EU4Environment in Eastern Partner Countries:
Water Resources and Environmental Data (ENI/2021/425-550)

SURFACE WATER SURVEY GEORGIA 2023

Contract-No: 20940-C1/GE-NEA-2023/4

Funded by the European Union

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ABOUT EU4ENVIRONMENT – WATER RESOURCES AND ENVIRONMENTAL DATA

This Programme aims at improving people's wellbeing in EU's Eastern Partner Countries and enabling their green transformation in line with the European Green Deal and the Sustainable Development Goals (SDGs). The programme's activities are clustered around two specific objectives: 1) support a more sustainable use of water resources and 2) improve the use of sound environmental data and their availability for policy-makers and citizens. It ensures continuity of the Shared Environmental Information System Phase II and the EU Water Initiative Plus for Eastern Partnership programmes.

The Programme is implemented by five Partner organisations: Environment Agency Austria (UBA), Austrian Development Agency (ADA), International Office for Water (OiEau) (France), Organisation for Economic Co-operation and Development (OECD), United Nations Economic Commission for Europe (UNECE). The action is co-funded by the European Union, the Austrian Development Cooperation and the French Artois-Picardie Water Agency based on a budget of EUR 12,75 million (EUR 12 million EU contribution). The implementation period is 2021-2024.

https://eu4waterdata.eu

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List of abbreviations

ADA..... Austrian Development Agency

EaP..... Eastern Partners

EU ..... European Union

EU4EnvWD ..... EU4Environment in Eastern Partner Countries: Water Resources and Environmental Data

EUWI+..... European Union Water Initiative Plus

IOW/OIEau ..... International Office for Water, France

OECD..... Organisation for Economic Cooperation and Development

RBD..... River Basin District

RBMP..... River Basin Management Plan

UBA..... Umweltbundesamt GmbH, Environment Agency Austria

UNECE..... United Nations Economic Commission for Europe

WFD..... Water Framework Directive

NEA..... National Environment Agency

Executive Summary

This report has been prepared within the frames of the Agreement [20940-C1/GE-NEA-2023/4] executed for “EU4 Environment” by the NEA. The subject of agreement was surface water monitoring in western part of Georgia. This report presents the results of this survey which included both chemical and biological sampling and analyses in the Rioni basin.

The main objective of the survey was to carry out a harmonized data collection which shall form a basis for the evaluation of existing or development of new assessment methods for the biological quality element “benthic invertebrates” in selected river types of Georgia. Based on this method, the ecological status of the rivers and water bodies included in this survey can be classified in the future. These results will contribute to the status assessment and risk analysis within the national river basin management plan and form a sound methodological basis for future monitoring programs.

All chemical analyses were done in accordance with the laboratory accreditation procedures. The transport, storage, (if necessary) preservation and the chemical analysis were undertaken according to the laboratory accredited procedures together with the application of internal analytical quality controls (AQC).

Generally, the outcome confirmed earlier findings of significant anthropogenic impacts at several sites. According to the chemical analysis, water quality still meets the requirements of the corresponding legal document (except for a slight exceedance of pH 8.5 at some sites). In spite of time constraints during the sampling (long travel time through the large river basin), partly unfavourable hydrological conditions (flood at river Kutaisi), and methodological discrepancies (much less individuals counted per sample as required in the AQEM manual), the survey provided valuable and important data for future monitoring activities in Georgia.

1. Introduction and Scope

The monitoring was carried out in spring 2023 in the basin Rioni according to the requirements of the Water Framework Directive (WFD). The tasks were fulfilled by the monitoring team from Georgia's National Environment Agency (NEA) the with help of the EU4Environment Project.

The objective of the survey was to provide a sound methodological basis for future monitoring programs as essential part of river basin management planning. The survey included the following activities:

- Sampling of surface water at 27 sampling sites for analysis of general physico-chemical parameters
- Sampling of benthic invertebrates
- Documentation of the hydromorphology
- Site description using standardized field protocols
- Analyses of general physico-chemical parameters and biological quality elements (benthic invertebrates)
- Reporting

Table 1: Parameters analyzed in the field and in the laboratory.

Country	Georgia
River basin	Rioni
Campaign [1)]	May 2023
Objective	Surface Water Monitoring Programe
Quality elements	Biological quality components: **X Macrozoobenthos** ☐ Phytobenthos Supporting elements: **X Hydro-morphological site desription** **X General physico-chemical quality elements**
Preparation of field work [2)]	Date 28.04.2023
Field work	Dates 01.05.2023 – 08.05.2023
Chemical analyses	May 2023
Biological analyses	May – August 2023
Reporting	December 2023 (draft) to July 2024 (final)
Submission of technical report	December 2023

2. Description of the river basin and the main pressures

2.1. The river basin and its main rivers

River Tkibula is a river in West Georgia, Tkibuli municipality. It originates on the southern slope of the Nakerali ridge at an altitude of 1175 m asl. Length 9.4 km, basin area 43.6 km². It is fed by rain, snow and underground water. It connects to Tkibuli reservoir. Before the construction of the reservoir, Tkibula was lost in the shaft near the so-called "watershed" in the Akhalsopli reservoir and came out on the other side under the name of Dzevruli. Water from the Shaori reservoir flows through the diversion canal in Tkibula. A waterfall mode is characteristic. Water is abundant in spring and winter.

Shaori reservoir is located in Racha-Lechkhumi and Kvemo Svaneti region, in Ambrolauri municipality. wyalsacavi is located on the northern slope of the Rachi mountain range, in the Shaori basin. Created by an earthen dam that dams the Shaor River. The Shaori reservoir stretches from the southwest to the northeast, its length is 7.1 kilometers, the greatest width is 2.7 kilometers. The greatest depth is 14.5 m, the average depth is 9.8 m, the area is 9.2 km². The volume of water is 90.6 million m³. It is fed by tributaries and precipitation that falls on its surface (1500 mm per year). Kebuli is built with sub-cretaceous carbonate rocks, where karst processes are well developed. There were small karst lakes – Kharistvali and Drikhithvali, which are covered with water from the reservoir. The banks of the reservoir are mostly low and steep, in some places they are flat.

River Chkhrimela is located in the municipalities of Kharagauly and Zestafoni. The left tributary of Dzhirula. It originates on the western slope of the Likhi ridge, at an altitude of 1150 m asl. Its length is 39 km. Basin area — 490 km². It is fed by rain, snow and underground water. Flooding is known in the spring, as a result of snowmelt, from mid-February to early June. There is water scarcity in summer and winter, whereas in autumn floods caused by rains may occur. The average annual flow at the estuary is 13.6 m³/s.

The Kvrilila River originates on the southern slope of the Rachi mountain range, in Ertso Kebbuli. It flows from the Ertso Lake at an altitude of 1711 m asl and flows into the Vartsikhi Reservoir. Before the construction of the reservoir, it joined the river Rion from the left side. The length of the river is 140 km, the total fall is 1628 m, the average slope is 11.6‰, the area of the basin is 3598 km^2, the average height of the basin is 790 m asl. The river has 2906 tributaries of different orders with a total length of 5254 km. The main tributaries of Kvrila river are Gvizhga (19 km), Gedura (13 km), Lashura (13 km), Chikhura (21 km), Zhruchla (18 km), Sadzalikhevi (10 km), Katzkhura (13 km), Dzirula (94 km), Cholaburi (20 km), Lukhuta (21 km), Shabetaghele (15 km), Peshavia (15 km), and Tskaltsitela (49 km). The frequency coefficient of the river network in the catchment basin is 1.45 km/km^2. The river is fed by snow, rain and groundwater, while the role of snow in the river's nutrition increases in the highlands. Groundwater plays a secondary role in river nutrition. The water regime of the river is characterized by spring floods, autumn floods and unsustainable summer and winter water scarcity. The course of the flood is often disrupted by flash floods caused by rains. Particularly intense floods are observed in autumn, which are caused by long rains. Fall floods exceed spring flood levels in their height, and annual maximums are more often recorded in autumn. In summer and winter months, the river is characterized by unstable levels. In Sachkheri zone, 44.2% of annual runoff flows in spring, 18.6% in summer, 18.2% in autumn and 19.0% in winter. Icy events, mainly in the form of floes, are recorded in the middle of the Kvirila River in individual cold winters. Kvirila River is used for irrigation and energy purposes.

