European Water 58: 365-370, 2017.

Study of contamination of the transboundary river Kura in Georgia

E. Bakradze[1*], G. Kuchava[1] and L. Shavliashvili[2]
[1] *LEPL National Environmental Agency, Georgia*
[2] *Georgian Technical University, Georgia*
[*] *e-mail: h.bakradze@gmail.com*

Abstract: In the article is presented pollution study on the River Kura and its surrounding area at background and anthropogenic points - dynamics of the last year. The study covers the Kura river basin with its tributaries from the Turkish border up to the Azerbaijan border in the article is presented the assessment of the pollution distribution from the upstream to downstream taking into account transboundary issues. River Kura environmental assessment on the territory of Georgia was based on physical-chemical and chemical parameters, which are characteristic for the basin. physical-chemical (water temperature, pH, BOD5, biogenic elements, main anions and cations, total petroleum hydrocarbons (TPH), heavy metals and other parameters were measured depending the EU Water Framework Directive. The sampling of the water, conservation, labelling, storage and transportation were produced in the accordance with the International Standard Organization (ISO) methodology. The study was conducted in the accredited laboratory by the ISO 17025 standard. Analyzes were carried out by the atmospheric air, water and soil analyses laboratory of the National Environmental Agency of the Ministry of environment and natural resources protection of Georgia in the following technical and instrumental support: plasma –emission spectrometer (ICP-OES) on the ISO 11885: 2007; Ion chromatography ICP_OES; spectrometers; GC_MS; IC; conductivity meter; pH meter; turbidity meter; DO meter.

Key words: anthropogenic impact, pollution transboundary Georgia, Turkey, Azerbaijan, Kura, water quality, pollutants, EU directives

1. INTRODUCTION

The basin of the river Kura cover the territory of the five countries of Armenia, Azerbaijan, Georgia, Iran, and Turkey. The total area of the Kura basin is approximately 188,400 km^2, occupying the greater part of the South Caucasus (Egorov 1951) (Figure 1).

The ecosystems of the Kura basin, similar to the entire Caucasus Eco region, are highly diverse and include a broad range of landscapes, from semi-deserts and arid shrub lands to mesophyll relic broadleaf forests and alpine grasslands (https://en.wikipedia.org/wiki/Kura_River).

Human activities in the second half of the twentieth century have had its effects on the quality and quantity of the water in the rivers (Shiklomanov 1979). Ranges of factors, including industrial pollution, domestic waste, agricultural pesticides, large-scale irrigation, flood control, hydropower schemes and watershed degradation have affected the basin.

2. MAIN PART

The Kura river basin is an internationally significant river system, which is seriously degraded and continues to be degraded. The basin covers almost all of Armenia and Azerbaijan, and a sizeable part of the populated and urbanized parts of Georgia. Kura river system is a source of water for all sectors and users: industry, agriculture, energy and residential uses (Trapaidze 2012).

Deterioration of water quality in the Kura river basin has significant transboundary consequences in the downstream countries (http://www.fao.org/nr/water/aquastat/basins/kura-araks/index.stm). This can be confirmed by the presence of chemical compounds of anthropogenic origin in the transboundary sections of the basin as well as in bottom sediments of the Kura Delta in the Caspian Sea. Water pollution in the Kura basin comes from a number of land based sources including industrial and mining sites, agricultural lands, households in rural areas and municipalities. Wastewater treatment facilities are absent in many municipalities and enterprises, and are available only in some locations in the Aras basin in Iran. Most of the wastewater treatment facilities were built 20- 30 years ago and are currently non-operational (National Environmental Agency).

The largest source of pollution for the Kura River is municipal wastewater, which specifically affects the river Kura downstream of large cities. Hence, water pollution in the Georgian part of the Kura River and its tributaries is mainly linked to human activities stemming from point and non-point pollution sources. The key drivers for these sources and the related pressures on water resources are the following.

Point sources:

1. Municipal sewage from cities and settlements.
2. Industrial wastewater.
3. Wastewater from hospitals, recreation and etc.

Non-point sources:

1. Surface run-off from agricultural fields.
2. Storm runoff from cities and landfills.

Key pressures from point sources:

Municipal sewage from cities and settlements pollute water with organic matters, nitrogen and phosphorus compounds.

