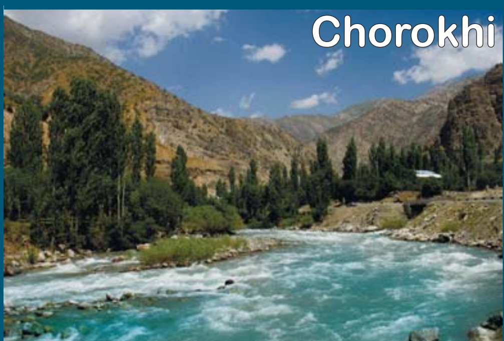
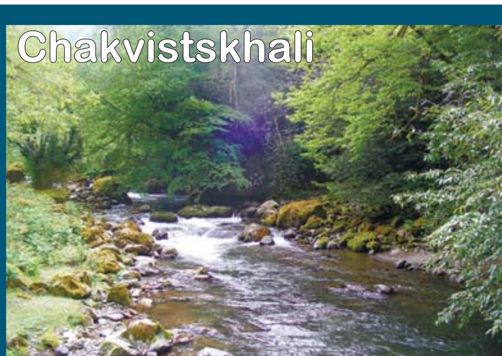
The Chemical-Ecological Conditions of Agricultural, Every-day and Industrial Waste Waters of Adjara Black Sea Coastline Rivers: new public management

(COLLECTIVE MONOGRAPH)





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Nino Kiknadze, Nunu Nakashidze, Darejan Jashi, Gultamze Tavdgiridze, Nargiz Megrelidze**: The Chemical-Ecological Conditions of Agricultural, Every-day and Industrial Waste Waters of Adjara Black Sea Coastline Rivers: new public management**: collective monograph / [edited by **Dubovická Lenka,** Ing. PhD (Economic Sciences), Academic Society of Michal Baludansky, Košice, Slovakia, **Olha Rudenko**, Doctor of Science in Public Administration, Professor, Chernihiv National University of Technology, Ukraine]. – Published by Academic Society of Michal Baludansky, Košice, Slovakia, 2018 – 92 p. – (educational-scientific series: "Public management and administration"; issue 9). Printed by UK Technical University of Košice, Slovakia; Printing 300.

In the Monograph chemical-ecological research results of rivers of the Black Sea Coastline of Adjara and some agricultural, every-day and industrial waste waters are analysed. Chemical consistency of natural waters is showed and the influencing factors at its formation as well as chemical analysis methods of natural waters. The quality of natural water is evaluated for drinking, technical, every-day, irrigation and fish-farming purposes. The main polluting substances of rivers' waters and the methods of their treatment are described, Legislative Acts of Georgian Government about Technical Regulation of Water protection Lines are described.

In the second part of monograph certain results of experimental research of organoleptic and physical-chemical parameters of agricultural and industrial waters flowing in The Black Sea, as well as big and small rivers' waters of Adjara Coastline are given in details. Based on received data, expertise examination protocols of above-stated research subjects are drawn and it is verified that anthropogenic load of Adjara Black Sea Coastline during years influences at ecological conditions of it.

The researches are made at inside waters of Adjara Region: Tchorokhi, Adjaristskhali, Khorolistskhali, Choloki, Kintrishi, Chakvistskhali, bartskhana, Periistskhali, Kapreshumistskhali, Kubastskhali, Mejinistskhali, also, at waters of some agricultural-industrial enterprises which are located in Batumi, Kobuleti, Adlia, Kvariati, Khelvachauri and Urekhi territories and the waste waters of which flow in the Black Sea.

The present Monograph is intended for the use of students of natural sciences (chemistry, biology, bio-chemistry, and ecology), agricultural (agro-chemistry, soil studies) specialties as well as for the use of professor-lecturers working in the state fields and for scientific-workers of research institutions.

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Contents

Introduction

Problem Actuality

The water is a natural, inextinguishable, unexhausted resource. It is used in all the sphere of human activity and it plays an important role in natural processes. Without the water it is impossible to develop various fields of industry and agriculture. One of the main reasons for lack of fresh water pollution of water reservoirs with agricultural, every-day and industrial waste-waters which consist of various organic and inorganic substances which affect adversely on human health, physiological conditions of plants and animals, zooplankton and ikhtiofauna. Without water it is impossible to provide functioning and development of heavy industry, chemical, energetic, nutritious and other fields, as well as agriculture which needs great amount of water for irrigation of territories (54% from general water consumption). The main water users are plant-growing and cattle-breeding. The modern agriculture with its fertilizers, with cattle-breeding, with active means of fighting with malignant plant diseases intensively pollutes the water. Important part of them after usage are met in ground and surface waters. The fresh water is used with a great amount by communal economy for drinking and everyday life which is accompanied by pollution with important quality.

The rivers' waters are the mostly available fresh water which has been polluted by the huge exploitation of it by a human. The waters of polluted waters mostly flow in the sea which causes worsening the ecological conditions of the sea and which to its part has certain negative economic aspects as it loses its creative meaning. The water is characterized by the important quality which is self-refreshing and self-restoration qualities, but in order to make these processes available the consistency of polluter in it should not exceed maximum permissible concentration (MPC). At present, anthropogenic factors are considered to be the basic polluter of surface waters. The rivers are intensively polluted by industrial facilities, agricultural farmings, and cattle-breeding farmings, waste waters of populated areas and flash flood waters. The exploitation conditions of small rivers are especially alarming, which is the basic part of hydro-geographical chain and which equals to 75% of annual waste waters.

Therefore, identification of quality of water resources is one of the basic objectives of public economy development which serves increasing every-day, cultural and security levels of population. Nowadays, the list of substances the maximum permissible concentration norms of which are identified and approved for any kinds of waters exceeds 500 numbers. Foreseeing strictly Maximum Permissible Concentration (MPC) and carrying monitoring of it, is necessary for water safety and therefore, for solving global problem of environmental protection. Coming out from the above-stated the requirements against surface waters, underground waters and drinking water as well has not only national, but global interest; hence, carrying periodic seasonal analysis in the waters of territories of any country is in the interest of any state, for the purpose of identifying the quality of water.

The character of inside waters of Adjara is stipulated by quiet complex geological structure, relief and climate peculiarities. Geological structure and relief make influence on the speed of waste waters and chemical consistency of waters. From Adjara inside waters the main is rivers which belong to mountainous rivers type. Because of small territory and hard separation of its relief the length of majority of rivers is small (up to 75 km) and therefore their basin does not cover a big territory. The exception is river Tchorokhi (length 438 km). No river of Adjara originates from the territories of constant snow and glacier. They are nourished by rain, snow-melt and underground waters. Almost all the rivers of Adjara belong to the Black Sea Basin.