River Dzirula is a river in Western Georgia and a left tributary of the Kviril River. It flows through the municipalities of Sachkheri, Kharagauli and Zestafoni. It originates on the western slope of the Likhi ridge, at an altitude of 1252 m asl. The length is 83 km, the area of the basin is 1270 km². It is fed by snow, rain and underground water. The main tributaries are Dumala, Chkhrimela, and Khelmosmula. Floods are known in spring, water scarcity in summer, floods in autumn-winter. The average annual consumption near the village of Chima is 26.6 m³/s, used for irrigation.

The Rioni River originates on the southern slope of the Caucasus Range near the Price Mountain, 2620 m asl, and joins the Black Sea near the city of Poti. The length of the river is 327 km, the average slope is 7.2 ‰, the catchment area is equal to 13,400 km2, the average height of the Rion river catchment is 1084 m. The hydrographic network of the Rioni river basin is well developed. The frequency coefficient of the river network on the left side of Rion river is 1.04 km/km^2, and the frequency coefficient of the river network on the right side is 0.92 km/km^2, with an average of 0.99 km/km^2.

The river Rion has large tributaries in the Kolkheti plain after its exit. Its main tributaries are: Jojora (with a length of 50 km), Kvrila (140 km), Khanistskal (57 km), Tshnistskal (176 km), Noghela (59 km), Tekhura (101 km), Civi (60 km). Eight tributaries have a width of 25 to 50 km, 14 tributaries have a length of 10 to 25 km, and the remaining 355 tributaries have a length of no more than 10 km individually. Their total length is 720 km. The catchment basin of the river occupies half of Western Georgia. Its largest part (68%) is located on the southern slope of the Caucasus Range, 13% of the river basin is on the northern slopes of the Adjara-Imereti Range, and the remaining 19% is on the Kolkheti Plain. The Rion River is fed by glaciers, snow, rain and ground water, but is mainly fed by snow and rainwater. Its water regime is characterized by spring-summer floods and floods throughout the year. The maximum runoff on the river is observed in spring, when 38.8% of the annual runoff flows. 18% of annual runoff flows in autumn, and 19.7% in winter. The distribution of annual runoff between months is very uneven. The maximum runoff is usually observed in the month of May and is 13.9% of the annual runoff, while the minimum runoff is recorded in January and is equal to only 5% of the annual runoff.

River Tskaltsitela is in Western Georgia, in the municipalities of Tkibuli and Terjoli. It originates on the slopes of Mt. Nakerala, located on the Rachi ridge, at an altitude of 1080 m asl. It is attached to the river Kvirila from the right. Length 49 km, basin area 221 km². The main tributary is the river Chala. It is fed mainly by rainwater. Waterfalls are characteristic throughout the year. The average annual consumption at Rion is 7.56 m³/s. Downstream it borders the city of Kutaisi from the east.

River Oghaskura is located in Western Georgia and a tributary of river Gubisskali. It originates on the southern slopes of Mount Sataflia, crosses the northwestern part of the city of Kutaisi, passes through the settlement of "Autofactory" (mostly in an artificial bed), then village Partskhanakanev and Ertvi river. Gubistskal village 3-4 km from Kutaisi. The length is 22 km. It is fed by atmospheric precipitation and ground water. In the case of heavy rainfall, it is characterized by flooding, which creates a danger of flooding the streets of densely populated areas of Kutaisi. The river bed within the city is heavily polluted with household, construction and other types of waste.

River Gubistskhali is located in the municipalities of Tskaltubo and Samtredia and formed by the confluence of the Kumi and Sami rivers near the village of Dadalauri at an altitude of 105 m asl. It flows on the Imereti plain. It is attached to Rion river from the right side, near the city of Samtredia. Length 36 km, basin area 442 km². It is nourished by rain and underground water. There is a flood in the spring, and a lack of water in August and September. The average annual consumption is 16.3 m³/s, used for irrigation. There is a natural bridge built with limestone breccias of the Cretaceous period in the upper reaches of Gubisskali, in the Sami valley, at an altitude of 235 m asl.

Tekhuri is a river in Western Georgia, in the territory of Martvili and Senaki municipalities of Samegrelo-Zemo Svaneti region. It originates on the southern slope of the Egris ridge, near the peak Tekhurishdud, 2400 m asl. River Rion is attached to the right. Length 108 km, basin area 1040 km². The main tributary is the Abasha River. It is fed by rain, snow and underground water. Floods are known in spring, waterfalls throughout the year. The average annual flow near Nokalakev is 31.8 m³/s. They are used for sawing wood and for village mills. Lebarde resort is located in the upper part of the valley. There are 503 tributaries in the river basin, with a total length of 1047 km. The main tributaries with a length larger than 10 km are: the left Chkhorotsku river (11 km), the left Tsachkhura river (12 km), the right Gurdzeni river (20 km), the right Nakhuri river (11 km), the left Abasha river (66 km). After joining the Abashi Basin, the Tekhuri Basin takes an asymmetric shape. The density coefficient of the river is equal to 1.01 km/km².

The river bed is moderately undulating and mostly undulating. In the vicinity of the village of Doberazen, it divides into 2-3 branches, due to which low, unstable islands with a pebbly-sandy surface are formed. Knees and rapids are typical for the river bed, on average every 30-50 meters. The width of the river bed varies from 2 m (2.5 km below the headwaters) to 20 m (in the village of Doberazen). 5 m mostly prevails. The depths at the knees are 0.3-1.6 m, and at the bottoms are 0.4-5 m.

Abashitskali is a river in Georgia, in Martvili and Abashi municipalities of Samegrelo-Zemo Svaneti region, the left tributary of Tekhuri river. Length 66 km, basin area 370 km². It starts from the southern slopes of the limestone massif. Its head is formed by the rivers Rachkhitskal and Toba, which merge above the village of Baldi (sea level 325 m). Abasha is nourished by rain, snow and underground water. Runoff is relatively evenly distributed throughout the year.

Noghela is in Abashi and Martvil municipalities, the right tributary of the Rion, has its source in the southwest of the Askhi massif, at 680 m asl. Length 51 km, basin area 130 km². It is fed by rain, snow and underground water.

Flooding caused by rains is characteristic. Maximum runoff in July and November, minimum in winter. The average annual consumption is 4.86 m^3/s.

Tskhenistskali River originates in the central part of the Caucasus range, south of the Sharivtsek pass, from the glacier at 2700 m and joins the Rion river from the right side, 1.3 km southwest of Sajavakho village. The length of the river is 176 km, the total fall is 2684 m, the average gradient is 15%, the area of the catchment basin is 2120 km^2, and the average height of the basin is 1660 m asl. The river has 897 tributaries of different orders, with a total length of 2200 km. Important tributaries are Zeskho (19 km long), Gobishuri (12 km), Laskanura (20 km), Khledula (34 km), Lektareshi (24 km), and Janaula (21 km). The frequency coefficient of the river network is 1.09 km/km^2. The area of glaciers in the river basin is 12.9 km^2. The main shaper of river runoff is snowmelt water. The river is fed by snow, rain, ground and glacier water. Its water regime is characterized by spring-summer floods and well-defined winter water scarcity. 70-75% of annual runoff flows in spring-summer, 18-20% in autumn, and 8-10% in winter. The river is used for irrigation and energy purposes. Above the town of Tsageri, from the left bank of the river, a 6.5 km long tunnel has been built, through which the river Water from Tshnisskli in the amount of 50-60 m^3/s is supplied to Lajanuri reservoir for energy purposes. The reservoir created on the Lajanuri river, which receives additional nutrition from the river Tshnisskali, operates the Lajanur power plant, the produced water of which flows into the river. In Lajanur and then in Md. Rion. on the river, village Near Matkhodji, the main structure of the Khoni-Samtredia irrigation system has been installed. The mentioned irrigation system serves to irrigate 1200 ha of Imereti region.

Khevistskali is a river in Western Georgia in the municipalities of Chokhatauri and Samtredia. It originates on the southern slope of the Guria series, at an altitude of 850 m, near the peak of the glacier (1204 m asl). It is attached to the rion from the left near the village of Vazisubani. The length is 32 km. It is fed by rain, snow and underground water. The average annual flow at the estuary is 4 m^3/s.