Industrial wastewater impacts the rivers in the basin causing the pollution with heavy metals, in particular cases, rivers: Mashavera and Kazretula flows near the vicinity of the "RMG Copper", (formerly JSC Madneuli). It is a mining company established in 1975. RMG Copper is currently involved in ore, copper, and gold mining and smelting.

2.1 Transboundary water cooperation

Transboundary water basins of the Caucasus include: The basin of the Kura River, Chorokhi River, Psou River, the Terek River, the Alazani River, the Debed (Debet) River, and lakes of Kartsakhi, Djandara, and others.

The extent of two longest Rivers in the Caucasus – the Kura and Araks (Araz) constitutes more than 1000 kilometers. Average volume of the river flow of Caucasus rivers fluctuates sharply, reaching its maximum in the regions of the Great Caucasus and Adjara (Adjara-Trialeti ridge), where these levels reach 1000 mm, in the lowland of Kura-Araks (Araz) they constitute 50 mm.

When it comes to transboundary monitoring it can be said that no joint monitoring activities on the river Kura between Georgia and Azerbaijan are undertaken as part of the regular monitoring programme. However, transboundary monitoring activities have been undertaken as part of the EU funded EPI project: Transboundary River Management for the Kura River basin Phase II and III – Armenia, Georgia, Azerbaijan to help Georgia, Armenia and Azerbaijan to understand and practice a common approach to surface water quality monitoring and assessment based on the EU WFD methodology. In 2012 three rounds of field surveys in pilot basins using WFD methodology were made: Khrami and Alazani basins (Georgia); Ganikh basin (Azerbaijan) (Matthews 2011-2013).

River Kura environmental assessment on the territory of Georgia was based on physical-chemical and chemical parameters, which are characteristic for the basin.

The Major transboundary problems are: the reduction of water flow and changes, deterioration of water quality, ecosystem degradation and flooding.

Therefore, the issue is very relevant and needed transboundary ecological situation assessment depending the European Union Water Framework Directive (EU WFD).

Physical-chemical (water temperature, pH, BOD_5, biogenic elements, main anions and kations, total petroleum hydrocarbons (TPH) (Nauka 1986), heavy metals and other parameters were measured depending on the international standard organization (ISO) standards in compliance with the EU WFD methodologies implementation of the environmental quality standards, introduction of intercalibration were in place. In addition, it is important to mention that human activity impacts on the river objects were assessed (Turkey build HPP on the river Kura, municipal and food industry waste water discharges into the river, irrigation, etc.) which is necessary for characterization and identification of the water bodies at risk to define environmental goals.

2.2 Research methods

The following parameters were measured in the laboratory: cations, anions, nutrients, BOD5, heavy metals.

- Sampling and transportation were implemented according to ISO 5667-4:1987; ISO 5667-3;
- Field analysis of physical-chemical (dissolved oxygen, pH, temperature, salinity) parameters were determined on the sampling site with the mobile devices;
- Laboratory analysis of samples in particular, cations, anions, nutrients were made in accordance with (ISO 10304-1: 2007, ISO 7150-1, ISO 9964, ISO 6059), BOD5 (ISO 5815-1: 2010);
- Heavy metals in water samples were determined using inductively coupled plasma optical emission spectrometry (ICP-OES) on the basis of ISO 11885: 2007 standard.

2.3 Results

According to the obtained data from 32 points on 36 measured ingredients on the river Kura and its tributaries, water belongs to the hydrocarbonate class, calcium group. The highest concentration of ions in this basin has been observed in summer and autumn, the lowest in winter and spring. The latter is caused by the factor of water dilution during floods. The above specified dynamics have been adhered to at all sites of water quality control. The river Kura is a polluted river according to some ingredients in lower course due to anthropogenic activities (Khashuri, Gori, Tbilisi and Rustavi cities); also polluted are the tributaries of the river Kura Suramula and Lekhura, Debed, Mashavera (Figure 1).

