipoda	+	+	+	-	-	-
Isopoda	+	-	-	-	-	-
Dermaptera	+	+	-	-	-	-
Ephemeroptera, im.	+	-	+	-	-	-
Ephemeroptera, lrv.	+	+	+	-	-	+
Plecoptera, im.	-	-	-	-	-	+
Plecoptera, lrv.	+	-	+	-	-	+
Hemiptera	+	-	-	-	-	-
Orthoptera	+	-	-	-	-	-
Odonata, lrv.	+	-	-	-	-	-
Coleoptera, im.	+	+	+	-	-	+
Coleoptera, lrv.	+	+	-	-	-	-
Hymenoptera	+	-	+	-	-	-
Vespoidea	+	-	-	-	-	-
Formicoidea	+	+	+	+	-	+
Diptera, im.	+	+	+	-	+	+
Diptera, lrv.	+	+	-	+	-	-
Brachycera, lrv.	+	+	+	-	-	-
Nematocera, im.	+	+	+	-	-	-
Nematocera, lrv.	+	+	+	+	-	-
Trichoptera, lrv.	+	+	+	-	-	+
Trichoptera, im.	+	-	-	-	-	-
Lepidoptera,	+	+	+	-	-	-

lrv.						
Pisces	+	-	-	-	-	-
Fish eggs	-	-	+	-	-	-
Detritus	-	+	+	+	+	-
Periphyton	+	+	+	+	+	-
Group in total	32	24	29	7	8	14

3.3. Ichthyofauna Survey

Use of racket-net when the river-bed was blocked by boulders was less-effective and additional use of fishing rods could not change the existing situation. It was recommended to use fish-traps.

During the next-stage surveys, fish-traps were used, which are showed on the picture below:



3.3.1. The field surveys of the first stage (April-May)

Fish species identified as a result of the field surveys

№	Species	Control Area				In Total
		1	2	3	4	
1	Carassius auratus gibelio	-	-	4	2	6
2	Barbus lacerta cyri	-	2	4	2	8
3	Capoeta capoeta	6	-	-	-	6
4	Squalius cephalis orientalis	-	-	2	4	6
5	Alburnoides Bipunctatus	8	2	6	2	18
	In total	14	4	16	10	44

No brown trout was caught during the field surveys which is consistent with the fact that the Paravani water is most of the year warmer than the level acceptable for the brown trout. Nevertheless, one brown trout has been examined at the fish passage in 2015

Quantitative and Sexual Composition according to the Monitoring Points

№	Latin Name	Control Points			
		1	2	3	4
1	Carassius auratus gibelio	-	-	4 (?)	2 (?)
2	Barbus lacerta cyri	-	2 (♂0 - ♀2)	4 (♂1 - ♀3)	2 (♂1 - ♀1)
3	Capoeta capoeta	6 (♂2 - ♀4)	-	-	-
4	Squalius cephalus orientalis	-	-	2 (♂0 - ♀2)	4(♂0 - ♀4)
5	Frit (Eastern)	8 (♂3 - ♀5)	2 (♂2 - ♀0)	6 (♂1 - ♀5)	2 (♂2 -♀0)

Fish length, weight and age registered during the field surveys (L – cm.., W – g., A – y.)

№	Name	Control point			
		1	2	3	4
1	Carassius auratus gibelio	-	-	L 9,1 – 10,6 W 21,5 – 32,5 A 1+ - 2+	L 10,5 – 14,5 W 35,0 – 87,2 A 2+ - 3+
2	Barbus lacerta cyri	-	L 16,1 – 23,6 W 54,0 – 171 A 2+ - 3+	L 6,9 – 16,0 W 26,3 –54,0 A 1+ - 2+	L 10,4 – 21,3 W 32.0 – 124 A +3 - +4
3	Capoeta capoeta	L 15,3 – 17,3 W47,7 – 74,4 A 2+ - 4+	-	-	-
4	Squalius cephalus orientalis	-	-	L 9,6 – 13,5 W 54 – 88 A 2+ - 3+	L 11,3 -14,4 W 50 – 57 A 1+ - 2+
5	Alburnoides bipunctatus	L 9,45 - 15,20 W 16,0 – 71,58	L 4.93 – 6,65	L 5,3 – 8,6 W 2,9 – 9,85	L 7,2 – 14,4 W 6,4 – 13,3

