Journal of the Georgian Geophysical Society, e-ISSN: 2667-9973, p-ISSN: 1512-1127
Physics of Solid Earth, Atmosphere, Ocean and Space Plasma, v. 28(2), 2025, pp. 57-63

Determination the Water Quality Classification of the River Kvirila

[1]Lali U. Shavliashvili, [1]Gulchina P. Kuchava, [1]Ekaterina Sh.Shubladze, [2]Givi V. Gavardashvili, [3]Zurab Rikadze, [1]Mariam Sh. Tabatadze

[1] Institute of Hydrometeorology, Georgian Technical University
[2] Tsotne Mirtskhulava Institute of Water Management, Georgian Technical University
[3] National Environmental Agency of the Ministry of Environment Protection and Agriculture of Georgia
[1]e-mail: shavilashvililali09@gmail.com

ABSTRACT

In Georgia, the Chiatura municipality of the Imereti region is one of the most vulnerable points in terms of environmental pollution. The main problem of the municipality is the intensification of mining activities (manganese production). Manganese mining in Chiatura causes great damage to the Kvirila river. Determining the cleanliness of the river is necessary because the mined ore is washed with the water of the Kvirila river, after which the wastewater flows into the Kvirila river without treatment and pollutes it.
The following parameters were determined in the water samples taken: physicochemical and hydrochemical parameters, namely: pH, electrical conductivity, biogenic substances - NO_2^-, NO_3^-, NH_4^+, PO_4^{3-}, basic ions, mineralization, heavy metals: Cu, Zn, Pb, Cd, Ni, Co and the total form of manganese. River Kvirila water samples was taken background and below the pollution source.
The following conclusions were drawn as a result of the study:
1. According to the pollution index, the water of the Kvirila river downstream of the Andro LLC fell into the "highly polluting" category, and downstream of the Jruchula LLC - into the "dirty" category, on the basis of which they were assigned the 5th and 4th classes of water quality, respectively.
2. The Kvirila river at its background point fell into the "clean" category and was assigned the first class of water quality.

Keywords: *pollution, manganese, Kvirila river, hydrochemical parameters, water quality*

Introduction

Chiatura Municipality is located in the northern part of Upper Imereti, in the rever Kvirila Velley. The main problem of the municipality is the intensification of mining activities (manganese production). Ore mining is associated with many contradictory issues. On the one hand, it is a source of income and new job creation, on the other hand, in terms of environmental pollution, it causes significant damage to the environment and the local population [1-3]. The negative impact of the mining industry is especially noticeable when developing deposits in an open-pit manner.

Currently, the company "Georgian Manganese" carries out works the extraction of manganese concentrate by the mining method, but licenses have also been issued to small private companies. There are about 20 deposits in the municipality, of which 9 are of the mining and 11 are of the open-carries type. https://socialjustice.org.ge.

Manganese mining in Chiatura has caused significant damage to the hydrographic network there, in particular the Rgani Gorge and the Kvirila river. In Chiatura Municipality, the Kvirila river flows into a ravine, so it is not used in the irrigation system, as the location of the villages and the river complicates this process. At the same time, the Kvirila river is used for hydromelioration in the villages of Zestaponi, Terjola, and Baghdati, which causes pollution of agricultural lands.

In Chiatura, ore processing plants are located on the river bank and use the water of the Kvirila river to wash ore, as a result of which the river becomes significantly polluted and turns black. The industrial wastewater generated during the ore washing process contains a large amount of suspended particles, heavy metals, and manganese compounds and flows into the Kvirila river without treatment.

Research area and methods

The work uses the physicochemical and hydrochemical indicators of the waters of the Kvirila river in the areas adjacent to the manganese processing plants of Chiatura Municipality.

To solve the set tasks, samples of the Kvirila river water were taken from the background and downstream of the pollution source 4 times over a period of 2 years.

The following physicochemical and hydrochemical parameters were determined in the water samples taken: pH, electrical conductivity, biogenic substances - NO_2^-, NO_3^-, NH_4^+, PO_4^{3-}, basic ions, mineralization, heavy metals: Cu, Zn, Pb, Cd, Ni, Co and the total form of manganese [4].

The analyses were carried out using modern methods and equipment that meet and comply with European standards, namely:

1. Ion Chromatograph-IC-1000; ISO100304-1:2007
2. Spectrophotometric method - SPECORD 205; ISO 7150-1: 2010;
3. Plasma-emission spectrometer - ICP-OES; Epa method 200.8;
4. Field portable equipment - Hanna Combo pH/EC/TDS/PPM Tester HI98129;
5. pH-meter - Milwaukee-Mi 150.