Adjara fresh water resources include rivers, lakes, marshes and underground waters. According to 2014 water taking analysis, the resource of surface waters existing in the region mostly are used in hydro-energetics (94%), for drinking-agriculture purposes (4%), for industrial purposes (1,6%) and the rest of amount for irrigation. In the region there are mineral treatment acidic and sulphurous waters. The water resources are less used for firsh-farmings and recreational purposes.

Adjara is one of the most distinguished regions in Georgia with the frequency and intensity of natural disasters. Long-term and abundant precipitation, including heavy snowfall causes high repetition of fluids-floods, landslides-raging mountain torrents, snow avalanches and natural cataclysms connected to these natural disasters. It is added by soil erosion processes in the Black Sea coastline and alongside with the rivers as Adjara region is distinguished by especially high amount of precipitation. It is quiet high the repetition possibility of these processes in the territories of Shuakhevi and Khulo, where basins of small rivers included in Adjara upper line mostly flow. Various kinds of dangerous geological processes are: landslide, raging mountain torrents, erosion, washing rivers and sea coastlines and snow avalanches which inflicthuge material damage to population, infrastructural institutions and sometimes they causehuman death. In winter with heavy snowfall, in 80 % of populates units of Adjara, there is a risk of landslides. For the purpose of prevention and decrease of negative influence of natural disasters, it is important to regulate surface waste waters of slopes and systematization of them, as well as carrying drainage activities, cleaning-strengthening river-channels and installation of shore-strengthening gabions, strengthening sea coasts, moving the population houses to safe places and carrying other activities as well. During development-reactivationof natural geological processes it is important to create vulnerable lands monitoring system for the purpose of protecting the population from expected damages, carrying appropriate researches and elaboration of forecasts having high probability. Besides, it is important to provide elaboration of rehabilitation and adaptation plans and emergency action plans at municipality levels.

During years, anthropogenic influence at Adjara coastline has made significant impacts at its ecological conditions. According to the 2013 Adjara Climate Changes Strategy, construction of multi-floor buildings in the territory of Batumi Cape is connected to great risks, the load of which cannot hold coastline which is weakened by the landslides near at Cape coast. The permanent upload of sea level up to 2-3 mm/per year and increasing number of strong storms has been forecasted as estimated influence of global warming. Herewith, taking into account estimated activation of existing erosion processes, it is necessary to continue shore-strengthening works.

The main goals for identifying surface waters quality are: their usage for drinking, irrigation purposes and every-day life, determination of water suitability for fish-farmings, identification of river pollution sources with agricultural and other industrial waters. The reasons for worsening rivers' waters qualities are: every-day and industrial residuals, sewage waters, treatment plants, landfills, usage of fertilizers and pesticides in agriculture, sliding the wood-forest, etc.

The actuality and innovative character of issues discussed in the given work is stipulated by the fact that water-protection lines of Adjara Black Sea Line Rivers are densely populated in the most territories and as it is known it is forbidden: to flow waste waters in rivers without special license which is issued by state environmental authorities according to the rule set under the laws and in agreement with State Hygienic Supervision Service; as well as it is forbidden to construct industrial, transportation, construction, communal and other kinds of facilities/objects; spraying with pesticide and deforestation of plants and forest; storage – burying fertilizers, every-day, agricultural and industrial residuals/wastes; using chemical and bio-preparations above permissible norms.

Research Goal

Taking into account the role of rivers' waters in every-day life of a human as well as in development of various fields of public agriculture , the main goal of our research was to study ecological conditions of Adjara Coastline rivers flowing in The Black Sea, for which we have carried chemical-expertise examination of waters of some small and big rivers. Studying ecological conditions of rivers gave us possibility to identify compliance of set parameters to the permissible norms set by the State standards for further discussion of purity quality of the mentioned rivers' waters. In addition, we have studied hygienic conditions of waste waters from some agricultural, every-day life and industrial facilities located in Adjara Black Sea Coastline.

Research Objectives

According to research goals, research objectives were:

- Based on literary sources, review of various factors influencing at chemical consistency of natural waters and formation processes of them;
- Description of protection measures of water facilities from pollution;
- Review of legislative base about technical regulation for protection of surface waters from pollution, categories of water consumption, principles for identification of maximum permissible concentration of polluting substances in surface waters, quality classification of surface waters and regulating flow of polluting substance in them, controlling and monitoring surface waters;
- Description of general requirements about regulating water consistency and substances in water reservoirs according to their categories;
- Carrying chemical-expertise research in the waters of Adjara region Black Sea coastline small and big rivers', for the purpose of identifying their pollution quality, which took into account determination of their organoleptic and physical-chemical parameters. The following were determined the waters of rivers: from organoleptic parameters – smell, colour, transparency; physical-chemical parameters – temperature, pH, suspended particles, general rigidity, dry residual, water soluble oxygen, biochemical oxygen demand during 5 days and nights (BOD_5), permanganate rustiness, chlorides and sulphates, nitrates and nitrites, ammonium nitrogen, phosphates, sulphides, from toxic elements – plumbum, copper, zinc.
- Studying ecological conditions of waste waters from agricultural, every-day life and industrial facilities / units located in Adjara Black Sea Coastline;
- Based on carried experiment the comparative description of research subjects is made, seasonal dynamics of their qualitative indicators are studied and based on research results it is identified pollution quality of rivers' waters.

Research Subject

For achieving research goals we have selected the following as the research subjects:

1. Form inside waters of Adjara region: Tchorokhi, Adjaristskhali, Khorolistskhali, Choloki, Kintrishi, Chakvistskhali, Bartskhana, Periistskhali, Kapreshumistskhali, Kubastskhali, Mejinistskhali;

2. Some agricultural-industrial facilities, located in the territories of Batumi, Kobuletim, Adlia, Kvariati, Khelvachauri, Urekhi, the waste waters fo which flow directly in the Black sea, in particular:

   Construction companies: Ltd "Batumi Construction-Refurbishment Company"; "Road" Ltd, "Zimo-7" Ltd, "Arena" Ltd, , "Breakstone" Ltd, "Granite" Ltd, "Ementi Building-Company" Ltd.