		A 1+	W 2,0 – 6,0 A 0+ -1+	A 1+ -2+	A1+ - 2+

3.3.2. The Field Surveys of the second stage (June)

Fish species fixed as a result of monitoring

№	Species	Control Area				In Total
		1	2	3	4	
1	Carassius auratus gibelio	-	-	4	-	4
2	Barbus lacerta cyri	-	-	6	2	8
3	Capoeta capoeta	-	-	2	1	3
4	Squalius cephalis orientalis	-	-	2	3	5
5	Alburnoides Bipunctatus	4	6	6	8	24
6	Oxynoemacheilus brandtii	-	-	2	4	6
7	Ponticola constructor	1	-	3	5	9
	In Total	5	6	25	23	59

Quantitative and sexual ratio of different fish species for each control area

№	Species	Control Area			
		1	2	3	4
1	Carassius auratus gibelio	-	-	4 (♀4)	-
2	Barbus lacerta cyri	-	-	6(♂2 - ♀4)	2 (♂1 - ♀1)
3	Capoeta capoeta	-	-	2 (♂1 - ♀1)	1 (♂0 - ♀1)
4	Squalius cephalus orientalis	-	-	2 (♂0 - ♀2)	3(♂1 - ♀2)

5	Alburnoides bipunctatus	4 (♂3 - ♀1)	6 (♂2 - ♀4)	6 (♂1 - ♀5)	8 (♂3 -♀5)
6	Oxynoemacheilus brandtii	-	-	2 (♂2 - ♀0)	4 (♂2 - ♀2)
7	Ponticola constructor	1 (♂1 - ♀0)	-	3(♂0 - ♀3)	5 (♂3 - ♀2)

Fish length, weight and age registered during the field surveys (L – cm.., W – g., A – y.)

№	Name	Control point			
		1	2	3	4
1	Carassius auratus gibelio	-	-	L 11,3 – 11.8 W 35,0 – 39,4 A 2+	-
2	Barbus lacerta cyri	-	-	L 7,4 – 14,8 W 18,8 –52,0 A 1+ - 2+	L 11,5 – 24,0 W 31,8 – 115,6 A +2 - +4
3	Capoeta capoeta	-	-	L 17,7 – 24,3 W 83,4 –103,0 A 2+	L15,7 – 21,8 W 80,6 – 97,8 A2+
4	Squalius cephalus orientalis	-	-	L 9,6 – 13,5 W 54 – 88 A 2+ - 3+	L 11,3 -14,4 W 50 – 57 A 1+ - 2+
5	Alburnoides bipunctatus	L 10,0 - 14,8 W 17,2 – 67,40 A 1+ - 2+	L 5,6 – 7,0 W 3,7 – 8,2 A 1+	L 5,5 – 7,8 W 3,0 – 10,3 A 1+	L 8,5 – 12,5 W 9,3 – 18,0 A1+ - 2+
6	Oxynoemacheilus brandtii	-	-	L 6,0 – 7,3 W 3,6 – 10,8 A 1+	L 8,3 – 9,0 W 5,3 – 16,3 A1+
7	Ponticola constructor	L 10,0 – 13,3 W 15,8 – 58,8	-	L 11,4 – 15,3 W 51,8 – 63,4	L 7,7 – 9,1 W 4,6 – 14,7

		A 1+ - 2+		A 2+	A1+

3.3.3. The field surveys of the third stage (September)

Fish species fixed as a result of monitoring

№	Species	Control area				In total
		1	2	3	4	
1	Carassius auratus gibelio	-	-	7	-	7
2	Barbus lacerta cyri	-	-	3	4	7
3	Capoeta capoeta	-	-	3	1	4
4	Squalius cephalis orientalis	-	-	4	5	9
5	Alburnoides Bipunctatus	9	6	11	8	34
	In total	9	6	28	18	61

Fish length, weight and age registered during field surveys (L – cm.., W – g., A – y.)