According to the recommendations of the Water Framework Directives of the European Union countries (2000/60/EC), for the classification of surface waters, a water pollution index (S) was calculated, for the calculation of which at least 6 or 7 hydrochemical indicators are required. In our case, the average multi-year data of 9 hydrochemical and physicochemical indicators were used in the calculations.

The pollution index was calculated according to Equation 1 [5]:

$$S = \sum_{i=1}^{N} \frac{Ci/MAC}{N} \qquad (1),$$

Where,

Ci - is the concentration of the hydrochemical indicator;
MAC - the maximum permissible concentration of the hydrochemical component;
N - is the number of indicators used in the calculations.

Results

The Chiatura municipality was selected for the study, where the Kvirila river is under anthropogenic load. The work uses the multi-year database of the National Environment Agency, which fully meets the requirements proposed by the Framework Directive, as well as the results of research conducted within the framework of the Shota Rustaveli National Science Foundation grant FR-23-6375.

Among the biogenic compounds, inorganic nitrogen compounds are noteworthy, which can be formed in water by the decomposition of nitrogen-containing organic compounds, and can also enter surface waters through atmospheric precipitation, leaching of fertilizers from the soil, and industrial and agricultural-domestic wastewater. Research on the distribution of nitrogen-containing substances in river waters and water quality assessment are important in ensuring a safe environment for human health.

Table 1 discusses 12 ingredients, of which only two (ammonium and manganese ions) exceed the maximum permissible concentration. Fig. 1 shows a graphical representation of manganese values.

As can be seen from the data, at the Kvirila-Chiatura upper point, all data are within the normal range, while at the Kvirila-Chiatura lower and Kvirila-Zestafoni lower points, the content of ammonium ions exceeds the MPC. The manganese content is also high at the Kvirila-Chiatura lower, Kvirila-Zestafoni upper and lower points. As can be seen from Fig. 1, the ammonium content slightly exceeds the MPC, namely, 1.1 and 1.3 times the MPC. The manganese content is 2.7; 2.5 and 2.5 times the corresponding MPC.

Table 1. Average multi-year data of the Kvirila river
Statistical data of the National Environmental Agency (2020-2024)

N	**Ingredient**	**Kvirila-Chiatura Upper**	**Kvirila-Chiatura Lower**	**Kvirila-Zestafoni Upper**	**Kvirila-Zestafoni Lower**	**MPC***
1	pH	7.58	7.67	7.69	7.72	6.5-8.5
2	Ammonium, mgN/l	0.331	0.439	0.360	0.486	0.39
3	Nitrites, mgN/l	0.126	0.111	0.110	0.106	3.3
4	Nitrates, mgN/l	0.467	0.699	0.611	0.571	45
5	Phosphates, mg/l	0.049	0.076	0.057	0.061	3.5
6	Calcium, mg/l	31.00	40.84	37.43	36.44	
7	Magnesium, mg/l	7.34	8.31	8.20	8.01	
8	Mineralization, mg/l	199.20	257.18	240.71	236.72	
9	Manganese, mg/l	0.0892	0.2725	0.2445	0.2484	0.1
10	Copper, mg/l	0.0048	0.0062	0.0066	0.0051	1.0
11	Zinc, mg/l	0.0157	0.0234	0.0216	0.0254	1.0
12	Lead, mg/l	0.0025	0.0030	0.0031	0.0033	0.03

* - **MPC** - maximum permissible concentrations according to Technical Regulations for Surface Water (Decree №425 of the Georgian government as of 31th december of 2013, Tbilisi) [6]

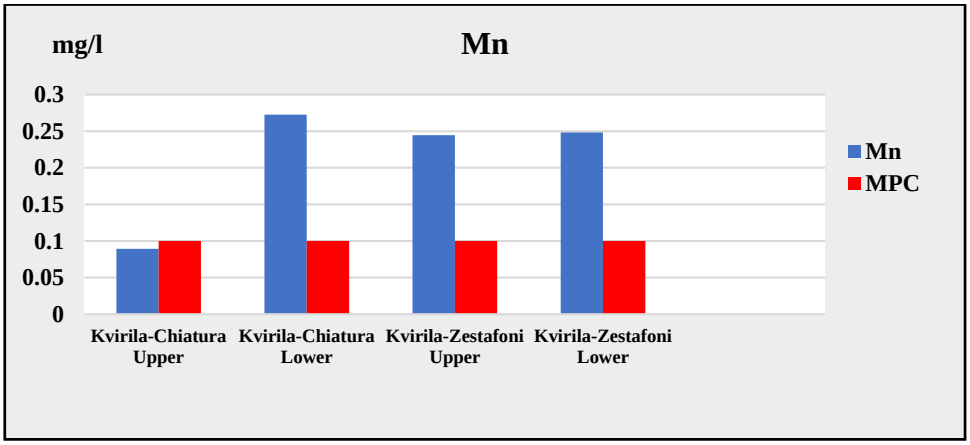

Fig. 1. Average multi-year manganese content in the Kvirila river, 2020-2024.