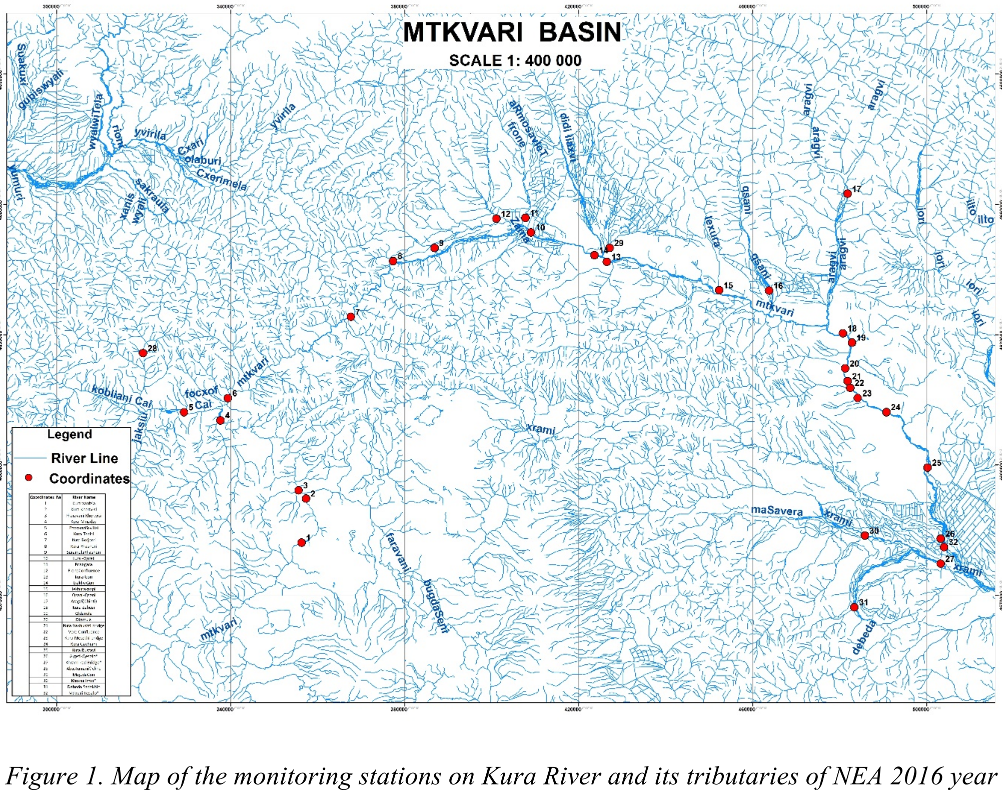

Figure 1. Map of the monitoring stations on Kura River and its tributaries of NEA 2016 year

The observed pH values were normal and typical for mountainous rivers, especially in the upper reaches of the basin in Georgia.

Dissolved Oxygen (DO) refers to the amount of oxygen dissolved in river water, and is the most important indicator of the health of a water body and its capacity to support a balanced aquatic ecosystem of plants and animals. Depending the obtained data dissolved oxygen is always satisfied. Conditioned by the rather natural hydro-morphological conditions and hydrological regime of the river. The higher the flow rate, the higher the DO concentration.

Ammonium (NH_4^+) is the ionized form of ammonia (NH_3), which occurs when the water is acidic. The degree to which NH_3 forms NH_4^+ depends on the pH of the river water. If the pH is low, more NH_3 molecules are converted into NH_4^+ ions, while when the pH is high the hydroxide ion abstracts a proton from the NH_4^+ ion, generating NH_3. When NH_4^+ nitrogen levels in surface waters are too high, they can be toxic to some aquatic organisms. On the other hand, if the levels are only moderately high, plant and algal growth will usually increase, due to the abundance of nitrogen available as a nutrient. Accordingly, this will impact on other water quality attributes, such as increasing the BOD_5 and lowering DO levels. DO levels can also be lowered when NH_4^+ nitrogen is high due to the increased occurrence of nitrification (see Figure 2). Average annual concentrations of ammonium.