№	Name	Control point			
		1	2	3	4
1	Carassius auratus gibelio	-	-	L 9,18 – 11.2 W 26,5 – 29,0 A 1+	-
2	Barbus lacerta cyri	-	-	L 8,1 – 12,3 W 16,7 –44,6 A 2+	L 12,1 – 22,5 W 28,3 – 103,1 A +2 - +3
3	Capoeta capoeta	-	-	L 5,17 – 5,60 W 83,4 –103,0 A 1	L 8,21 W 80,6 A1
4	Squalius cephalus orientalis	-	-	L 8,2 – 14,3 W 54 – 88 A 2+ - 3+	L 9,3 -12,4 W 50 – 57 A 2+
5	Alburnoides bipunctatus	L 8,0 - 11,8 W 21,1 – 42,5 A 1+ - 2+	L 5,6 – 7,0 W 3,3 – 9,7	L 5,5 – 7,8 W 3,7 – 8,0 A 1+	L 7,2 – 14,4 W 6,4 – 13,3 A1+ - 2+

			A 1+		

3.3.4. The field surveys of the fourth stage (October-November)

Fish species fixed as a result of monitoring

№	Species	Control Area				In Total
		1	2	3	4	
1	Carassius auratus gibelio	3	2	4	5	14
2	Barbus lacerta cyri	-	-	2	4	6
3	Capoeta capoeta	-	1	2	1	4
4	Squalius cephalis orientalis	-	-	2	8	10
5	Alburnoides Bipunctatus	4	8	14	12	38
	In total	7	11	24	30	72

Fish length, weight and age registered during the field surveys (L – cm.., W – g., A – y.)

№	Name	Control point			
		1	2	3	4
1	Carassius auratus gibelio	L 10.0 – 11.4 W 34.3 – 39.5 A 2	L 7.6 - 12.4 W 23.0 – 42.3 A 1+ - 2	L 9.0 – 9.8 W 25.2– 29,8 A 2	L 11.0 – 12.8 W 26,5 – 29,0 A 2 – 2+
2	Barbus lacerta cyri	-	-	L 6.0 – 12,3 W 16,7 –44,6 A 1 – 2+	L 12,1 – 22,5 W 28,3 – 103,1

							A +2 - +3
3	Capoeta capoeta	-	L7, 5, – 8,21 W 80,6 – 97,8 A1 – 2+	L 15,1 – 15,6 W 83,4 –103,0 A 2+ - 3+		L 25,7 – 26.5 W 83,4 –103,0 A 3 – 3+	
4	Squalius cephalus orientalis		-	-	L 8,2 – 14,3 W 54 – 88 A 2+ - 3+	L 9,3 -12,4 W 50 – 57 A 2+ - 3.0	
5	Alburnoides bipunctatus	L 4,0 - 5,8 W 21,1 – 42,5 A 1+ - 2+	L 5,6 – 7,0 W 3,3 – 9,7 A 2+ - 3	L 5,5 – 7,8 W 3,7 – 8,0 A 1 -2+	L 7,2 – 14,4 W 6,4 – 13,3 A 2 - 3+		

3.4. Interviews with the local fishermen

The Aquatic Monitoring Plan covered getting additional information from the local fishermen via interviews.

Due to the fact that periods of the first and the second stages of monitoring coincided with the period of prohibition of fishing in Georgian waters

(May-August), it was hard to find fishermen. However, we found 3 local fishermen and interviewed them.

Interviews were carried out according to the methodologies provided by the Aquatic Monitoring Plan.

The interviews revealed that in general, the most common species for the River Paravani are:

1. Riffle Minnow (Alburnoides bipunctatus)
2. Barbel (Barbus lacerta cyri)
3. Khramulya (Capoeta capoeta)

According to the species composition, the following species can be found in the project area of the River Paravani:

1. Crucian (Carassius auratus gibelio)
2. Barbel (Barbus lacerta cyri)
3. Riffle Minnow (Alburnoides bipunctatus)
4. Khramulya (Capoeta capoeta)
5. Mursa (Luciobarbus mursa)
6. Chub (Squalius cephalus orientalis)

In the upper part of the River Paravani, in the vicinity of the Saghamo Lake, the interviewers additionally mention:

1. Brown Trout (Salmo trutta)
2. Gudgeon (Romanogobio persus)

Existence of those species mentioned by the interviewersis is confirmed by the literature sources too, namely, Brown Trout (Salmo trutta) - Барач, Г. П. 1941. “Рыбы Пресних Вод.” In Фауна Грузии, 288. Тбилиси: Академия наук Грузинской ССР; and Gudgeon (Romanogobio persus) - **Source:** Tatia Kuljanishvili “Fish diversity of the Paravani and Saghamos tba, population structure and dynamics”, Master’s thesis, Ilia State University, Tbilisi, 2016.