According to our data, out of the 12 ingredients identified, two ingredients stand out with a content exceeding the MPC - ammonium and the total content of manganese. However, it should be noted that the content of some elements is close to or exceeds the MPC, but their high content is no longer visible in the average content. As can be seen from Fig. 2, the content of ammonium ions below Kvirila-LLC “Andro” is 1.2 times higher than the MPC. And the content of manganese is 92.5 times and 37.9 times higher than the MPC, respectively, which is clearly seen in Fig. 1 and 2. The remaining ingredients are within the norm.

Tables 1 and 2 provide a list of hydrochemical and physicochemical indicators, from which we selected 9 components that more or less characterize the water quality of the Kvirila river and which will be used in the relevant calculations.

Table 2. Average two-year data for the Kvirila river
Results obtained within the framework of the grant (2024-2025) [7]

N	Ingredients	Kvirila-below "Andro" Ltd	Kvirila-below "Jruchula" Ltd	Kvirila-background	MPC*
1	pH	8.0	8.1	7.9	6.5-8.5
2	Ammonium, mgN/l	0.479	0.361	0.301	0.39
3	Nitrites, mgN/l	0.341	0.021	0.045	3.3
4	Nitrates, mgN/l	1.597	0.808	0.945	45
5	Phosphates, mg/l	0.194	0.132	0.096	3.5
6	Calcium, mg/l	84.19	43.89	30.89	
7	Magnesium, mg/l	28.11	12.27	10.40	
8	Mineralization, mg/l	928.07	322.68	234.58	
9	Manganese, mg/l	9.2536	3.7933	0.1083	0.1
10	Copper, mg/l	0.0257	0.0190	0.0038	1.0
11	Zinc, mg/l	0.0254	0.0277	0.0031	1.0
12	Lead, mg/l	0.0053	0.0024	0.0012	0.03

* - MPC - maximum permissible concentrations according to Technical Regulations for Surface Water (Decree №425 of the Georgian government as of 31th december of 2013, Tbilisi) [6]

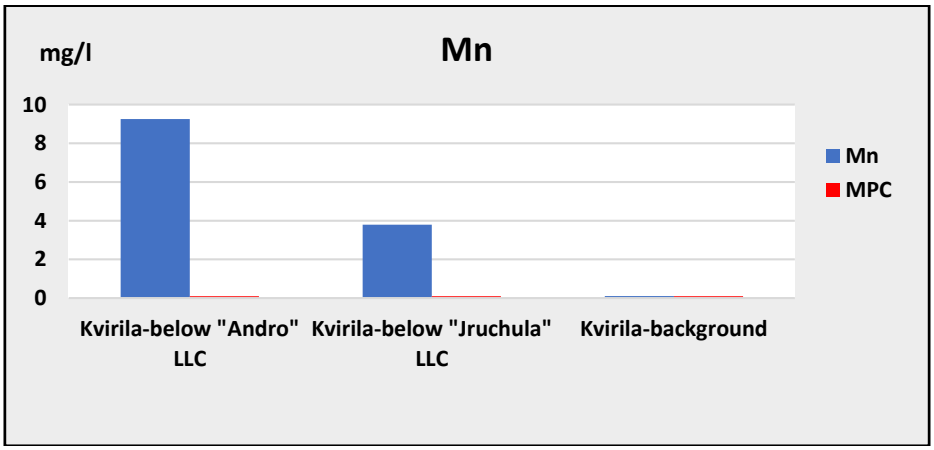

Fig. 2. Average two-year manganese content from the bacground of the Kvirila river and downstream of "Andro" LLC and "Jruchula" LLC, 2024-2025

Based on the results obtained, the classifications of the considered river (i.e. the pollution degree class) were assessed according to the values given in Table 3, which are proposed by the European Directive.

Table 3. Assessment of water quality classification using pollution indices

Surface water	Pollution index	Water quality class
Clean	0.2 - 1.0	1
Slightly polluted	1.0 - 2.0	2
Polluted	2.0 - 4.0	3
Dirty	4.0 - 6.0	4
Heavily polluted	>6.0	5

By inserting the values from Tables 1 and 2 into Equation (1), the river pollution index at the mentioned points was obtained (Table 4 and 5), on the basis of which they were assigned the corresponding water quality class.