3. The waste waters coming out from various car-wash stations of Batumi which flow in The Black Sea;

4. The waste waters coming out from various agricultural, every-day life and industrial facilities / objects of Batumi, in particular:

   Adlia customs terminal "Toria"; "Batumi Water Channel" Ltd (Adlia Treatment Plant); Railway Buffer Capacity; Khelvachauri Borough "Bread Products" Ltd, "Sanitary cleaning" Ltd; Urekhi, Flour-milling Plant "Bashaki"; Hotel Complex "Oasis", Hotel Complex "Kvariati-2005", Central Agricultural Market; Batumi Airport (treatment plant).

Material-technical base of researches were: National Agency of Environment, Environmental Pollution Monitoring Regional Department, Adjara Autonomous Republic Ministry of Agriculture, LEPL "Laboratory Research Center", National Agency of Standards, Technical Regulations and Metrology of Georgia (Tbilisi), Batumi Shota Rustaveli State University Chemistry Department, Agrarian and Membrane Technologies Institute. ***Methodological base of research was*** legislative normative, technical regulations, state standards, hygienic rules and norms, general requirements about water consistency and water substances in water reservoirs according to water consumption categories.

Sources

The present research relies on Georgian law on standardization, Resolutions of Georgian Government about approving technical regulation on rivers and surface waters of Georgia, as well as under-law acts and other normative acts of Georgian in this field, state standards about methods for determination of water quality parameters, researches in the field of surface waters of various scientists working in Georgia and abroad in various times, the materials from the internet are also used in the given work.

Volume I. REVIEW OF LITERARY DATA

I.1 Water and Importance of it in Biosphere

The water with itsimportance has second place on the earth after the oxygen, as 70,8 % (2/3 of the area) of the earth is covered with water . the water has been created in our planet 3-3,5 billion years ago. Nowadays, the amount of water equals to $1{,}45.10^9$ km and the amount of fresh waters -35 million km^3, which is 2% of general water amount. For fresh water resources renewal the special role has water rotation in hydrosphere. The attention of world towards quantitative and qualitative parameters of water is stipulated by increased demand on water. In agriculture where the significant part of water is used for irrigation, the costs of fresh water equals to 150-200 m^3 per 1 person, and in such countries where there is shortage of water this parameters equals to 20-50 m^3.

The water is a natural resource which is polluted by human activity and its ecological conditions worsen, which actually causes reduction of water supply. In case, if the metal supply is exhausted, it can be changed with plastic material and other polymers, in case if vegetal and animal oils are exhausted, synthesis oils can be created. Usually instead of air sometimes it is possible to use artificial mixture of airs. As for the water, despite the illusion of inexhaustive character of it, the pollution of this natural resource takes place so rapidly, that at present the humanity faces difficult issue of keeping pure water. The water is building material which is used by living organism. It takes in the organism all necessary substances and removes from it everything that is not useful. The water is universal dissolving substance. Allthe vital nutritious product consists of water: vegetables up to 80-90 %; meat up to 50%; milk up to 89-89%, etc. in human body 78% is water and this level of water must be kept as reduction of it up to 20% causes human body death. Losing the water is dangerous for human body rather than starving as without it a human dies in several days. The day-night demand of adult person on water equals to 35-45 gr per each kilogram and until 6 months a person needs 4 times more water. Demand on water depends on a season, climate and the character of performed work by a human. The day-night norm of water in usual conditions is 2,5 litres, from which 1 litre is drinking water. 1,2 litre water is included in daily food norm and 0,3 litre is created in human body as a result of metabolism. The water is industrial raw material, often deficit and very valuable one. Enhancing the population, development of industry and agriculture causes growing consumption of water.

Technical progress is accompanied by growing environmental pollution and first of all water pollution. Multiple of substances flow daily in rivers, seas and oceans, sometimes the substances having absolutely strange consistency. Regarding to this it is necessary to elaborate new methods for analysis of water polluting substances, selecting the more complete forms of removing the polluting substances. But, the spectrum of polluting substance develop much more rapidly rather than the methods selected against them. Therefore, maintaining purity in water reservoirs is based on modern rationale technologies of water elaboration. The water is not met in pure form in nature. It consists of multiple organic and inorganic admixtures. Receiving absolutely pure water could not be achieved for the present moment. According to the dissolved substances the water is divided into the following groups: fresh, mineral, and salty. Hydrosphere is discussed as kinetic system, which is sustainable towards the influence of inside and outside factors only during its sufficient diversity.

Adjara fresh waters include rivers, lakes, marshes, and underground waters. The surface waters resource existing in the region mostly is used in hydro-energetics (94%), for drinking-agricultural means (4 %), for industrial mean (1,6 %), the rest for irrigation. Mineral, treatment acidic and sulphurous waters exist in the region. The water resources are less used for fish farmings and for recreational means.

The rivers of The Black Sea Basin flow in Adjara territory. The following rivers are distinguished with well-watering qualities: Tchorokhi, Adjaristskhali, Matchakhela, khorolistskhali, etc. the biggest and the most well-watered river of the region is Tchorokhi, the length of which is 21 km in the limits of the Municipality (general length 438 km). Matchakhela Reserved Territory is in the territories of Khelvachauri municipality where river Matchakhela flows which is trans-border river between Georgia and Turkey. Matchakhela Gorge is characterized with rare diversity of endemic and relict species. 10868 hectare of the Gorge is covered by forest, the 75% of which is untouched by human hand. The significant part of the territory is occupied by Kolkhetian type mixed leafy forestwith the domination of beech. Besides, chestnut, oak and others are met in the forest. From coniferous species 13 plants are included in Red Book List of Georgia. The territory is rich with fauna. In Khelvachauri the mountainous type rivers are met mostly. Because of strong separation of relief the length of rivers is short and the area of their basin is small. No river of municipality has source from the constant glacier and the snowy territory. The rivers are mostly nourished by underground, rain and snow-melt waters for this reason they are characterised by the fluids in Spring and Autumn. The rivers are characterized by great falling; speed flow at some parts the rivers flow in narrow and deep gorges that they create river rapids and waterfalls. All significant river sin the territory of the municipality is the tributary of river Adjaristskhali and they flow in the Black Sea (Table 1).

I.2 Chemical Consistency of Natural Waters and Factors Influencing of Formation of Them

The chemical consistency of natural waters is complex of various mineral salts and organic admixtures and airs dissolved in waters. Almost all chemical elements known for us is dissolved in natural waters but the majority of them are so small that it is impossible to determine them because of insufficient sensibility of analysis method.