One fisherman out of three also named the Rainbow Trout, which possibly can be found there because of the number of fisheries existing on the River Paravani.

3.5. Aquatic Habitats

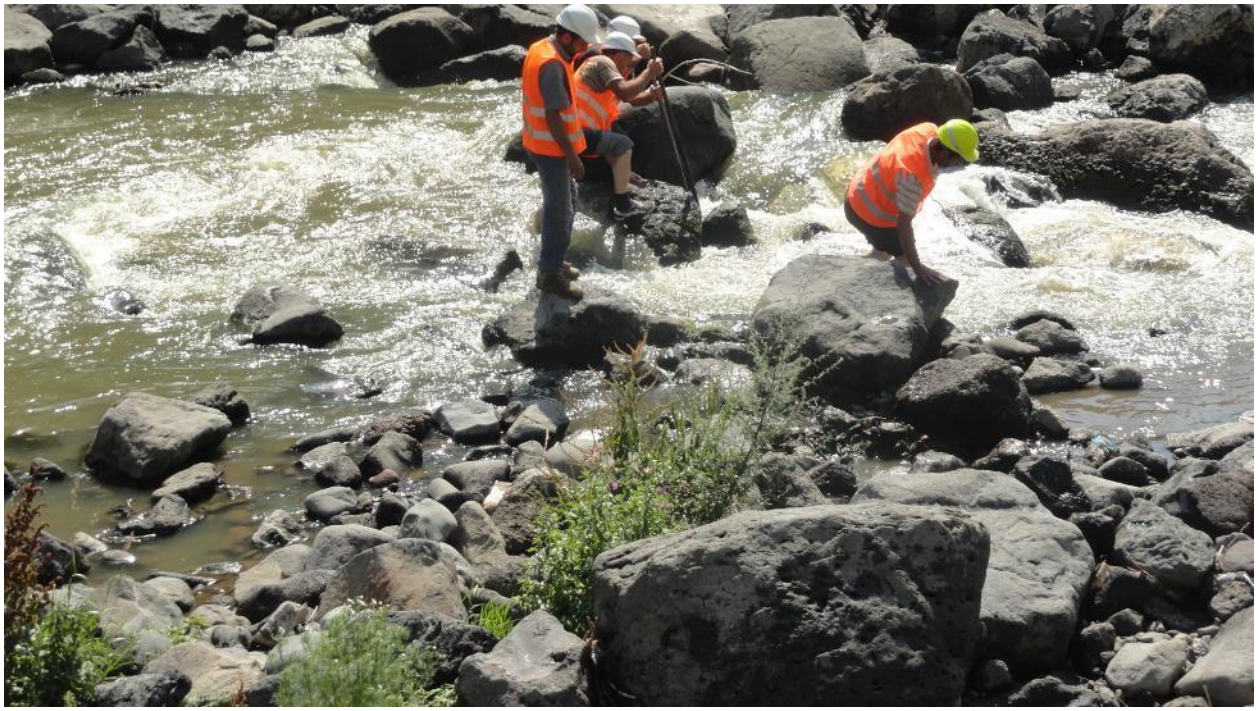
Fish rheo reaction to the water flow is unconditional reflex behavioral reaction which is reflected in behavior while fish gets into the water flow, starts swimming against the stream. All the other aspects of fish behavior in water flow, including spawning and feeding migration, are related to this reaction.

Rheo reaction, as all the other forms of orientation in space, arises as a result of activation of the specific receptors and existence the relevant irritants to these receptors.

Centrifugal accelerations as well as linear accelerations of water flow are perceived by fish in water stream. So, blockage of the riverbed with the big boulders is a thread not only of the blockage of migration ways but changes of water flow speeds. This factor will impact the fish rheo reaction and specifically, the stimulus to swim upstream.