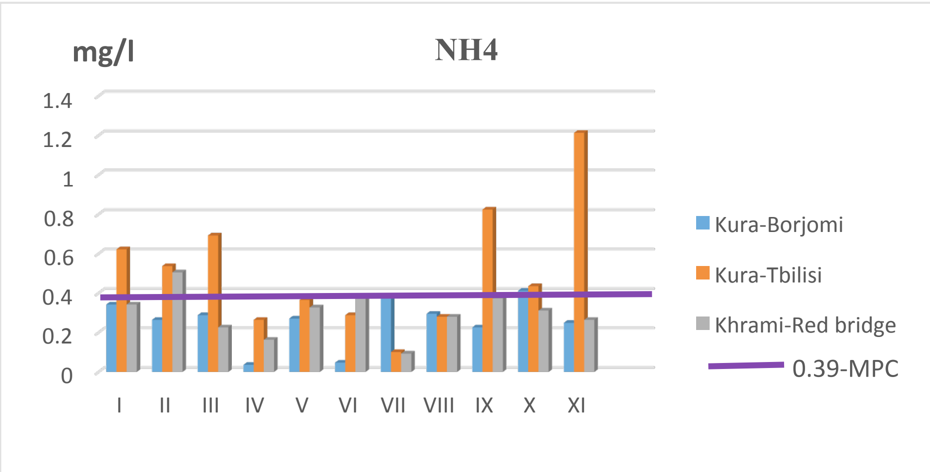

Figure 2. Average annual concentrations of ammonium.

Figure 2 is showing that ammonium concentrations in different monitoring stations in Georgia has increasing trend in downstream direction from Khertvisi near the Turkey-Georgia border towards Rustavi upstream of Georgia-Azerbaijan border. This trend is typical for river water impacted by municipal waste water and agricultural drainage water, causing an increasing organic pollution load from upstream to the downstream section of the river. Meanwhile, even at the Tbilisi monitoring location the observed NH_4^+ concentration is still below the MPC (maximum permissible concentration) in various periods of the year (0.39 mg/l).

Figure 3 shows the dynamic of changes of BOD_5 concentration for the year 2016.

According to the overall data, the concentrations of BOD_5 and NH_4^+ indicate a limited impact of human activities on water quality in the Kura river basin, as most measured concentrations did not exceed the established MPC limits. Exemptions were observed for certain months during the low flow seasons. Although the impact on river water quality appears to be and there is an urgent need for the riparian countries to develop a long-term integrated regional environmental compliance action plan aiming at reducing the pollution loads from different sources, with special focus on municipal waste water from main cities and villages located in the river basin. Meanwhile there is a lack of information on the biological river water quality.

The heavy metals with a high relative atomic mass, including arsenic, copper, cadmium, chromium, lead, manganese, mercury, nickel, and selenium, persisting in nature and potentially causing damage or death in animals, humans, and plants, even at concentrations as low as 1-2 micrograms. Heavy metals used in industrial processes can be carried by air and water when discharged in the environment. Since heavy metals have a propensity to accumulate in selective body organs (such as brain and liver) the average safety levels in food or water is often misleadingly. Figure 4 shows the dynamic of changes of heavy metals concentration for the year 2016.