At present with various physical-chemical methods it is possible to identify and evaluate the consistency and quality of natural waters which includes determination of the following basic parameters:

1. Organoleptic parameters;
2. Basic ions, or macro-components: Cl, SO_4^{2-}, HCO_3^-, CO_3^{2-}, K^+, Na^+, Mg^{2+}, Ca^{2+};

3. Soluble airs - O_2, N_2, H_2S, CO_2;
4. Biogenic admixtures – nitrogen, phosphorus, plumbum and silicium admixtures;
5. Organic substances – various organics acids, complex ethers, phenols, humus substances, proteins, amino acids, etc.
6. Micro elements;
7. Polluting substances, pesticides, surface active admixtures.

The following factors make influence on the consistency of natural waters:
a) physical-geographical (relief, climate, soil coverage);
b) geological factor (consistency of mountain rocks, technical structure, hydrological conditions);
c) physical-chemical factors (chemical qualities of elements, acidic – basic and rusting-regenerative, macro and micro-components, soluble airs, cationic exchange);
d) biological factors (vital activity of plants and vital organisms);
e) artificial or anthropological (all those factors which are connected to human activity).

Table 1

Khelvachauri Municipality Rivers and their tributaries

Name of river's (tributary)	The location of source above sea level (m)	Length (km)	Width (m)	Depth (m)	Speed (m/per second)	Average ability of falling down per 1 km (m),	Water catchment basin area (sq /km)	Perennial average expenses (m^3 / per second)	Average annual runoff (mln /m^3)
1	2	3	4	5	6	7	8	9	10
Chorolhi	2700	438 (on the territory of Georgia-26)	80	1,5-4,8	0,7-2,5	6,2	22 130	278	8767
Tributaries:									
Adjaristskhali	2379	90 (on the territory of the municipality-5,5)	(on headwater - 1-6, on the river confluence- 40-60		1,5-2	26,4	1540	51,5	1624,1
Machakhlistskhali	2285	37 (on the territory of Georgia -21)	In the middle of the river 11-16	0,4-0,8	2,5 (On the headwater- 0,5-0,8)		369	20,8	655,9

1	2	3	4	5	6	7	8	9	10
Tributaries:									
Skurdidi	2151	11							
Jochostskhali		6					11,8	0,98	30,9
Charnali	1142	13					25,3	1,2	37,8
Mejinistskhali		9							
Bartskhana		8,6	On the headwater-2, on the river confluence - 14			13,2	16,9	1,32	41,6
Tributaries:									
Akhalshenistskhali		4,5							
Periistskhali		2,5							
Khorolistskhali	1160	13	8-62,5			29,9	52	3,3	104,1
Tributaries:									
Kapreshumis-tskhali		2,8							
Abanostskhali (Trout famring)		6					3,9	0,25	7,9

Enriching the natural waters with this or that element is caused by not only general consistency of these elements in mountainous rocks and soils but movement or migration ability of the elements. A.E. Fersman divides inside and outside factors of migration, which determine behaviour of chemical elements in natural waters. According to him inside factors are: valency of elements, ion radiuses, ion potentials and outside factors are - the earth energetics consistency of atmosphere and climate.

The more is metal valency the less soluble admixtures they create and therefore the low is their migration ability. Hence, one – valency alkali metals as a rule create easily soluble admixtures ($NaCl$, Na_2SO_4), two-valency alkali soil metals–less soluble admixtures ($CaCO_3$, $CaSO_4$, $MgCO_3$), three-valency metals (Al^{3+}, Fe^{3+}) even less soluble admixtures. The exception is $MgSO_4$, as well solluble salt and $AgCl$ as hardly soluble substance.

The more movement ability of hydrated ions the less their ion radius is. Taking into account valency and ion radius ions existing in natural waters according to migration ability are classified with the following succession:

$$NO_3^- > Cl^- > SO_4^{2-} > CO_3^{2-} > K^+ > Na^+ > Ca^{2+} > Mg^{2+}$$

The migration ability of elements highly depends on *pH* of natural waters. The majority of chemical elements is movable in wide diapason of *pH* and they have intensive migration ability in acid and alkali area as well (Na^+, K^+, Cs^+, Li^+, Rb^+, F^-, Cl^-, Br^-, I^- etc.).

Cationic exchange plays important role in chemical consistency of natural waters which on one hand is the result of mountainous rocks narrow dispersive clay fraction and on the other hand water interaction. The more is mountain rock dispersive quality and cationic valency the stronger is absorption and death of them by the mountain rocks. In case, if the cationic valency is equal then their absorption is grown by increasing atomic mass. According to cationic exchange energy cation are stand with the following classification:

$$H^+ > Fe^{3+} > Al^{3+} > Ba^{2+} > Ca^{2+} > Mg^{2+} > K^+ > Na^+$$

Hence, hydrogen cation is characterised by the highest cationic exchange ability. The area reaction or pH makes influence at cation absorption, by the growth of which from 6 to 11, cationic exchange volume is grown by 2-3 times as hydrogen ions limit cationic exchange in soil-water exchange complex. Mostly in natural waters cationic and not anionic exchange takes place as consistency of mountain rock and soil colloids basically is created by SiO_2 –, Al_2O_3– and with other negatively charged mycelium, which actively absorp positively charged cations.

One of the basic factors influencing at consistency and quality of natural watersis anthropogenic factors, so human activity. There is no natural water eco-system in the earth which does not suffer from anthropogenic influence with this or that quality. In most cases, here jointly act natural and artificial factors. According to influence quality artificial factors are divided into chemical and physical factors. Chemical factors are: flowing waste waters in water facilities being polluted in various forms, which cause changes of chemical consistency of water. Physical factors are changing such physical parameters of water as temperature and rusting – restoration potential which cause creation of a new changed consistency of water. In frequent cases the natural purifying factor of waters is the oxygen soluble in them which causes rusting the polluting substances and their neutralizing:

$$(CH_2O)_n(NH_3)_m \xrightarrow{HNO_3} CO_2 + H_2O + N_2 + NH_3$$

$$NH_3 \xrightarrow{HNO_3} N_2 + H_2O$$

But this conditions create a problem for alive organisms in water and the whole eco-system and of course for a human as during this time the oxygen disappears and denitrificates at the same time which causes removing nitrate admixtures of nutritious nitrogen in soil. After all oxygen and nitrates are spent, sulphur enters the process of photosynthesis:

$$CO_2 + H_2O + H_2S + n\nu \xrightarrow{\text{Purpura Bacteria}} H_2SO_4$$

$$CO_2 + H_2O + H_2S + n\nu \xrightarrow{\text{Purpura Bacteria}} S$$

Where $n\nu -$ is - energy quantum in photosynthesis process. In these conditions demand on oxygen is satisfied on the basis of restoration of sulphate-ions. The total reaction is expressed as follows:

$$(CH_2O)_n(NH_3)_m \frac{SO_4^{2+}}{n\nu} CO_2 + H_2O + H_2S + NH_3$$

Hydrogen sulphide H_2S, is created in the form of final product which causes serious pollution of eco-system.