As the review of the aquatic habitats of the River Paravani showed, in the tailrace riverbed of the project area there were sections which were blocked by the large boulders that in the conditions of reduction of the water flow, hindered the formation of attractive speed of water flow for rheophilic fishes inhabiting in the river. So, this could be a hampering factor for the different types of fish migrations.

In the reports of the first and second phases a recommendation to free the riverbed from the big boulders was given. This recommendation was fulfilled before the third phase surveys.



In the living environment and HPP operational zone, fish interact with the water flow where water flow speed and intensity of turbulence and together with them, water temperature and other parameters are changeable. In such conditions, fish for movement choose specific zones of water flow which are acceptable for their motivation. By creating specific gradient conditions or in exploitation process of the HPP, by regulation of these conditions fish behavior management can be reached.
Reduction of water flow has the direct impact on the changes of water flow speed and accordingly, the migration processes of fishes. Effectiveness of fish passing in fish ladder gives an additional value to this factor.

3.6. Monitoring of Fish Passage Effectiveness

Among the species recorded during surveys, Khramulya *(Capoeta capoeta)* is the only potential user of fish passage for seasonal feeding purposes. Existing fish passage is suitable for those species of fish.

As two stages of determination fish passage effectiveness showed, fish passage through the fish ladder was not recorded. This could be explained by the following conditions:

The first phase surveys (April-May):

a) Water temperature in April was still low;
b) In April it is recorded the highest rate of water flow and accordingly, the highest turbidity;

c) Water intake and water discharge into the Mtkvari River by the HPP and increase of water volume in the Mtkvari River cause fish movement to the Mtkvari River.

The second phase surveys (June)

a) The second phase surveys were preceded and then followed by worsening climate conditions (heavy rains). This caused critic increase of water turbidity which can be considered as the hindering factor of migration.

Due to the above mentioned factors, experts recommended to change monitoring methodology provided by the Aquatic Monitoring Plan.

The survey results of two phases convinced us that observations on fish passing through the fish ladder would have been organized constantly and not periodically. For this reason, it was recommended to monitor the fish passage constantly.

But on this stage equipping of the fish ladder with the relevant observation equipment according to the given manual was a long lasting work implementation of which could not be done before the start of the third phase survey. That's why it was decided, on this stage for the appropriate monitoring, to use bilateral fish traps installed through the fish ladders, which would provide to capture fish moving both downstream and upstream.

During the first three stages of surveys fish passing through the fish ladder was not recorded.

The survey results of the fourth phase convinced us that observations of fish passing through the fish ladder should be organized during the longer period of time and not periodically. The confirming factor is that passing of Khramulya was recorded (caught by the tool indicated on the picture above) through the fish ladder during the period of the fourth phase surveys.

It must be mentioned that massive passing of fish through the fish passage is expected in case if the fish species, sharply characterized by spawning and feeding migration, are recorded in the river. In

other ways fish passage has one basic function, particularly to avoid genetic isolation of the same species and the same fish species can move in the river-bed without any interruption. In this case hydro-technical construction on the River Paravani fulfils its function.

To assess the effectiveness of fish passage, long-term monitoring is needed, because massive passing of fish through the fish passage was not recorded during surveys. It is recommended the HPP to conduct self-monitoring of fish passage.

COUNTING FISH IN FISHWAYS

Trapping

In principle, counting by trapping consists of catching the fish in a suitable facility installed either in the fishway or at its exit, and counting them manually before releasing them upstream.

The trap usually consists of a mesh cage or chamber fitted with a non-return system (inscale) placed inside the fishway. To recover the fish for monitoring procedures, or else to count them, the fish are concentrated into a small volume of water, either by partial emptying of the trapping facility or else by raising a grille from the base of the trap. In some cases fish will be transferred and counted manually, while in others, their numbers can be counted visually.

The dimensions of the trap must allow for the maximum number of fish likely to be present in the installation at any one time. They will therefore depend on the daily migration peaks of the various species and on the frequency of operation of the facility. The volume of the trap is calculated by allowing a minimum volume of around 15 litres per kg of fish trapped.