River Supsa originates on the northern slope of the Meskheti mountain range near the peak Mefistskaro, at an altitude of 2800 m asl. It is attached to the Black Sea near the village of Grigoleti. The length is 117 km, the area of the river basin is 1130 km^2. The main tributaries are Gubazeuli, Bakhvistskal, Baramidzestskal, and Shuti. The northern border of the basin extends to the Guria ridge, the southern one to the Meskheti ridge (in the upper reaches) and the Nasakiral ridge (in the lower reaches). The basin is built with tuffogenic rocks, sandstones, sandy-conglomerate sediments, clays. In the head section, the basin is surrounded by subalpine meadow vegetation, below 2000 m asl – by a forest consisting of sochi (palm tree), pine, beech, larch, oak and others. A large part of the basin below the village of Bukissikhi is occupied by agricultural fields. It is fed by rain, snow and underground water. It knows about water falls (16-27 times a year). Spring floods are relatively short. The water regime of the river mainly depends on the amount and intensity of atmospheric precipitations, the maximum flow near the village of Khidmaghala reaches 700 m^3/s, the minimum flow downstream is 4 m^3/s, the average long-term flow at the mouth is 46 m^3/s.

River Natanebi is a river in Georgia, in the region of Guria. It originates on the northern slope of the Meskheti mountain range, at 2548 m asl, near the peak of Sakornia, the village of Kotupili is attached to the Black Sea, its length is 60 km, the area of the river basin is 657 km^2. It is fed by rain, snow and underground water. Floods are known in spring, low water in July-August, floods throughout the year. The average annual consumption is 33.5 m^3/s. They are used for mills and irrigation. Important tributaries are Bjuzh and Choloki. Nataneb shows the features of a mountain river in the upper reaches, while in the lower reaches it is a typical lowland river.

2.2. Pressure sources selected for the investigative monitoring

This section provides the outcome of the pressure-impact analysis for the Rioni river basin. The information was collected partly during the field campaign, partly from desktop research prior to the field work. Table 2 list the major enterprises in the basin, which discharge industrial wastewater into the natural waterbodies. No information is available on the discharge of the untreated wastewater or related to the question whether the activities require biological treatment or not.

Typically, most rivers are not affected by a single pressure alone but characterized by multi-stressors. As far as known, the following main pressure are expected to affect the aquatic communities and the ecological status:

Tkibula river: industrial activities (coal mining);

Kvirila upstream, Chkherimela and Dzurula rivers: current road construction

Kvirila downstream and Khanistskali rivers: settlements, industrial activities (ferroalloys and manganese ore);

Rioni and Oghaskura rivers: various activities (hydropower, mining use, settlement);

Supsa, Abasha, Tekhuri, Tskhenistskali rivers: mining;

Natanebi river: settlement.

Table 2. Major enterprises in the Rioni-Enguri river basin.

Name of entrepreneur	Activity	River
"Saknakhshiri" (GIG)	Coal mining	Tkibula
Roads Department of Georgia	Road construction	Chkherimela Dzirula Kvirila up
Energo Pro	Hydropower	Rioni
Unknown	Mining use	Abasha Tekhuri Tskhenistskali Supsa Rioni
Georgian Manganese	ferroalloys and manganese ore	Kvirila Down Khanistkali

Table 3. Characterisation of the sampling sites in the Rioni-Enguri river.

River	River type	Site	Nr	HMWB [1)]	Risk [2)]	Sign. pressure [3)]
Tkibula Down	0 (The main river joins the Akhalsopeli reservoir)	Tkibuli	01	No	PR	H
Tkibula Up	0 (The main river joins the Akhalsopeli reservoir)	Tkibuli	02	No	NR	N
Shaori Reser-voir	An artificial reservoir	Near Nikorts-minda	03	NO	NR	N
Chkherimela	4 rows of tributaries	Dzirula rail-way station	04	No	PR	H
Dzirula	3 rows of tributaries	Tseva	05	no	PR	H
Kvirila	1 rows of tributaries	Zestaphoni up	06	no	R	H, O, U
Kvirila	1 rows of tributaries	Zestaphoni down	07	no	R	H, O, U
Khanistskhali	1 rows of tributaries	Vartsikhe	08	no	NR	N
Kvirila	1 rows of tributaries	Kvirila to close rioni vartikhe	09	no	R	H, O, U
Rioni	0 (The main river joins the Akhalsopeli reservoir)	Kutaisi Down	10	no	PR	H
Rioni	0 (The main river joins the Akhalsopeli reservoir)	Kutaisi up Ji-mastaro	11	no	PR	H

Tskaltsitela	1 rows of tributaries	Near Kutaisi Gelati	12	no	NR	N, H
Oghaskura	2 rows of tributaries	Kutaisi up	13	no	PR	H, O, U
Oghaskura	2 rows of tributaries	Kutaisi Down	14	no	R	H, O, U
Gubistskhali	1 rows of tributaries	Maghlaki	15	no	NR	N
Lagoba	3 rows of tributaries	Ganiri	16	no	PR	H, O, U
Gubistskhali	1 rows of tributaries	Confluence Ianeti	17	no	NR	N
Tekhuri	1 rows of tributaries	Nokhalakevi	18	no	NR	N
Tekhuri	1 rows of tributaries	Senaki	19	no	PR	H
Abashistskhali	2 rows of tributaries	Down High-way	20	no	PR	H
Rioni	Main River	Zemo Chala-didi up	21	no	PR	H
Noghela	2 rows of tributaries	Naesakavo	22	no	PR	H
Tsk-henistskhali	1 rows of tributaries	Marani Rail-way	23	no	PR	H
Rioni	1 rows of tributaries	Dapnari	24	no	NR	N
Khevistskhali	2 rows of tributaries	Vazisubani	25	no	PR	H
Supsa	Main River	Kveda dzimiti	26	no	NR	N
Natanebi	2 rows of tributaries	Ozurgeti	27	no	PR	H

[1)] Assignment as provisional HMWB: yes / no

[2)] Assignment of the risk status: R = at risk, PR = possibly at risk, NR = not at risk

[3)] Significant pressure: N = no significant pressure, P = organic pollution, E = eutrophication, T = toxic impact, H = hydro-morphological alterations, M = multistressor, O = other, U = unknown

3. Methods

3.1. Quality elements

Three quality elements have been chosen:

- Macroinvertebrates (= macrozoobenthos) as biological quality element;
- General physico-chemical parameters (no specific relevant pollutants such as heavy metals);
- Hydromorphology for site description

During the pre-treatment period of the samples and before tests were performed, each sample was kept according to the instructions, specific methodology and specific SOPs. In order to maintain integrity of the samples, keeping samples for a long period was avoided. At the same time, samples were kept in the proper condition of temperature and humidity. Before the analyses were done, the measurement and test equipment were calibrated internally by the laboratory staff.

During the hydromorphological research, the guidelines provided by international experts "General guidelines for surface water research" were used. During the field survey, the hydromorphological condition of each point was described, field survey protocols were filled, and river water flow was measured.

3.2. Sampling sites

Prior to the sampling campaign, the locations of the sampling sites were discussed and agreed by the project staff and appropriate units of MEPA and NEA (Water Management and Pollution Monitoring). The sampling points are presented in the Table 4 and Figure 1.

Table 4: Sampling sites with geographical coordinates in the Rioni-Enguir river basin.