Table 4. Water quality classifications assigned to the Kvirila River according to pollution indices

River		Pollution Index	Water Quality Class
1	Kvirila-Chiatura Upper	0.3	1
2	Kvirila-Chiatura Lower	0.6	1
3	Kvirila-Zestafoni Upper	0.5	1
4	Kvirila-Zestafoni Lower	0.6	1

Table 5. Water quality classifications assigned to the Kvirila river according to pollution indices at the bakground and downstream of "Andro" LLC and "Jruchula" LLC

River		Pollution Index	Water Quality Class
1	Kvirila-below "Andro" LLC	10.6	5
2	Kvirila-below "Jruchula" LLC	4.5	4
3	Kvirila-background	0.3	1

According to the data, the Kvirila river was classified as “clean” according to the pollution index and was assigned the first class of water quality at its background point, while below “Andro” LLC and “Jruchula” LLC, pollution indices were assigned 10.6 and 4.5, respectively, and at the background point - 0.3. At the mentioned points, the Kvirila river was classified as “highly polluting” below “Andro” LLC, and as “dirty” below “Jruchula” LLC. On the basis of which they were assigned the corresponding water quality classes of 5th and 4th.

Conclusion

1. The paper presents the data obtained within the framework of the multi-year (2020-2024) and grant (2024, 2025) study of the Kvirila river by the National Environmental Agency. Physico-chemical and hydrochemical indicators were determined in the analyzed water samples;
2. The river pollution index and river water quality were determined (taking into account the Water Framework Directive-2000/60/EC);
3. It was determined that the Kvirila river was assigned the 1st water quality class in terms of the pollution index and was classified as “clean” (according to the data of the National Environmental Agency), which is due to the fact that the observation points were taken below from the pollution sources and the river self-cleans and, accordingly, low concentrations were recorded;
4. The Kvirila river downstream of Andro LLC was classified as “highly polluting”, and downstream of Jruchula LLC as “dirty”. On this basis, they were assigned the corresponding water quality classes 5 and 4, which is due to the fact that we took samples ~ 50 m from the pollution points, which is why the river cannot self-clean and high concentrations were recorded. Kvirila, at its bacground, fell into the “clean” category according to the pollution index and was awarded the first class of water quality.

The research is done with the support of "Shota Rustaveli national scientist faundation" [Grant number - FR-23-6375]

This paper was presented at the International Scientific Conference "Study and Sustainable Use of Natural Ecosystems in the Conditions of Modern Climate Change" dedicated to the 85th Anniversary of the

Establishment of the Georgian National Academy of Sciences, which was held on December 11, 2025 at the Institute of Hydrometeorology of the Georgian State Technical University. The abstract of the article is published in the T. N137 ISSN 1512 – 0902 https://doi.org/10.36073/1512-0902-2025-137, p. 15, in Georgian and English.

15th IconSWM-CE & IPLA Global Forum 2025: Proceedings of the Abstracts of 15th International Conference on Sustainable Waste Management & Circular Economy and IPLA Global Forum 2025; Graphic Era University, Dehradun, Uttarakhand and ISWMAW, India; October 29 – November 1, 2025 Sustainable Waste Management & Circular Economy 2025: ISWMAW Publication Secretariat 78.

References

[1] "The Impact of Extractive Industries on Developing Countries", Friends of the Earth - Europe, 2007. http://www.foeeurope.org/corporates/Extractives/social.pdf.

[2] Law of Georgia on the Safety of Hazardous Industrial Facilities, 10.12.1997.

[3] Tsereteli E., Gobejishvili R., Bolashvili N., Gaprindashvili G., Nanobashvili T. The State of Natural Exodynamic Disasters and the Risk of Anthropogenic Load Hazards in Georgia, Actions to Optimize Their Management. V. Bagrationi Institute of Geography Collection of Works, #4 (83). Tbilisi, 2012, pp. 50-63.

[4] Fomin G.S., Fomin A.G. Water. Quality control and environmental safety according to international standards. Handbook. Moscow, 2001.

[5] Tabatadze M., Dvalishvili N., Elizbarashvili M. The impact of Tbilisi Used Water on Ecochemical state of Small Rivers of the City. International Journal on Humanistic Ideology, 2016, DOI: 10.17378/AWC2016_29

[6] Maximum permissible concentrations according to Technical Regulations for Surface Water (Decree №425 of the Georgian government as of 31th december of 2013, Tbilisi).