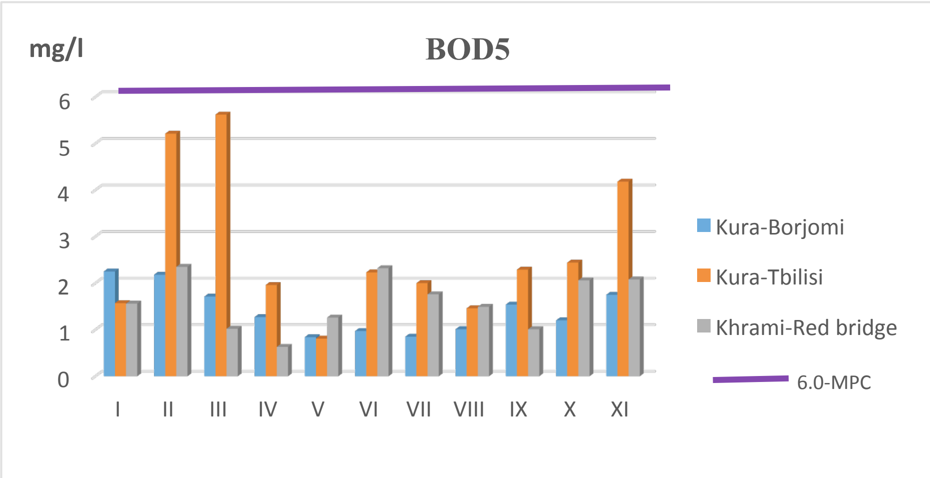

Figure 3. BOD_5 concentration for 2016 years in Kura River

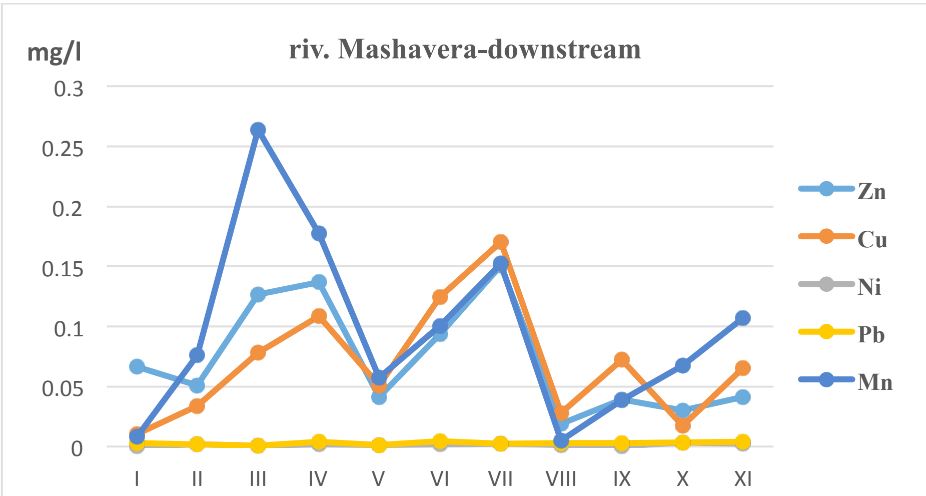

Figure 4. Heavy metal concentration for 2016 years in the river Mashavera a right tributary of the Kura River

Industrial wastewater impacts the rivers in the basin causing the pollution with heavy metals, in particular cases, rivers: Mashavera and Kazretula flows near the vicinity of the "RMG Copper", (formerly JSC Madneuli) it is a mining company established in 1975, RMG Copper is currently involved in ore, copper, and gold mining and smelting. In the countries of the Kura river basin increased attention is paid to the problem of heavy metal pollution of the aquatic environment. Mining activities, metallurgical, chemical and leather industries, as well as natural geochemical and hydro-chemical processes all pose a threat to surface water contamination with heavy metals. Depending the Figure 4. Mn concentrations exceeds the MPC (0.1mg/l) in various periods of the year.

3. CONCLUSIONS

The research can be considered as scientific-technological and innovative that means that up-todate newest technologies and innovative methodologies were used in the scientific study. Tasks were accomplished at proper level. Modern procedures of QA/QC, standards elaborated by ISO and US Environmental Protection Agency (EPA) were used for result verification.

- Were implemented Kura River water environmental assessment depending the improved monitoring program in accordance with the EU Water Framework Directive;
- Were identified sensitive areas on the Kura basin in direction of pollution;
- Were identified point and diffuse sources of pollution.

Water quality standards harmonization between the states of Georgia, Azerbaijan and Turkey is needed for sustainable use of natural resources and ecosystems for this purposes measures should be undertaken such as public awareness rising about the sustainable use of water in that way transoundary countries can benefit each other in scientific, technological and economical way.

REFERENCES

Egorov VV, 1951. Problems of Physical Geography. Formation History, Natural Features, and the Perspectives of Economic Development of Kura Delta.

Matthews MM, 2011-2013 Shared Waters Shared Challenges: A summary of the Transboundary Diagnostic Analysis for the Kura Ara(k)s River Basin. http://kura-aras.iwlearn.org/Welcome_files/TDA_FINAL_GEO_EN_SCREEN.pdf;

Nauka, 1986. Kaspiiskoe More: Gidrologiya i Gidrokhimiya (The Caspian Sea: Hydrology and Hydrochemistry), Moscow

Shiklomanov IA, 1979. Antropogennye izmeneniya vodnosti rek (Anthropogenic Changes in the Flow of Rivers) - Leningrad: Gidrometeoizdat.

Trapaidze Vaja 2012. Water resources.