Site Nr.	RBD	River name	Site name	Latitude	Longitude
1.	Rioni	Tkibula	Tkibuli down bridge	42° 19.666'	42° 58.596'
2.	Rioni	Tkibula	Tkibuli up	42° 21.727'	43° 00.380'
3.	Rioni	Shaori reservoir		42° 26.089'	43° 04.081'
4.	Rioni	Chkherimela	Dzirula railway bridge	42° 04.735'	43° 09.536'
5.	Rioni	Dzirula	Tseva bridge	42° 05.608'	43° 07.761'
6.	Rioni	Kvirila	Zestaponi up bridge	42° 06.484'	43° 02.681'
7.	Rioni	Kvirila	Zestaponi down bridge	42° 07.196'	42° 58.338'
8.	Rioni	Khanistskali	Vartsikhe Bridge right branch	42° 08.967'	42° 43.676'
9.	Rioni	Kvirila	Vartsikhe bridge close to Rioni	42° 10.520'	42° 44.118'
10.	Rioni	Rioni	Kutaisi down	42° 11.137'	42° 43.220'
11.	Rioni	Rioni	Jimastaro Up bridge	42° 19.060'	42° 42.446'
12.	Rioni	Tskaltsitela	Near Kutaisi Gelati bridge	42° 17.912'	42° 45.267'
13.	Rioni	Oghaskura	Kutaisi up	42° 16.624'	42° 40.769'
14.	Rioni	Oghaskura	Kutaisi down	42° 15.468'	42° 36.096'
15.	Rioni	Gubistskali	Maghlaki	42° 15.320'	42° 30.400'
16.	Rioni	Lagoba	Ghaniri	42° 14.381'	42° 21.664'
17.	Rioni	Gubistskali	Ianeti Down near bridge	42° 10.418'	42° 25.678'

18.	Rioni	Tekhuri	Nokalakevi	42° 21.348'	42° 11.797'
19.	Rioni	Tekhuri	Senaki down railway bridge	42° 15.865'	42° 05.705'
20.	Rioni	Abasha	Abasha down highway near bridge	42° 13.775'	42° 10.132'
21.	Rioni	Rioni	Chaladidi	42° 12.855'	42° 47.522'
22.	Rioni	Noghela	Naesakavo bridge	42° 09.868'	42° 11.820'
23.	Rioni	Tskhenistskali	Marani near bridge	42° 09.364'	42° 17.924'
24.	Rioni	Rioni	Dapnari bridge	42° 07.154'	42° 19.875'
25.	Rioni	Khevistskali	Vazisubani near bridge	42° 05.698'	42° 15.062'
26.	Rioni	Supsa	Kveda Dzimiti	41° 59.352'	42° 03.658'
27.	Rioni	Natanebi	Ozurgeti under of bridge	41° 56.071'	41° 58.992'

Figure 1: Map of sampling sites.

3.3. Sampling period and conditions

The sampling was carried out from 1st to 7th May of 2023. The part of survey in the Rioni basin was done by national experts unassisted. Table 5 presents the list of sampling dates and time Furthermore, it covers a brief description of the general meteorological and hydrological conditions during the field work

Table 5: Sampling dates and information on meteorological and hydrological conditions during the field campaign in the Rioni-Enguri River basin.

Site No.	River	Location	Date	Time	Team	Met	Hyd	Elevation
1	Tkibula Down	Tkibuli	01.05.2023	14:00-14:27	GS AG IK GG	Drizzle	Medium	535

Site No.	River	Location	Date	Time	Team	Met	Hyd	Elevation
2	Tkibula Up	Tkibuli	01.05.2023	16:20-16:40	GS AG IK GG	Drizzle	Medium	600
3	Shaori Res.	Near Nikortsminda	01.05.2023	18:35-19:00	GS AG IK GG	Drizzle	Medium	1131
4	Chkherimela	Dzirula railway station	02.05.2023	10:20-10:50	GS AG IK GG	Dry	high	2085
5	Dzirula	Tseva	02.05.2023	12:10-12:40	GS AG IK GG	Dry	high	196
6	kvirila	Zestaphoni	02.05.2023	14:30-15:00	GS AG IK GG	Dry	high	158
7	kvirila	Zestaponi Down	02.05.2023	16:00-16:35	GS AG IK GG	Dry	high	142
8	khanistskhali	Vartsikhe	02.05.2023	17:40-18:20	GS AG IK GG	Dry	high	91
9	kvirila	Close to Rioni Vartsikhe	02.05.2023	18:40-19:20	GS AG IK GG	Dry	high	87
10	Rioni	Kutaisi Down	03.05.2023	11:10-12:10	GS AG IK GG	Cloudy	high	91
11	Rioni	Kutaisi up Jimastaro	03.05.2023	13:20-14:25	GS AG IK GG	Cloudy	high	165
12	Tskaltsitela	near Kutaisi Gelati	03.05.2023	16:00-16:30	GS AG IK GG	Cloudy	Medium	192
13	oghaskura	Kutaisi up	03.05.2023	18:00-18:30	GS AG IK GG	Cloudy	Low	157
14	oghaskura	Kutaisi Down	03.05.2023	19:20-19:40	GS AG IK GG	Cloudy	Low	106
15	Gubistskhali	Maghlaki	04.05.2023	12:00-12:30	GS AG IK GG	Dry	Low	69
16	Lagoba	Ganiri	04.05.2023	13:40-14:00	GS AG IK GG	Dry	Low	60
17	Gubistskhali	Confluence Ianeti	04.05.2023	14:40-15:10-	GS AG IK GG	Dry	Low	30
18	Tekhuri	Nokalakhevi	04.05.2023	17:05-17:25	GS AG IK GG	Dry	Medium	91
19	Tekhuri	Senaki	04.05.2023	18:00-18:30	GS AG IK GG	Dry	Medium	20
20	Abashistskhali	Down Highway	04.05.2023	19:00-19:30	GS AG IK GG	Dry	Medium	19
21	Rioni	Zemo Chaladidi up	05.05.2023	14:00-14:45	GS AG IK GG	Dry	Medium	6
22	Noghela	Naesakavo	05.05.2023	16:00-16:30	GS AG IK GG	Dry	Low	14
23	Tskhenistskhali	Marani Railway	05.05.2023	17:10-17:40	GS AG IK GG	Dry	Medium	19
24	Rioni	Dapnari	06.05.2023	11:30-12:15	GS AG IK GG	Dry	Medium	11
25	Khevistskhali	Vazisubani	06.05.2023	12:40-13:10	GS AG IK GG	Dry	Low	18
26	Supsa	Kveda dzimiti	06.05.2023	14:30-15:00	GS AG IK GG	Dry	Medium	45
27	Natanebi	Ozurgeti	06.05.2023	16:10-16:40	GS AG IK GG	Dry	Low	60

3.4. Responsibilities

Table 6: Responsibilities during the Surface Water Survey 2023.

Responsibilities	Institution, contact person, email-address
General	National Environmental Agency
Responsible for the organisation of surface water body sampling	**Institution**: National Environmental Agency **Contact person** Gela Sandodze **E-Mail**: gela.sandodze@nea.gov.ge
Field work	
Responsible for field work (biological and chemical sampling, hydro-morphological site description)	**Institution**: National Environmental Agency **Contact person** Gela Sandodze **E-Mail**: gela.sandodze@nea.gov.ge
Responsible for functional check of sampling equipment	**Institution**: National Environmental Agency **Contact person** Gela Sandodze **E-Mail**: gela.sandodze@nea.gov.ge
Responsible for calibration of on-site measuring equipment	**Institution**: National Environmental Agency **Contact person** Gela Sandodze **E-Mail**: gela.sandodze@nea.gov.ge

Responsibilities	Institution, contact person, email-address
Chemical analysis	
Overall responsible for the chemical analysis in the lab, including reporting and data delivery	**Institution**: National Environmental Agency **Contact person**: Lia Aptsiauri **E-Mail**: lia.aptsiauri@nea.gov.ge
Responsible for sample transport from the field to the laboratory	**Institution**: National Environmental Agency **Contact person** Gela Sandodze **E-Mail**: gela.sandodze@nea.gov.ge
Analysing laboratory and contact person	**Institution**: National Environmental Agency **Contact person**: Lia Aptsiauri **E-Mail**: lia.aptsiauri@nea.gov.ge
Biological analysis	
Overall responsible for the biological analysis in the lab, including reporting and data delivery	**Institution**: National Environmental Agency **Contact person**: Lia Aptsiauri **E-Mail**: lia.aptsiauri@nea.gov.ge
Responsible for field work (hydro-morphological site description) and Final hydromorphological report	Institute: National Environmental Agency Contact person: George guliashvili E-Mail: giorgi.guliashvili@nea.gov.ge mailto:ira-klikrdz414@gmail.com

4. Results

4.1. Hydro-morphological site description

The fieldwork was preceded by preparations in the office. Maps for all sampling sites were prepared, routes planned, available hydromorphological data was studied and field protocols were prepared. The field surveys were conducted from 1 May to 6 May 2023. Field protocol forms were completed in accordance with the guidelines at field exit. The completed hydromorphological site protocols for all sites are given in Annex # 6. The results of the hydro-morphological data collected during the field campaign are summarised in Table 7.