[7] Shavliashvili L., Kuchava G., Shubladze E., Gavardashvili G., Rikadze Z. Physico chemical and hydrochemical studies of the waters of the Kvirila rever and spring waters in chiatura Municipaliti. 1stInternational Scientific Conference ,,Modern Problems in Geophysics", Proceedings, ISBN 978-9941-36-434-1, ISSN 3088-4349, Tbilisi, Georgia, November 6-8, 2025, pp. 91-95.

მდინარე ყვირილას წყლის ხარისხის კლასიფიკაციის განსაზღვრა

ლ. შავლიაშვილი, გ. კუჭავა, ე. შუბლაძე, გ. გავარდაშვილი,
ზ. რიკაძე, მ. ტაბატაძე

რეზიუმე

საქართველოში, იმერეთის რეგიონის ჭიათურის მუნიციპალიტეტი ერთერთი მოწყვლადი წერტილია გარემოს დაბინძურების თვალსაზრისით. მუნიციპალიტეტის მთავარ პრობლემას წარმოადგენს სამთო-მოპოვებითი საქმიანობის (მარგანეცის წარმოება) ინტენსიფიკაცია. ჭიათურაში მანგანუმის მოპოვების შედეგად დიდი ზიანი ადგება მდინარე ყვირილას. მდინარის სისუფთავის დადგენა აუცილებელია, რადგან მდ. ყვირილას წყლით აწარმოებენ მოპოვებული მადნის გარეცხვას, რის შემდეგაც ჩამდინარე წყლები გაწმენდის გარეშე ჩაედინება მდ. ყვირილაში და ხდება მისი დაბინძურება.

აღებულ წყლის სინჯებში განისაზღვრა: ფიზიკურ-ქიმიური და ჰიდროქიმიური პარამეტრები, კერძოდ: pH, ელექტროგამტარობა, ბიოგენური ნივთიერებები - NO_2^-, NO_3^-, NH_4^+, PO_4^{3-}, ძირითადი იონები, მინერალიზაცია, მძიმე ლითონები: Cu, Zn, Pb, Cd, Ni, Co და მანგანუმის საერთო ფორმა. მდ. ყვირილას წყლის სინჯები აღებული იყო ფონური და დაბინძურების წყაროს ქვემოთ.

კვლევის შედეგად მიღებულია დასკვნები:

1. მდ.ყვირილას წყალი შპს „ანდრო“-ს ქვემოთ დაბინძურების ინდექსის მიხედვით მოხვდა „ძლიერ დაბინძრებულ“, ხოლო შპს „ჯრუჭულას“ ქვემოთ - „ბინძურ“ კატეგორიაში, რის საფუძველზეც მათ მიენიჭათ შესაბამისად წყლის ხრისხის მე-5 და მე-4 კლასი.
2. მდ. ყვირილა ფონურ წერტილში მოხვდა „სუფთა“ კატეგორიაში და მიენიჭა წყლის ხარისხის პირველი კლასი.

საკვანძო სიტყვები: დაბინძურება, მარგანუმი, მდ. ყვირილა, ჰიდროქიმიური პარამეტრები, წყლის ხარისხი

Классификации качества воды реки Квирила

Л. Шавлиашвили, Г. Кучава, Е. Шубладзе, Г. Гавардашвили, З. Рикадзе, М. Табатадзе

Резюме

В Грузии муниципалитет Чиатура Имеретской области является одним из наиболее уязвимых мест с точки зрения загрязнения окружающей среды. Главная проблема муниципалитета — интенсификация горнодобывающей деятельности (производство марганца). Добыча марганца в Чиатуре наносит большой ущерб реке Квирила. Определение чистоты реки необходимо, поскольку добытая руда промывается водой реки Квирила, после чего сточные воды без очистки попадают в реку и загрязняют ее.

В отобранных пробах воды были определены следующие физико-химические и гидрохимические параметры, а именно: pH, электропроводность, биогенные вещества - NO_2^-, NO_3^-, NH_4^+, PO_4^{3-}, основные ионы, минерализация, тяжелые металлы: Cu, Zn, Pb, Cd, Ni, Co и общая форма марганца. Пробы воды реки Квирила были отобраны ниже фонового уровня и источника загрязнения.

Исследование показало:

1. По индексу загрязнения вода реки Квирила ниже ООО «Андро» попала в категорию «сильно загрязнённая», а ниже ООО «Джрухула» - в категорию «загрязненная», на основании чего им были присвоены 5-й и 4-й классы качества воды соответственно.
2. Река Квирила в фоновой точке была классифицирована как «чистая» и получила первый класс качества воды.

Ключевые слова: загрязнение, марганец, река Квирила, гидрохимические параметры, качество воды.