The strong chemical polluters of anthropogenic character in natural waters are: oil, heavy metals, surface active admixtures, organic admixtures, fat acids, proteins, fats, carbon-hydrates, nitrates, ammonium, and microelements (Mo, Cu, Co, Ni, Hg).

The consistency of natural waters determines the productivity and quality of many enterprises and products, in particular: producing agricultural crops, fish-farmings, watering-irrigation measures, etc. For this reason, reasonable usage of water resources is not only priority of each country but it is a global problem of environmental protection.

I.3 Classification of Natural Waters. chemical methods of analysis of natural waters

The natural waters are divided into three basic classes according to the quality which anion is more in them, in particular:

I class – hydro-carbonate type waters;

II Class – sulphate type waters;

III class – chloride type waters;

I class waters are characterized with alkali reaction, they are mild waters, and a little bit mineralized, they are mostly created dissolving eroding products as a result of volcanic eruption . The main consisting parts of this type of waters are: $HCO_3^-; Ca^{2+}; Mg^{2+}$. Therefore, their chemical consistency is stipulated by the salts: $NaHCO_3$; Na_2CO_3; $MgCO_3$; $CaCO_3$.

II class waters are created as a result of interaction of exhausting products of various sediment rocks. Rivers, lakes and the majority of underground waters belong to this class. The main components of this type of water are: $Na^+; Mn^{2+}; K^+; SO_4^2$. Therefore their chemical consistency is stipulated by the salts: Na_2SO_4; $MgSO_4$; K_2SO_4; $CaSO_4$.

The III class waters are created as a result of water molecules absorption and cationic exchange between the solution and mountain rock (soil). The main components of this type of waters are: Cl^-; Na^+; Ca^{2+}; Mg^{2+}.Therefore, their chemical consistency is stipulated by the salts: $NaCl$; $MgCl_2$; $CaCl_2$.the oceans, seas, salty lakes and the majority of strongly mineralized waters belong to this type of waters.

In water mineralization the general amount of all mineral substances dissolved in it is implied. Water mineralization is expressed in general amount of dry residual, which is found by the evaporation of certain amount of water, drying out it and by further weighting of received dry residual. At present, the researchers have not got one opinion about classification of natural waters according to mineralization. The generally acknowledged size is regarded the mineralization quality,which is considered as the norm of saltiness of natural waters (Table 2).

Table 2

Classification of natural waters according to mineralization quality

Name	***mineralization quality, g/l***
ultra-fresh waters	<0,1
fresh waters	<1,0
over-salted waters	1,0 – 10,0
salty waters	10,0 – 50,0
ultra-salty waters	> 50,0

Nitrogen and phosphorus belong to biogenic components existing in rivers' waters. From nitrogen admixtures nitrates, nitrites and ammonium nitrogen are mostly typical for river. Increase of their concentration is the indicator of water pollution. In intensive development period of water plants nitrates, nitrites and ammonium nitrogen almost disappear from water (in Summer), then their consistency is increased in Autumn and it achieves its maximum in winter, when organic substances are dissolved and nitrogen is transformed from organic forms in mineral ones. In spring nitrates concentration still decreases in water as a result of vital activity of water plants. Phosphorus inorganic admixtures concentration in rivers' waters does not exceed 0,1-0,5 mg/l and their consistency is increased in case of water pollution, as a result of influence of various polluting factors.Seasonal dynamics of phosphates is like nitrates, nitrites and ammonium nitrogen dynamics.

In river waters organic admixtures mostly are represented in the face of humus acids and their derivatives. Humus admixtures gives the brownish almost turbid appearance to the water. The consistency of organic admixtures in waters are changed in the limits of 15-18 mg/l. the permanganate rustiness of organic admixtures in river waters varies in quiet wide diapason from 2 mg O_2/l to 50 mg O_2/l and even more. The river water rustiness is minimal in winter period and it is maximal in summer period when a big mass of organic admixtures happen in rivers (Table 3).

Table 3

Rivers' waters classification according to acidity

Acidity quality	***mg O_2/l***
very low	< 2
low	2-5
average	5-10
increased	10-20
very high	> 30

The soluble air consistency regime in river waters depends on vital activity of alive organisms, climatic zones and seasonal dynamics as well. From airs special importance is given to oxygen and carbon dioxide. The soluble oxygen in natural waters is in the form of molecule (O_2) and absorption speed of it from atmosphere in water facility increases byreducing the temperature, increasing the pressure and reducing the mineralization. Thestronger is process of photosynthesis in water, the higher water temperature is and the more biogenic admixtures are gathered in it. Reduction of oxygen consistency is supported by the processes such as rusting organic admixtures, breathing of alive organisms, micro-organisms and vital activity of bacteria as well as chemical rustiness of various admixtures. Accordingly, oxygen demand speed increases by the growth of water temperature and by the increase of bacteria and other alive organisms, which use oxygen in the process of chemical and biological rustiness. The consistency of soluble oxygen in surface waters varies in the limits of 0-14 mgO_2/l. and it experiences seasonal changes.

Carbon dioxide is spent strongly in river waters in summer - as a result of activation of photo-synthesis, by the reason of which, high amount of it from water surface is expressed in atmosphere, so carbon dioxide regime in river waters is against oxygen regime, so it is maximal in summer and minimal in winter.

The consistency of hydrogen-ions in natural waters is stipulated by the quantitative correlation of basically carbon dioxide and its ions:

$$CO_2 + H_2O \Leftrightarrow H^+ + HCO_3^- \Leftrightarrow 2H^+ + CO_3^{2-}$$

pH is indicator of hydrogen-ions, which for river water varies in the limits of 6,5-8,5 (Table 4). *pH* regime basically is stipulated by CO_2 regime. In particular, *pH* of rivers' waters is changed in the limits of 6,8-7,4 and in summer in the limits of 7,4-8,2. The surface waters in which CO_2 consistency is low have alkali reactions. *pH* water quality is one of the basic parameter at which vital activity of alive organisms in water, migration of elements, transformation of biogenic admixtures and cleaning the water depend on.