Table 7. Hydro-morphological characterzation of the sampling sites. Q = discharge, v = averag flow velocity, A = cross-sectional area, W = river width, Z = river depth.

Site No.	Sampling Date	Sampling Time	River and site name	Q [m³/s]	A [m²]	v [m/s]	W [m]	Z [m]
1	01.05.2023	14:00-14:27	River Tkibula Down – Tkibuli (1 stream)	12.5	18.8	0.66	24.0	0.78
			(2 stream)	0.05	1.06	0.05	3.00	0.35
			∑	12.6				
2	01.05.2023	16:20-16:40	River Tkibula up – Tkibuli	1.00	1.42	0.71	5.00	0.28
3*	01.05.2023	18:35-19:00	Shaori Reservoir – near nikortsminda	–	–	–	–	–
4	02.05.2023	10:20-10:50	Chkherimela – Dzirula railway station	17.8	16.2	1.10	25.0	0.65
5	02.05.2023	12:10-12:40	Dzirula – Tseva	38.7	31.2	1.24	44.0	0.71
6	02.05.2023	14:30-15:00	Kvirila – Zestaphoni	150	118	1.20	62.5	1.88
7	02.05.2023	16:00-16:35	Kvirila – Zestaponi down	152	104	1.46	97.0	1.07
8	02.05.2023	17:40-18:20	Khanistskhali – Vartikhe (1 stream)	14.6	15.2	0.96	19.0	0.80
			(2 stream)	33.8	21.8	1.55	24.0	0.91
			∑	48.4				
9	02.05.2023	18:40-19:20	Kvirila Close to Rioni Vartsikhe	231	437	0.53	130	3.36
10	03.05.2023	11:10-12:10	Rioni – Kutaisi down	402	–	–	–	–
11	03.05.2023	13:20-14:25	Rioni – Kutaisi up Jimastaro	390	142	2.75	80.0	1.78
12	03.05.2023	16:00-16:30	Tskaltsitela – near Kutaisi Gelati	6.31	6.94	0.91	14.0	0.50
13	03.05.2023	18:00-18:30	Oghaskura – Kutaisi up	0.11	0.59	0.19	4.00	0.15
14	03.05.2023	19:20-19:40	Oghaskura – downstream	0.24	0.61	0.39	4.60	0.09
15	04.05.2023	12:00-12:30	Gubistkhali – Maghlaki (1 stream)	4.54	4.05	1.12	16.0	0.25
			(2 stream)	0.46	0.60	0.77	3.00	0.20
			∑	5.00				
16	04.05.2023	13:40-14:00	Lagoba - Ganiri	0.09	0.38	0.24	2.00	0.19
17	04.05.2023	14:40-15:10	Gubistskhali Confluence Ianeti	7.54	9.96	0.76	30.0	0.33
18	04.05.2023	17:05-17:25	Tekhuri – Nokhalakhevi	29.7	32.8	0.91	52.0	0.63
19	04.05.2023	18:00-18:30	Tekhuri – Senaki	39.4	35.2	1.12	64.5	0.55
20	04.05.2023	19:00-19:30	Abashistskhali downstream of Highway	18.7	18.1	1.04	41	0.44
21	05.05.2023	14:00-14:45	Rioni – Zemo Chaladidi Up	380	522	0.72	140	3.73
22	05.05.2023	16:00-16:30	Noghela – Naesakavo	2.21	12.3	0.18	15.3	0.80
23	05.05.2023	17:10-17:40	Tskhenistskali – Marani Railway	69.7	153	0.45	68	2.25
24	06.05.2023	11:30-12:15	Rioni – Dapnari	323	583	0.55	160	3.64
25	06.05.2023	12:40-13:10	Khevistkhali – Vazisubani	0.90	3.02	0.30	14	0.22
26	06.05.2023	14;30-15:00	Sufsa - Kveda Dzimiti (1 stream)	35.3	62.9	0.31	40	1.57
			(2 stream)	0.058	5.83	0.01	19	0.31
			∑	35.4				
27	06.05.2023	16:10-16:40	Natanebi-Ozurgeti	4.52	4.98	0.91	13.5	0.37

* Because there is a Shaori reservoir, it was not possible to measure the discharge.

4.2. Results of the field research at the river sampling sites

Site Number 1 – Tkibula Down is located at the exit of Tkibuli city. In this section, the water generated by the Shaori HPP is combined in the Tkibula River bed. The hydromorphological condition has changed in this section. Household waste can be found in the river bed. Bed elements is found bars, islands, Riffles/Rapids. Bed substrates is found Cobble, Gravel/Pabble, Sand, coarse debris, Silt/mud, clay. Flow Types is found unbroken standing waves, Rippled, No perceptible flow.

Site Number 2 - Tkibula Up is located in the city of Tkibuli. In the mentioned section, the Tkibula River maintains its natural state. The river flows in a natural bed. There are small waterfalls and a steep section. There is household waste in the river. Bed elements is found Riffles, Rapid, Rocks, Step pool sequence. Bed substrates is found Bedrock, Boulder, Cobble, Gravel/Pabble. Flow Types is found Freefall, Chute, Chaotic, Broken standing waves, Rippled, No perceptible flow.

Site Number 3 - There is a reservoir of Shaori. Before the creation of the Shaori reservoir, the area was a river. Shaori valley, where There were 3 small lakes (Kharistvala, Zrokhitstvala, Satsarbia). Abundant precipitation During (1500 mm) certain areas of the areas surrounding the lakes (approx 5.0 km2) was under water. The reservoir for Shaor HPP was created by the construction of an earthen dam (dam). which river It is in the place of the section of Shaori where the water flow took place Going under the bed current. Filling of the Shaori reservoir began in 1954. The reservoir is fed by the river. Shaori with karst waters and atmospheric precipitation. The morphometric characteristics of the Shaori reservoir are: The water surface area is 9.2 km^2, The volume is 90.6 mln. M^3, The average depth is 9.8 m, The maximum depth is 4.5 m, HPP capacity 400,000 kW. It depends on the water level of the reservoir and its useful volume Conditions of exploitation of Shaor HPP. The reservoir is filled in spring and summer in the period (filling starts from April). It reaches its maximum level in May-June.

The reservoir was observed in 1955-63 years. during the observation period The maximum water level at the reservoir was recorded on August 6-9, 1961 at 1132.41 m. and the minimum on January 1, 1955 was 1123.19 m. on the reservoir The amplitude of the water level fluctuation is 5.36 on average, the maximum is 9.22 m and Minimum 3.75 m.

Ice events on the reservoir are due to its location and under the conditions of operation of the HPP. The ice cover remains on the Shaori reservoir From the second decade of December to the end of March. Average ice standing of the reservoir Duration is 75-80 days. The ice thickness in the reservoir reaches 20-40 cm.

During the years 2017-2021, the water level in the reservoir decreases significantly The minimum level that is fixed by the National Environment Agency by specialists, it amounts to 1126.43 m. drop in the water level is caused with hydro-meteorological conditions existing in the region during the mentioned period (concentration of atmospheric precipitation, high evaporation, etc.).

On May 1, 2023, the water level of the Shaori reservoir was 1131.65 m. The water level of the last year is based on traces 1131.90 m.

Site Number 4 - The research point of the Chkhrimela river is located near the Dzirula railway station. On both sides of the said section, there is an embankment structure, due to which the flow goes into the channel and the area is hydromorphologically changed. There are concrete fragments in the bed. Bed elements is found Bar, Island Riffles. Bed substrates is found Cobble, Gravel/Pabble, Sand, silt, mud, Clay. Flow Types is found unBroken standing waves, Rippled, No perceptible flow.

Site Number 5 - In the study section of the Dzirula River near the village of Chima, the right bank of the river is a rock and has not been changed. A road passes on the left bank and has been changed. The river produces left bank erosion. Household remains can be found in the river bed. Bed elements is found Bar, Island, Riffles. Bed substrates is found Bedrock, Boulder, Cobble, Gravel/Pabble, Sand, silt, mud, Clay. Flow Types is found unBroken standing waves, Rippled, No perceptible flow.