The most common dimensions of traps are from 2.5 m to 4.5 m in length, from 1.5 m to 3.0 m in width, and from 1 m to more than 2.5 m in depth.

Counting operations must take place at regular intervals to avoid keeping the fish for too long. Usually this will be one or more times per day. Surveillance to prevent blockages and poaching is also necessary.

The costs of trap facilities vary greatly, depending on the size of the fishway, the sophistication of the handling system, and the characteristics of the species affected. The operating and maintenance costs vary greatly from one location to another, depending on the abundance and nature of migrators, the degree of automation of the trap, and the need for cleaning and maintenance of the screens (which is often unpredictable). Depending on the site, between 0.5 and 4 staff will be required for trap management during the period(s) of operation.

The main advantage of this means of monitoring is that it is relatively easy to carry out, especially in small installations. Other advantages include the reliability of determining the species, the possibility of identifying the biological characteristics of the fish (size, weight, sex, etc.) and of removing individuals for marking or use as breeding stock.

The disadvantages are the risks of injury or stress to the fish, the burden of maintenance including the high manpower requirement and also the impossibility of collecting continuous, real-time data. Another inconvenience, which is difficult to assess, is the negative influence of trapping on the efficiency of the fishway, since some species are reluctant to enter a trap.

4. Conclusions

4.1. Water Quality

Results of analyses show that major changes in the water temperature, turbidity, pH and chemical oxygen demand did not occur during three phases of the survey. According to the chemical oxygen demand (COD) the river is considered to be clean in the third phase of the survey too.

According to the results of the water quality analysis, no negative effects of the operation of Paravani HPP has been observed.

4.2. Fish Resources

A zonal distribution is typical to the River Paravani ichthyofauna. As closer the river section is to the dam, as stricter living conditions are in it and accordingly, there can be found those species which better adapt with the environmental conditions. In the study area, spring trout was not recorded. Likely, spring trout population currently is recorded upper section of the river.

Down the weir, Riffle Minnow *(Alburnoides bipunctatus*) and barbell can be found mostly. In the confluence area with the Mtkvari River khramulya and crucian are recorded.

Construction and operation of HPP did not cause species changes. Talking about quantitative changes is hard because fish catching method provided by the Aquatic Monitoring plan does not let us determine the quantitative rate of fish population due to the big boulders in the riverbed. Most percentage of fish was captured in the confluence area of the river.

In the river Paravani, after the water intake structure, many springs flow into the river and if we consider an importance of water flow for the rheophilic fish inhabiting in the river, fish concentration in the confluence area and down the Mtkvari River won't be surprise.

In the River Paravani, in the project impact territory 5 species of fish can be found:

3.1. Riffle Minnow - 41%

3.2. Kura Barbel - 18,2%

3.3. Khramulya - 13,6%

3.4. Chub - 13,6%

3.5. Crucian - 13,6%

In the River Paravani ichthyofauna is represented by a limited number of rheophilic, cold water lover species of fish. Among them, the most common species are riffle minnow and barbell.

4.3. Aquatic Habitats

As the first and the second phase surveys of the aquatic habitats of the river Paravani showed, in the riverbed, in the tailrace of the construction there were sections which were blocked by the large boulders that in the conditions of reduction of the water flow, it could hinder the formation of attractive speed of water flow for rheophilic fishes inhabiting in the

river. So, this could be a hampering factor for the different types of fish migrations (spawning, feeding).
About the mentioned, it was recommended to clear the riverbed from the large boulders. This was fulfilled before the start of the third phase studies.

4.4. Macro Zoobenthos

From the zoobenthos of the River Paravani, during the third stage surveys, 13 groups are registered (*Hidrozoa, Nematoda, Oligochaeta, Hirudinae, Ostracoda, Hidrocarina, Tardigrada, Chironomidae, Coleoptera, Trichoptera, Ephemeroptera, Mollusca, Amphipoda*). Leading groups in zoobenthos are: *Oligochaeta* (38,47%), *Mollusca* (31,32%), *Chironomidae* (6,7%) and *Hirudinae* (2,9%). In the zoobenthos we meet rarely or in little quantities: *Hidrozoa, Tardigrada,*
Hidrocarina, Ephemeroptera, Coleoptera.