Table 4

Groups of natural waters according to *pH*

Name according Acidity	*pH*
very acid waters	<3
acid waters	3-5
poorly acid waters	5-6,5
neutral waters	6,5-7,5
poorly alkali waters	7,5-8,5
alkali waters	8,5-9,5
strongly alkali waters	> 9,5

Nowadays, chemical analysis methods of natural waters are divided into the following:

1. chemical methods (gravimetric and titrimetric analysis);

2. electric-chemical methods (potentiometer, conductor-meter and polarograophical analysis);

3. Optical methods (photometric, spectrophotometric, luminescence and spectral analysis);

4. Chromatographic methods (liquid chromatography, thin-layered chromatography ad air chromatography).

Gravimetrical method is based on omission of research component from solution in the form of sediment, further drying out and weighting of it (by taking to the constant weight). The sensitivity of gravimetric analysis equals to 10^{-4} %.

Titrimetric method is based on interaction of research component with standard solution during titration process, the completion moment of which is identified by changing the colour of indicator at equivalence point. By the volume of standard solution spent at titration, concentration of research component is calculated. The sensitivity of titrimetric analysis equals to 10^{-3} -10^{-4} %.

The sensitivity of electric-chemical methods equals to 10^{-5} -10^{-7} %. One of the types of it is potentiometer analysis, which is based on determination of indicator electrode potential drawn in analysis solutions, which is changed in direct proportion with solution concentration changes.

The basis of optical method is the ability of substances to absorb radiation energy in the form of quants, which comply with the length of certain wave. The absorption lines are located in ultra-sound, infra-red areas or in areas visible for light beam and on the basis of their qualitative evaluation the consistency of analysis component is identified in the solution. The main types of optic method are: spectrophotometric and photo-colorimetric methods. The sensitivity of optic methods is 10^{-7}% and more. These methods are exact, they are easy to perform and other substances make no influence at analysis results.

The chromatographic methods of diving liquid and gaseous mixturesare based on separation of mixture components between two phases (movable and immovable phases). The chromatographic system consists of sorbent (which includes immovable phase or itself is immovable phase) through which movable phase moves. During moving of movable phase, some easily soluble component moves much more rapidly at immovable phase surface, rather than other less-soluble components. The mixture components are divided with this principle into certain chromatographic zones.

During the recent two-three decades analytical chemistry of natural waters experiences significant changes, methods of it were improved which was stipulated by development of new fields of public economy and increase of demand towards the quality of natural waters. Therefore, the majority of classical methods were changed by modern much more sensitive methods of analysis. Automization of analysis methods and statistical elaboration of measuring results was established as one of the most important directions of analytical chemistry. The modern analytical chemistry of natural waters has already got the widen range which gives the possibility to determine micro- and macro-components of natural waters.

I.4 Quality Evaluation of Natural Waters, for Technical, Every-day, Irrigation and Fish-farming Purposes

The quality of natural waters which are used for various agricultural means is different, as these waters cannot always satisfy the requirements existing against them, so they can be used only after appropriate preparation of water. Therefore, the next stage is water preparation, so called “Norm-setting” problem. Whle identifying drinking-agricultural waters, he mineralization of it is foreseen, as well as water physical qualities, organoleptic parameters and micro and macro-components.
Drinking water has got the following requirements:

- It must be transparent, colorless, with typical taste and having no smell;
- Concentration of substance dissolved in water (especially soluble oxygen) must not exceed maximal permissible concentration norm;

- The water must be free from micro-organisms causing diseases;
- The consistency of malignant toxic elements for human health (Cu, Pb, As etc.) must not exceed the norms set under technical regulations.

From water physical qualities the special requirements are on the smell and taste of it which should not be unpleasant. Deterioration of these organoleptic indicators in water causes irritation of mucous and respiratory ways in humans and animals. Volatile odorous admixtures cause unpleasant smell of water, which are met in water as a result of vital activity processes of water-organisms as well as biochemical dissolving processes of organic admixtures, industrial as well as agricultural and every-day waste waters.

One of the basic criterion of useful water is mineralization of it which should not exceed 1000 mg/l. The very low mineralization (up 100 mg/l) is not desirable as well as it worsens the water quality and unsalted water is harmful as it decrease osmosis pressure in cell. During this time the water is similar to distil water and it requires enrichment with mineral water for the purpose of improving it in tasteful and hygienic substances. The same requirements are set for the animals drinking water as for human drinking water. The important role in drinking-economic water quality evaluation has rigidity of water, which should not exceed 7 mg/ per liter for drinking water. High rigidity causes undesirable cases of water usage.

pH, of drinking water according to requirements of drinking-every-day and fish-farming reservoirs must not exceed 6,5-8,5. The water pH is one of the important indicators of water quality as the size of pH makes great influence at chemical and biological processes existing in natural waters. The growth-development of water-plants, migration ability of elements and water aggression towards concrete and metals depend on size of pH. Heavy acids and their salts are with a high amount in polluted water reservoirs, which is caused by the flow of polluted waste waters, every day and industrial waters. In this case pH can be 4,5 and even less.

While evaluating chemical consistency of drinking water, the attention is paid to the consistency of various salts, especially chlorides and sulphates and the micro-biological conditions of water as well. The special risk for drinking water is the existence of feces mases from waste waters. In centralized water supply system, the amount of colibacillus is permissible not more than 3 per 1000 ml water. In case if the water is polluted with microorganisms, it is purified by the chlorides, ozonizing and other methods as well.

In different from drinking water in the requirements against the water for technical means the rigidity of it is the first aspect which is taken into account. The consumption of rigid waters in the whole number of industrial processes is not economic and desirable as sedimentation of salts at the mill surfaces causes uneconomic spending of fuel and activation of corrosive processes. High rigidity of water worsens organoleptic parameters of it as it gives the bitterish taste to the water and in case if the water is used for drinking purposes makes negative influence at food digestion organs.

Formation of incrust is a complex physical-chemical process during which weakly soluble salts are precipitated ($CaCO_3$, $MgCO_3$, $CaSO_4$, $CaSiO_3$, $MgSiO_3$). In case if $CaSO_4$ is with a big amount in natural water, it creates plaster incrust. In case if, the water consists of sodium silicate, it interacts with Ca and Mg sulphates and hardly soluble silicates are formed, which cause worsening the water quality: $CaSO_4 + Na_2SiO_3 \rightarrow CaSiO_3 \downarrow + Na_2SO_4$.

The natural waters are characterised by aggressive peculiarities of various kinds, which is caused by high consistency of hydrogen-ions, $CO_2 -$, Sulphates and Magnesium. This kind of aggression makes negative influence at such materials as concrete, reinforced-concrete and metals.