Site Number 6 - The point is located in the city of Zestafon. Hydromorphologically, the place has completely changed. Erosion is taking place on the left and right bank. The water flow goes in a straight direction, enclosed in concrete dams. On the left side of the river, the facts of dumping construction and household waste are recorded. Bed elements is found Bar, Riffles. Bed substrates is found Boulder, Cobble, Gravel/Pabble, Sand, silt, mud, Clay. Flow Types is found unBroken standing waves, nBroken standing waves, Rippled.

Site Number 7 - The point is located near the village of Second Svir. In this section, the river produces intense erosion on the right side. During floods, the stream collapses completely into the floodplain. There are embankment structures on both sides of the bridge. The area has changed hydromorphologically, as old quarry sites can be seen below the bridge. After the mining of inert materials, there are depressions and swampy areas in the bed. Bed elements is found Bar, Islands, Riffles. Bed substrates is found Boulder, Cobble, Gravel/Pabble, Sand, silt, mud, Clay. Flow Types is found unBroken standing waves, nBroken standing waves, Rippled, Chute, No perceptible Flow.

Site Number 8 - The point is located near the Vartsikhi reservoir. Hydromorphologically, the river is in an almost natural state in the mentioned section, only the bridge crossing has a slightly changed area. The river produces intensive lateral erosion, banks are washed away, islands are found in the bed. Bed elements is found Bar, Islands, Riffles. Bed substrates is found Boulder, Cobble, Gravel/Pabble, Sand, silt, mud, Clay. Flow Types is found unBroken standing waves, nBroken standing waves, Rippled, No perceptible Flow.

Site Number 9 - The point is located near the Vartsikhi reservoir. The river produces lateral erosion in the mentioned section. There are islands in the bed. Due to the proximity to the reservoir, the stream loses speed and flows slowly. On the left side is a sand-gravel processing plant that may pollute the river. Bed elements is found Bar, Islands. Bed substrates is found Sand, silt, mud, Clay. Flow Types is found unBroken standing waves, nBroken standing waves, Rippled, No perceptible Flow, Smooth.

Site Number 10 - The point is located below Kutaisi, near the highway bridge. The water flow is fixed in two branches, there are many islands in the bed. The river intensively washes the banks, which is why earth and sand-gravel dams are installed on the banks. Important hydromorphological changes in this section. Sand and gravel mining is operating in the bed. Importantly, Gumathes was flushing the hydroelectric reservoir, which is why the high water was recorded. Bed elements is found Bar, Islands, Riffle. Bed substrates is found Boulder, Cobble, Gravel/Pebble, Sand, silt, mud, Clay. Flow Types is found unBroken standing waves, Broken standing waves, Rippled, No perceptible Flow, Chaotic.

Due to the bridge railing, the water flow rate could not be measured at the mentioned point. Therefore, the water consumption was transferred from the measured cross section of Upper Kutaisi Jimastaro using the analog method.

Site Number 11 - The point is located in the lower basin of the Gumati reservoir. On the day of the survey, the washing of the reservoir was observed. The river water was murky. As a result of washing, the bank erosion was active in the lower buffet. On the left side of the river there is a concrete canal, in which water is taken for the HPP, the maximum water capacity of the canal is 180 m^3/s, but on the day of the research, there was no water in the canal because washing was in progress. Bed elements is found Bar, Islands, Riffle. Bed substrates is found Bedrock, Boulder, Cobble, Gravel/Pebble, Sand, silt, mud, Clay. Flow Types is found unBroken standing waves, Broken standing waves, Rippled, No perceptible Flow, Chaotic.

Site Number 12 - The point is located on the river Tskaltsitela in Gelti. On the right side of the river, due to intense erosion, shore protections of reinforced concrete structures and gabions have been installed. On the left side there is a rock and a natural shore. Bed elements is found Bar, Islands, Riffle. Bed substrates is found Bedrock, Boulder, Cobble, Gravel/Pebble, Sand, silt, mud, Clay. Flow Types is found unBroken standing waves, Broken standing waves, Rippled, No perceptible Flow.

Site Number 13 - The survey point of the Oghaskura River is located near Kutai. The river produces intense lateral erosion on both banks. To protect against erosion, gabions and a reinforced concrete structure are installed, which is damaged and concrete blocks are thrown into the water. Sewage water flows into the river. Construction materials are falling on both banks of the river and the hydromorphological situation has changed. Bed elements is found Bar, Islands, Riffle, step pool sequence. Bed substrates is found Boulder, Cobble, Gravel/Pebble, Sand, silt, mud, Clay. Flow Types is found unBroken standing waves, Broken standing waves, Rippled, No perceptible Flow.

Site Number 14 - The survey point of the Oghaskura River is located below Kutaisi. In this section, the river is artificially diverted into an earthen channel and straightened. The river does not have a pronounced valley, and often during periods of flooding, the river flows over the muddy part and floods the area. The area has been completely changed hydromortgologically. Changed flow-generating substrate flow types, etc. Sewage waters join the stream. Erosive processes are active. Household waste is dumped directly in the river and in its vicinity. Bed elements is found Bar, Riffle. Bed substrates is found Boulder, Cobble, Gravel/Pebble, Sand, silt, mud, Clay. Flow Types is found unBroken standing waves, Broken standing waves, Rippled, No perceptible Flow, Smoot.

Site Number 15 - The research point is located near Maglak village. The point maintains its natural state with less anthropogenic human intervention in the river bed. Erosive processes are active on the river. There are many islands

in the bed. Bed elements is found Bar, Riffle, Isladn. Bed substrates is found Boulder, Cobble, Gravel/Pebble, Sand, silt, mud, Clay. Flow Types is found unBroken standing waves, Broken standing waves, Rippled, No perceptible Flow.

Site Number 16 - The research point is located in village near Lagoba Human intervention is important in the river. During floods, the river overflows its banks and floods the surrounding area. Sewage water is connected. There is a gabion on the left bank of the river to protect it from floods. Bed elements is found Bar, Riffle, Isladn. Bed substrates is found Gravel/Pebble, Sand, silt, mud, Clay. Flow Types is Rippled, No perceptible Flow, upwelling, Smooth.

Site Number 17 - The point is located near Yanti village. Mdianre carries out erosive processes in this section. There are islands in the bed, there is also a bridge crossing nearby and there are gabions near the bridge. Bed elements is found Bar, Riffle, Island. Bed substrates is found Boulder, Gravel/Pebble, Sand, silt, mud, Clay. Flow Types is Unbroken Standing Waves, Rippled, No perceptible Flow, Smooth.

Site Number 18 - Tekhuri river is located in Nokalakevi. In this section, the river flows through the canyon. After exiting the canyon, on the right hand side there are coastal protection structures. The river maintains its natural state. Bed elements is found Bar, Riffle, Island. Bed substrates is found Bedrock, Boulder, Gravel/Pebble, Sand, silt, mud, Clay. Flow Types is Unbroken Standing Waves, Rippled, No perceptible Flow, Smooth.

Site Number 19 - Tekhuri river is located in Senaki. Sand-gravel mining is observed in the surrounding area. Because of the quarries, there are depressions where the water rises. The river produces intense erosion on both banks. The area has changed morphologically. Bed elements is found Bar, Riffle, Island. Bed substrates is found Boulder, Gravel/Pebble, Sand, silt, mud, Clay. Flow Types is Unbroken Standing Waves, Rippled, No perceptible Flow, Smooth.

Site Number 20 - The study area of Abashistskal river is located below the central road bridge. In order to protect this section from floods and erosion processes, embankment structures were built on both sides. There are islands in the river. The hydromorphological condition has changed. Bed elements is found Bar, Riffle, Island. Bed substrates is found Boulder, Gravel/Pebble, Sand, silt, mud, Clay. Flow Types is Unbroken Standing Waves, Rippled, No perceptible Flow, Smooth.