4.5. Determination of the Fish Passage Effectiveness

As the surveys of the three phases showed, in the frames of fish passage monitoring, fish passing through the fish ladder has not been recorded.
The survey results of two phases convinced us that observations on fish passing through the fish ladder would have been organized during the longer period of time or even constantly and not periodically. For this reason, it was recommended to change the survey methodology.
For effective monitoring, the recommendation was given, that it would be advisable to install bilateral fish traps through the fish ladders, which would provide to capture fish moving both downstream and upstream.

The survey results of the fourth phase convinced us that observations of fish passing through the fish ladder should be organized during the longer period of time and not periodically. The confirming factor is that passing of the *Khramulya* (*Capoeta capoeta*) through the fish ladder was recorded only during the period of the fourth phase surveys. The fish passage can be considered effective on the basis of the long-term observation.

It must be mentioned that massive passing of fish through the fish passage is expected in the case if the fish species, sharply characterized by spawning and feeding migration, are recorded in the river. In other ways fish passage has one basic function, particularly to avoid genetic isolation of the same fish species; and the same fish copies can move in the river-bed without any interruption. In this case hydro-technical construction on the River Paravani fulfils its function.

5. Recommendation

Observations on fish passing through the fish ladder should be organized during the longer period of time. It is recommended the HPP to conduct self-monitoring of fish passage.

Efficiency monitoring training of fish paasage proposed by us includes activities in two directions.

The first is efficiency monitoring directly of the fish passage, for conducting of which used methods can be generalized in the following directions:

1. Monitoring of fish passage hydraulic and mechanical operation.
2. Obtaining qualitative biological information, which indicates effective work of the fish passage (fish species, amount of each fish species entering the fish passage).
3. Counting those fish species having used the fish passage.
4. Comparing fish species and their amount gathered downstream from the hydrotechnical construction with fish species and their amount, which will use fish passage and determine the true efficiency of the fish passage.

Fish monitoring provides installation of the fish trap directly on the fish passage, and downstream from the hydrotechnical construction (at 100 m length of the riverbed) organizing fish capture by using installed nets and cast nets.

The second direction is training of the staff assigned by the hydropower management from the point view of fish monitoring, to ensure permanent internal fish passage monitoring by the hydropower station staff.

Described acrivities include carrying out training activities in spring during 5 days. During the other seasons, hereaftaer, the staff will carry out self-monitoring of the fish passage yearly.

According to hydrological and temperature regime of the River Paravani we recommend above mentioned activities to be carried out every year:

1. In spring – in the third decade of May
2. In autumn – in the third decade of September

6. Attachment

Annex 1: Description of Benthometer

Benthometer of Sadovsky:

Cylindrical Benthometer of Sadovksy
Height – 0.5 m
Diameter – 0.3 m

The principle of working with bathometer in the field.

Annex 2: Photos

Measuring Water Temperature

Preparing the Area for Macro-benthos Study

Macro-benthos Study

Fishing

Fishing

Fishing

Monitoring of Fish Passage

Ichthyofauna Study

Ichthyofauna Study

Barbell (*Barbus lacerta*)

Bleak (*Alburnus filippi*)

Khramulya (Capoeta capoeta)

Crucian (*Carassius carassius*)

Barbel

l (*Barbus lacerta*)