For identifying the usage quality of natural waters for irrigation it is necessary to know their temperature, mineralization quality, chemical consistency and irrigation coefficient. Besides the quality of natural waters suitability depends on soil type, the consistency of water-soluble slats and the plant coverage type. In salts dissolved in waters used for irrigation, sodium salts are considered to be the most toxic ones, the malignancy quality of which can be descripted with the following correlation: $Na_2CO_3 : NaCl : Na_2SO_4 = 1:3:10$. For improving waters' qualities consisting of sodium, plaster $(CaSO_4)$, is added to water which transforms Na_2CO_3 to less toxic one Na_2SO_4. The salty and over-salted waters are totally non-useful for irrigation, the saltiness of which exceeds 7% as they cause soil saltiness.

The suspended particles existing in natural waters make influence at water transparency, consistency of components dissolved in water, the speed of sediment creation and absorption of toxic substances. The water in which suspended particles are more is not useful for recreation means. The turbidity of natural waters is caused by narrow dispersive admixtures in water which is stipulated by reduction of insoluble organic and inorganic admixtures. According to hygienic requirements of water quality the turbidity of drinking water should not exceed 1,5 mg/l.

The quality of natural waters is an important parameter of biochemical oxygen demand during 5 days and nights BOD_5, according to which we can discuss water pollution quality by organic admixtures. The special pollution organic admixtures of water are: Formaldehyde, Alcohol, Phenol, Naphtolies, Krezol, Resorcini, Pyrocatechines, Oil, surface-active admixtures. Determination of BOD_5 in surface waters is necessary for evaluation of their pollution quality and for controlling effective operation of treatment plants.

Determination of soluble oxygen in surface waters is involved in quality evaluation programs for the purpose of estimation life conditions of alive organisms and fishes and for regulation of treatment process of waste waters. Existence of soluble oxygen in water is some kind of indicator of biological activity of it.

Increasing nitrites and ammonium nitrogen in surface waters indicate about their new pollution and increase of nitrate consistency indicates an old pollution. The consistency of nitrate-ions in surface waters is connected to first of all to the flow of every-day, agricultural and industrial waste waters in rivers, as well as by irrigation (where nitrogen fertilizers are used) and other kinds of waters. Nitrates in surface waters are in soluble forms, they have high migration ability and therefore, they can cause pollution of deep layers of waters.

I.5 General Description of Basic Polluters of Rivers' Waters

Under the term hydrosphere pollution reduction of biosphere function and ecological importance is meant as a result of happening malignant substances in it. Chemical and bacteriological pollution,, radioactive admixtures, mechanical and radiation pollution are considered to be the basic polluter of water. It can be of a organic and inorganic origin. Toxic and non-toxic. The basic polluters of river's waters are: chemical pollution, acids, alkali salts, oil and oil products, pesticides, etc. biological polluters are: viruses, bacteria, the organism causing various kinds of diseases, etc.

The most polluted rivers of Georgia are: Mtkvari, Rioni, Khvirila, Tkhibuli, Gubistskhali. In the majority of those rivers the consistency of phenols, hydrocarbon, copper, magnesium, zinc and nitrogen is high in connection to national and international standards. One of the basic sources of pollution is factories and oil-treatment enterprises. Georgian rivers are significantly polluted by communal waters and pesticides used in agriculture. So, for example, the consistency of organic substance in river Mtkvari exceed the maximum permissible concentration by 1,5 times and the consistency of phenols by 11 times. The important water polluters are heavy metals the happening of which in water is stipulated by operation of a number of industrial fields (cellulose treatment, mountainous – mining, oil-processing, steel production, etc.) and enterprises. As a result of happening admixtures of heavy metals in a big amount of water they are dissolved rapidly, they are precipitated in the form of carbonates, sulphates or sulphides. Some part of them are absorbed in the bottom at mineral and organic sediments. As a result of this the consistency of heavy metals is increased in the bottom. The heavy metals start dissolving in water even before the saturation. Then they are dissolved in water which makes malignant influence on environment. To some extent this process is noted during fluids. During this time pH is decreased or strengthened vital activity of micro-organisms is present. Radioactive residuals are especially dangerous for the organism, so their flow in water reservoirs are impermissible.

In Georgian Law “About Water” flowing various kinds of residuals and toxic-radioactive waste is forbidden. For preventing the pollution, the appropriate measures are used which forbid flowing various solid wastes and other things as well. The river water-protection line is considered to be its alongside territory in which special mode is set to protect pollution of water resources. The water-protection line can be dry river-bed, alongside terraces of it, tall and steep slope type natural coasts, as well as bordering gorges of the river. The width of the river water-protection line is calculated from the edge of river-bed at both sides with the following rule: for the river with 25 km length it equals to 10 meters; for 50 km length river it is - 20 meters; for 75 km length river – 30 meters; for 75 kilometers it is 50 meters. In the limits of rivers water-protection line the following is forbidden: construction or widening and reconstruction of already existing enterprises except the cases set by the law; spraying the perennial plants, roots and forests with pesticides via air spray method; storage and burying mineral fertilizers and industrial residuals. For the rivers there are set maximum permissible concentrations of floating materials, consistency of accentuated substances, smell, taste, color, water temperature, mineral admixtures, water soluble oxygen concentrations, toxic and malignant substances, bacteria causing the diseases.

The polluted water is also non-useful for production. The usage of such water violates normal operation of technological processes and reduces the product quality. The polluted waters bring non-desirable results while irrigating agricultural crops. It causes over-salting of soils, salts omission from soils, increasing the acidity of it, pollution of rivers with rough dispersive and colloidal substances as well as with malignant micro-organisms and helminth eggs, which happen in human body from the nutritious products. The term “pollution” reflects the influence of all toxic substances which a human throws and puts in eco-sphere. Ecologically the word “Pollution” means getting dirty, dumping, removing, worsening. Pollution is undesirable change of environment which partly r fully is the result of human activity. It makes direct or indirect influence at energy distribution at radiation level as well as at physical-chemical qualities of environment and vital processes of alive organisms.

The water quality is stipulated by natural factors, in particular, 15-20% of polluting water reservoirs comes to atmosphere. The substances which pollute water reservoirs are of a mineral, organic and bacteriological origin. Mineral are: sand, clay, slats, acids, alkalis, solutions and emulsions of mineral oils. Organic polluters can be of a vegan and animal origin. Bacteriological pollution is caused by yeast and mildew fungus, as well as various micro-organisms (including the bacteria causing diseases which are only of an animal origin). The polluters also make negative influence on things in the ownership of a human and by destructing natural relaxation environment in nature. The polluters may cause deformation of a human body.