Site Number 21 - The survey point was presented by international experts at the following coordinate in Chaladidi 42° 9.868'N 42° 11.826'E, But it was not possible to measure water costs at a given point. There are no bridges to cross, etc. On this point, only the protocol was filled, which is given in Annex 21.1. At this point, Mdianre produces intense erosion. Earthen and gabion-type guards have been installed to protect the banks. During floods, the damaged part of the gabion often breaks through the river and floods the surrounding area and villages. Bed elements is found Bar, Island. Bed substrates is found Boulder, Gravel/Pebble, Sand, silt, mud, Clay. Flow Types is Unbroken Standing Waves, Rippled, No perceptible Flow, Smooth.

The point Rioni Zemo Chaladidi up - At a given point, the water flow was measured by means of a ferry, a doppler was attached to the ferry, and the water flow was measured that way. At this point, Mdianre produces intense erosion. Earthen and gabion-type guards have been installed to protect the banks. During floods, the damaged part of the gabion often breaks through the river and floods the surrounding area and villages. . Bed elements is found Bar, Island. Bed substrates is found Boulder, Gravel/Pebble, Sand, silt, mud, Clay. Flow Types is Unbroken Standing Waves, Rippled, No perceptible Flow, Smooth.

Site Number 22 - The point is located near Naesakavo. Mdianre produces intense lateral erosion. The speed of water flow in the bed is small, which promotes the development of algae, and therefore algae are found in the water. There is a fence in the stream right up to the cut-off point, which is an obstacle. Bed elements is found Bar, Island. Bed substrates is found Boulder, Gravel/Pebble, Sand, silt, mud, Clay. Flow Types is Unbroken Standing Waves, Rippled, No perceptible Flow, Smooth.

Site Number 23 - The research point of Tshnistskal river is located in the village of Maran. The river produces erosion in this section. Gabions are arranged to protect the banks. There are concrete and gabion structures embedded in the bed. Hydromorphological changes can be observed in this section. Bed elements is found Bar. Bed substrates is found Gravel/Pebble, Sand, silt, mud, Clay. Flow Types is Rippled, No perceptible Flow, Smooth, Upweling.

Site Number 24 - The point is located on the River Rion near the Dafnar Bridge. The river produces erosive actions. The letter is in its natural state, no hydromorphological change is observed. During floods, the river overflows its bed and floods the surrounding agricultural fields. Bed substrates is found Gravel/Pebble, Sand, silt, mud, Clay. Flow Types is Rippled, No perceptible Flow, Smooth, Upweling.

Site Number 25 - The research point is located in Vazisubani village. There are islands in the bed. Mdianre produces erosion. To protect against erosion, there are gabions, which are damaged and thrown into the bed. The area has changed hydromorphologically. During floods, Mdianre ponds the surrounding area and floodplain. Bed elements is found Bar, Island. Bed substrates is found Boulder, Gravel/Pebble, Sand, silt, mud, Clay. Flow Types is Unbroken Standing Waves, Rippled, No perceptible Flow, Smooth.

Site Number 26 – The research point is located near the village of Uta Dzimit. Hydromorphologically, the area has not changed. There are islands in Acapote. Only up to the bridge crossing are concretes to protect from the bridge. The river produces erosion on both banks. During floods, it moves from the banks and floods the surrounding area. Bed elements is found Bar, Island. Bed substrates is found Boulder, Gravel/Pebble, Sand, silt, mud, Clay. Flow Types is Unbroken Standing Waves, Rippled, No perceptible Flow, Smooth, Upweling.

Site Number 27 – The research point is located in the city of Ozurgeti. The river produces erosive processes on both banks. Remains of an old ruined bridge can be found in the bed. The area has changed hydromorphologically. A gabion has been installed to protect the banks and reduce flooding. Bed substrates is found Boulder, Gravel/Pebble, Sand, silt, mud, Clay. Flow Types is Unbroken Standing Waves, Rippled, No perceptible Flow, Smooth, Upweling.

4.3. Chemical results

Analytical samples were brought to the laboratory on May 8, 2023, the analyses started on the same day. The results of the determined parameters were compared with the Approval of Technical Regulations for Protection of Surface Water Pollution in Georgia (Government of Georgia Resolution N425 December 31, 2013 Tbilisi).

20 chemical parameters were determined in 27 rivers of Rioni basin. They include physico-chemical parameters measured in the field, BOD_5, COD, main ions, nutrients as well as ammonium and nitrite as indicators of organic pollution.

The studied rivers are little to normally mineralized rivers with a range of electrical conductivity of 66 to 504 µS/cm. Noteworthy is an enhanced NO3 concentration at Oghaskura Kutaisi-lower, bridge (11.6 mg/l NO_3) as well as the very high turbidity at some sampling sites (e.g. Kutaisi lower: 11.8 g/l, Jimastskaro bridge: 7.6 mg/l, Oghaskura Kutaisi-lower, bridge: 1.0 g/l), which can be attributed to the flood in these rivers during the sampling campaign. However, due to the limited time available for the field work, repeating the sampling at another date with more favourable hydrological conditions – which would be necessary to get reliable data – was not possible. Total phosphorus concentrations ranged from 0.124 to 0.465 mg/l. These values are very high compared to values from mountainous and alpine rivers elsewhere in Europe. However, for those parameters where maximum permissible concentrations (MPC) are defined, all measured values are within acceptable limits. No MPC was exceeded except for 6 sites, where pH was slightly above the required upper limit of 8.5.

The results are presented in detail as test reports (Annex 4b) and as summary table in Annex 4a. Table 8 provides the range and the arithmetic mean of the measurements for all parameters over all 27 sampling sites.

Table 8: Summary of chemical analyses with minimum, average and maximum values of 27 sampling sites.

Parameter	MPC	min	avg	max
Water temperature WT, °C		10.0	14.5	19.1
Electric conductivity EC, µS/cm		66	236	504
pH	6.5–8.5	7.9	8.4	8.9
Oxygen concentration O_2, mg/l		8.8	10.4	12.3
Oxygen saturation O_2, %		85	103	119
Nitrate (ion) NO_3, mg/l	45.0	0.060	2.125	11.590
Nitrite (ion) NO_2, mg/l	3.3	0.010	0.321	0.790
Ammonium (ion) NH_4, mg/l	0.39	0.002	0.126	0.290

Parameter	MPC	min	avg	max
Ortho-phosphate (ion) PO_4, mg/l	3.5	0.004	0.175	0.442
Sulphate (ion) SO_4, mg/l	500	2.0	12.0	29.9
Chloride Cl, mg/l	350	0.1	1.4	9.8
Biological oxygen demand BOD_5, mg/l	6.0	0.9	1.3	1.8
Chemical oxygen demand COD, mg/l	30.0	1.8	2.5	3.8
Potassium K, mg/l		0.2	0.6	2.1
Sodium Na, mg/l		0.5	3.3	11.4
Calcium Ca, mg/l		10.8	44.5	85.9
Magnesium Mg, mg/l		0.3	13.2	31.6
Total suspended solids TSS, mg/l		2.0	1100	11746
Total phosphorus P_{tot}, mg/l		0.124	0.278	0.465

MPC = maximum permissible concentrations On Approval of Technical Regulations for Protection of Surface Water Pollution in Georgia (Government of Georgia Resolution # 425 December 31, 2013 Tbilisi)

4.4. Biological results

A total of 54 taxa (gamma diversity) was found during the campaign at 27 sampling sites in May 2023 (Table 9). At single sites, the number of taxa varied between 5 and 16. However, no taxa at all are included in the table from 5 sites, where no samples were taken. These sites excluded, the mean taxa richness (alpha diversity) is 9.6, which results in a beta diversity of 5.6. Shannon diversity ranged between 1.05 and 2.54, while evenness varied between 0.62 and 0.93 (Table 10).

It must be stressed that the total number of individuals per sample was far lower than required in the AQEM manual and exceeded the threshold of n = 700 in only 1 single case. It is strongly recommended to follow the manual more strictly during the next sampling campaign. It will results in a higher taxa richness, which is one of the elements of the ecological status assessment system.

The results of individuals per taxon for each sample is given in Annex 7.

Table 9: Taxa list of macroinvertebrates found during the field campaign in May 2023.