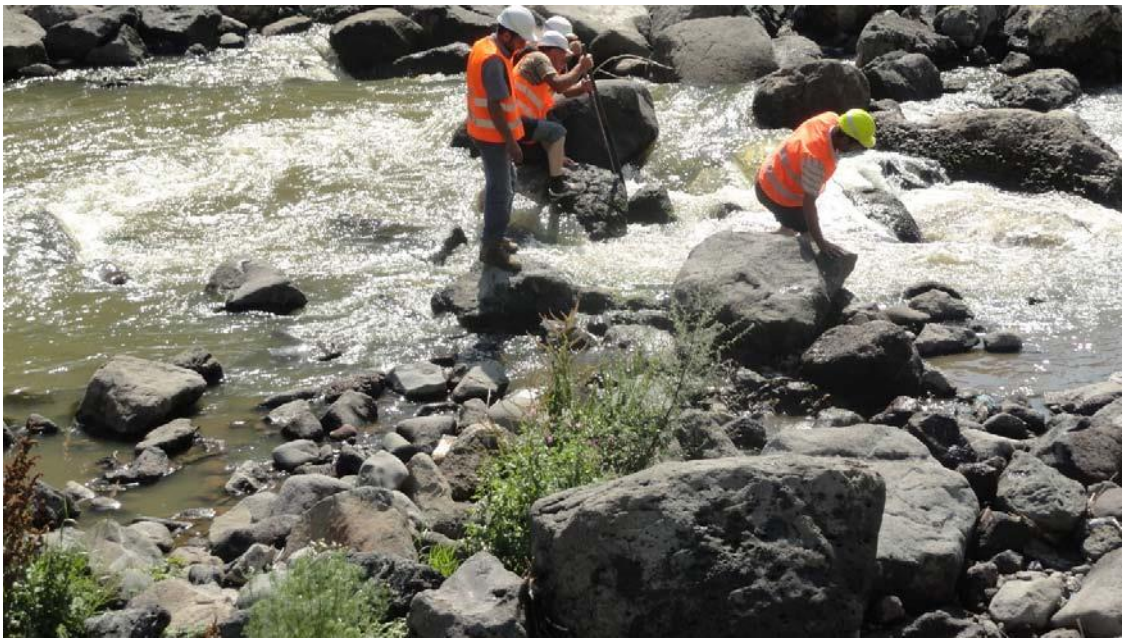
Chub (*Leuciscus borysthenicus*)

Riffle Minnow (*Alburnoides bipunctatus*)

Barbell (*Barbus lacerta*)

Measuring Water Temperature

Macro-benthos Study



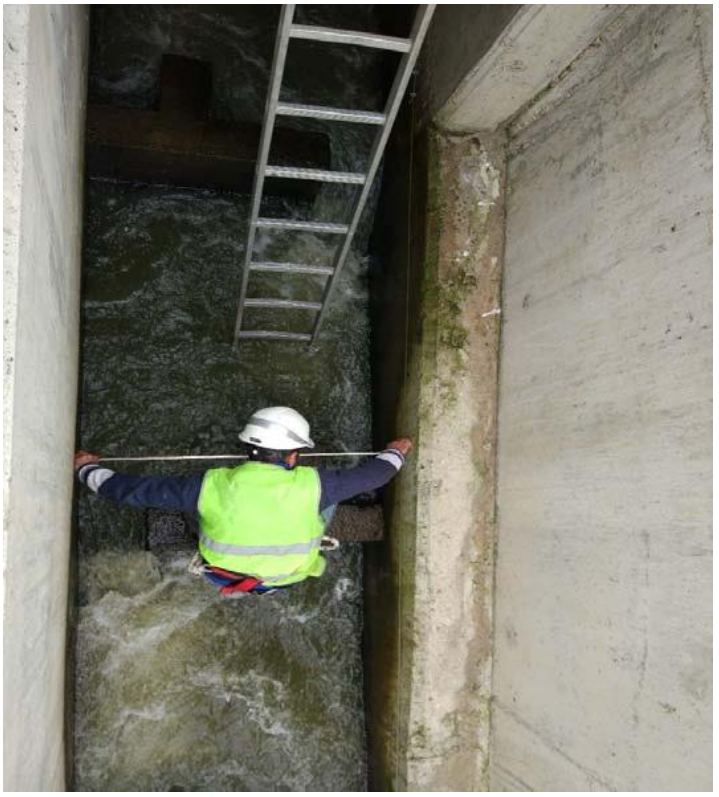
On the basis of the recommendation, to free the riverbed from the big boulders is taking place.

Preparatory Works for Installation Fish Traps in the Fish Passage

ICEIA

The report of the third phase of monitoring fish fauna Paravani river in the impact area of Paravani HPP

Preparing Fish Trap for Installation in the Fish Passage



Preparatory Works for Installation Fish Trap in the Fish Passage

Macro-benthos Study

Fish Breeding Stock in Quiet Flows of the Riverbed (Chub Breeding Stock)

Fish Breeding Stock in Quiet Flows of the Riverbed (Chub Breeding Stock)