Major Group	Class/Order	Family	Taxon	AQEM ID
Mollusca	Bivalvia	Sphaeriidae	*Pisidium* sp.	6425
	Gastropoda	Lymnaeidae	Lymnaeidae Gen. sp.	8428
			Stagnicola turricula	6906
		Melanopsidae	Melanopsidae Gen. Sp.	16819
		Neritidae	Neritidae Gen. sp.	9691
		Planorbidae	Ancylus sp.	8872
			Planorbella sp.	9152
Annelida	Hirudinea	Erpobdellidae	Erpobdellidae Gen. sp.	5162
	Oligochaeta	Lumbricidae	*Eiseniella tetraedra*	5075
			Lumbricidae Gen. sp.	5900
			Lumbricus sp.	5909
		Naididae	Naididae Gen. sp.	6068
		Tubificidae	*Tubifex* sp.	7115

Major Group	Class/Order	Family	Taxon	AQEM ID
			Tubifex tubifex	7116
			Tubificidae Gen. sp.	7117
Crustacea	Amphipoda	Gammaridae	*Gammarus* sp.	5293
Insecta	Odonata	Calopterygidae	Calopterygidae Gen. sp.	10619
		Gomphidae	Gomphidae Gen. sp.	8410
	Ephemeroptera	Baetidae	*Baetis* sp.	4419
		Caenidae	*Caenis* sp.	4528
		Ephemerellidae	*Ephemerella* sp.	5137
		Ephemeridae	*Ephemera* sp.	5128
		Heptageniidae	*Ecdyonurus* sp.	5053
			Epeorus sp.	5119
			Rhithrogena sp.	6747
		Leptophlebiidae	*Paraleptophlebia* sp.	6308
		Oligoneuriidae	*Oligoneuriella* sp.	6183
	Plecoptera	Leuctridae	*Leuctra* sp.	5790
			Leuctridae Gen. sp.	8437
		Nemouridae	*Nemoura* sp.	6108
	Coleoptera	Elmidae	*Elmis* sp.	12072
			Limnius sp.	12093
	Trichoptera	Apataniidae	*Apatania* sp.	4334
		Goeridae	Goeridae Gen. sp.	9981
		Hydropsychidae	*Hydropsyche* sp.	5605
		Hydroptilidae	*Hydroptila* sp.	5616
		Lepidostomatidae	Lepidostomatidae Gen. sp.	5725
		Limnephilidae	Limnephilidae Gen. sp.	5809
		Psychomyiidae	Psychomyia sp.	6662
			Psychomyiidae Gen. sp.	6663
		Rhyacophilidae	Rhyacophila sp.	6780
		Sericostomatidae	Sericostoma sp.	6818
	Diptera	Blephariceridae	Blepharicera sp.	4464
			Liponeura sp.	5891
		Ceratopogonidae	Bezzia sp.	4452
			Ceratopogonidae Gen. sp.	4585
		Chironomidae	Chironomidae Gen. sp.	4642
			Tanypodinae Gen. sp.	6972
		Empididae	Empididae Gen. sp	5097
		Limoniidae	Hexatoma sp.	5481
		Pediciidae	Dicranota sp.	4955
		Simuliidae	Simuliidae Gen. sp.	6842
			Simulium sp.	6853
		Tabanidae	Chrysops sp.	9324

Table 10: Results of the biological analysis (counted individuals, taxa richness, Shannon Diversity H' and Evenness E).

Sampling site	Ind.	Taxa	H'	E
Kvirila - Zestafoni	17	7	1.76	0.90
Kvirila _ Downstream	65	10	1.93	0.84
Gubistskali - Ianeti	117	7	1.44	0.74
Tskhenistskali -Marani	55	7	1.34	0.69
Shaori - Reservoir	35	7	1.37	0.70
Tekhuri - Nokalakevi	76	6	1.53	0.86
Dzirula - Tseva	104	11	1.90	0.79
Tkibula _ Downstream	164	13	1.93	0.75
Lagoba _ Downstream	114	12	1.91	0.77
Tkibula _ Upstream	87	16	2.54	0.92
Khanistskali - Vartsikhe	77	5	1.04	0.64
Tekhura - Senaki	287	10	1.49	0.65
Oghaskura - Kutaisi _ Upstream	328	12	1.92	0.77
Tskaltsitela - Kutaisi - Gelati	166	12	1.97	0.79
Gubistkali - Maglaki	718	9	1.39	0.63
Chkherimela - Dzirula - Railway	114	15	2.31	0.85
Supsa - Kveda Dzimiti	141	12	2.11	0.85
Natanebi - Ozurgeti	175	6	1.43	0.80
Oghaskura - Kutaisi _ Downstream	453	5	1.23	0.77
Khevistskali - Vazisubani	696	10	1.46	0.64
Noghela - Naesakavo	129	7	1.77	0.91
Abasha - Abasha _ Downstream	208	12	2.06	0.83
Kvirila - Close to Vartskihe	0	0		
Rioni - Kutaisi _ Downstream	0	0		
Rioni - Kutaisi Up - Jimastaro	0	0		
Rioni - Chaladidi	0	0		
Rioni - Dapnari	0	0		
All sites		**54**		

5. Discussion of results

In summary, the results indicate strong anthropogenic impacts on the studied river basin. Due to the construction of irrigation systems, the rivers significantly deviate from their natural state. The morphological change of rivers due to hydroelectric power plants is well illustrated. Sewage effluent remains a major pollutant in water bodies. Sand-gravel mining enterprises systematically extract inert material from the riverbed, resulting in the formation of trenches in the riverbed, swamp, and completely changing the riverbed and bed processes. It should be noted that the amount of water in the lower rivers decreases due to water extraction and water consumption. Any type of impact on river channels, such as water withdrawals for irrigation or power plants, changes the natural state of rivers. Therefore, during any such intervention, it is necessary to take into account the knowledge of experts in order to minimize the damage to the morphology.

The results of chemicals the determined parameters were compared with the Approval of Technical Regulations for Protection of Surface Water Pollution in Georgia (Government of Georgia Resolution N425 December 31, 2013 Tbilisi). 20 chemical parameters were determined in 27 rivers of Rioni basin. They include physico-chemical parameters measured in the field, BOD_5, COD, main ions, nutrients as well as ammonium and nitrite as indicators of organic pollution. For those parameters, were MPC are defined, no exceedance was observed except for 6 sites, where pH was slightly above the required upper limit of 8.5. Enhanced concentrations however were observed at single sites for NO_3 and total suspended solids. Total phosphorus values were high compared with mountainous and alpine rivers elsewhere in Europe, indicating either anthropogenic impact or an influence of turbidity. In terms of mineralization, the studied rivers lie within typical range (electrical conductivity 66–504 µS/cm).

Results of the biological analysis are available from 22 of 27 sites, but from 5 sites no values are included in the results table. Total taxa richness was 54 (gamma diversity), mean taxa richness was 9.6 (alpha diversity), giving a beta diversity of 5.6 (as the ratio of these two values). The number of indivuales per sample was much lower than required in the AQEM method manual (no. of individuals per sample in all but 1 case <700, in some samples <50). Therefore, the true taxa richness is expected to be significantly higher. As a consequence, no ecological status was calculated as the requirements of the MHS / AQEM method was not fulfilled.

6. Next steps and Lessons learned

All field work was done with sufficient respect of personal safety. However, one conclusion and immediate lesson learned is the fact that the size of the basins like Rioni requires much time and effort just for travelling and transport. The field team had to cope with a considerable lack of time for the field work. Unvafourable hydrological conditions, e.g. at Rioni Kutaisi (flood), would have required to postpone the sampling at another date with lower water level and discharge. However, this was not possible within the current project for lack of time resources.

Biological analysis was carried out at 22 sites, while no data were gathered from 5 sites. The number of indivuals per samples shall be increased to meet the requirements of the AQEM method manual.

7. Annexes

Annex 1: Field protocols summary (in Excel format)

Annex 2: Field protocols

Annex 2: Photo documentation

Annex 3: Hydro-morphological site description

Annex 4a: Chemical data summary (in Excel format)

Annex 4b: Chemical analyses test reports

Annex 5: Protocol for sample handover

Annex 6: Water quality norms

Annex 7: Biological data summary (in Excel format)

Annex 8: Metadata

Annexes are available as separate documents

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