As a result of pollution with natural factors in the deeper layers of the Black Sea then 200 m there is a high concentration of hydrogen sulphides. In case, if 1 liter of water consists of

1 mg hydrogen sulphides, it is already poison. The concentration of hydrogen sulphides at the bottom of the Black Sea is 7 mg/l. Therefore, there is no life below 200 m in The Black Sea excluding anaerobic Sulphur bacteria. The example of polluting water resources with natural factors is underground mud volcanos which include a great amount of oil and omit air and heat. The natural pollution source of water resources is the decomposing water and marshy plants.

French scientist F.Ramadi offers the basic types of pollution and the following classification of their malignant influence:

I. **Physical Pollution**: radioactive substances (radiation), heating or radiative pollution, noise and low-frequency vibration (infra-sounds);

II. **Chemical Pollution**: formations of carbon dioxide airs, hydrocarbons, washing substances, plastic materials, pesticides and other synthesis organic substances, Sulphur, nitrogen admixtures, heavy metals, solid admixtures, aerosols, organic substances subordinated to boiling;

III. **Biological Pollution**: microbiological poisoning of respiratory and digestive tube (bacteria, viruses). Changes of biocenosis with incorrect introduction of new vegan and animal species; biological pollution causes micro-biological poisoning of water and distribution of such diseases as infectious hepatitis, typhoid, dysentery and intestinal infections;

IV. **Aesthetic Malignancy**: violation of places of interest and landscapes with rough urbanization and with the less valuable buildings. Construction of industrial centers in virgin forests and reserved territories.

Local, regional and global types of pollution are varied. The local pollution implies pollution of a certain place (soil, water and air). Regional pollution includes more territory but when a person throws rubbish in a biosphere, no substance stays at its place. It moves in a big territory through air masses and water and takes a global character. As it is known the main means for distribution of polluting substances, is the movement of atmospheric masses (winds) and hence, knowledge of movement regime of air masses has great importance to identify pollution mechanisms of biosphere. The polluting substance is transferred and distributed not only via the influence of abiotic factors (wind, water, soil) but any polluting admixture can be assimilated by live organisms and hence it is involved in trophic chain of eco-system, it [participated in metabolism of biocoenosis, by which makes malignant influence at various species of a vegan and animal origin participating in the trophic chain.

According to physical conditions the polluting substances existing in waste waters basically can be divided into non-dissoluble, colloidal and soluble admixtures. To its part this polluting substances can be mineral, organic, bacterial and biological. In biosphere pollution, special place takes radioactive radiation pollution. Radioactive substances in Air and Soil are met as a result of testing atomic weapon, water used in reactors and radioactive residuals. These substances poison soil, water and air for which it jeopardizes all alive organisms including a human. In dangerous pollution of the soil and water the special place has pesticides - chemical substances used against agricultural pesticides and diseases. The pesticides are basically organic admixtures having small molecular weight and various dissolving ability. In different from other polluting substances, they are sprayed out in natural environment which unprecedentedly increases their assimilation by vegan and animal organisms.

During chemical and thermal elaboration of raw plants, during turning into coke the wood and coal, phenols are distributed with a big amount in nature. Besides, they enter into omitted airs of petrol and diesel motors. Phenols are substances being in everyday contact with a human as they enter the products. The water is polluted with phenols by little amount but anyway it is regarded as the basic polluters of every-day waste waters. Dissolving phenols in water depend on chemical structure of their molecule and environmental conditions. The main part of phenols in water reservoirs happen from cellulose-paper factory combines, as the timber consists of water soluble phenols. Organic substances of natural origin rapidly dissolve with microorganisms in water.

The oil is dangerous organic polluting substance of natural waters. In consists of such oxygen-consisting admixtures as aldehydes, ketones and carbon acids. Oil happens in environment with various ways. The oxygen licked in soil is mixed with ground parts and goes on a large distance deeply. Oil happened in water experiments micro-biological dissolving and this process goes on so slowly that easily absorptive component of oil are evaporated and the rest ones are rusting slowly. As a result of oil pollution sea organisms are poisoned, fauna is turned poor, the amount of fish is decreased and the resort beaches are polluted. Annually from5 to 10 million tons of oils flow in world ocean.

Mineral pollution of waters ar caused by various chemical admixtures the basic sources of which are agriculture, metallurgy ad other fields. The amount of plumbum which is met in World Ocean annually equals to 25 thousand tons. Besides, copper, zinc, chromium, nickel, cadmium and other elements are discovered in hydrosphere, which are strongly toxic for resident organisms of fresh and sea waters. In addition, it is very dangerous pollution of sea with mercury. Annually, in ocean 5 thousand tons of mercury admixtures happen. The hydrosphere is intensively polluted by nitrates and phosphates which are used with large amounts in agriculture. The main water polluter is chemical and bacteriological pollution, the less met is physical pollution. The chemical pollution is the most distributed, sustainable and far longing pollution. Bacterial pollution is distribution of pathogenic bacteria, viruses, fungus and others in water. This type of pollution has temporal character. Mechanical pollution is characterized by distribution of various mechanical admixtures (sand, silt) in water. These admixtures may significantly deteriorate organoleptic parameters of water.

Among heavy metals zinc and plumbum are less toxic but their large amount in metallurgical residuals pollutes the soil and depressingly affects the growth of micro-organisms. Plumbum may happen in natural water from mountainous rocks and atmospheric dust. It exists in river water in the suspended form. In various rivers one from of plumbum may be more rather than other but in ecological aspect the great importance has suspended forms of plumbum. The dissolved plumbum consistency in river water averagely equals to 1 m kg/l and in various regions it is characterized by notably changes. In alpine and sub-alpine zone waters high consistency of plumbum is connected to intensive washing out of this element from mountainous rocks and high sedimentation of aerosols from atmosphere typical to these zones. The factories acting in plumbum and polyamatal ore areas significantly increases plumbum consistency in natural waters. Similar to other heavy metals, plumbum can connect to fermenting agent molecules and to cancel their initial function.

The major part of Adjara territory is structured with paleogenic volcanic formation rocks. Adjara Black Sea Coastline Rivers cross volcanic rocks. River Adjaristskhali at the whole length of it flows almost at all levels of paleogenic sediments. From the source to the middle part (up to village Kokotauri) the river flows at upper eocene volcanogenic sediments which are represented with two divisions: Adigeni and Ghorjomi divisions. The both divisions are structured with volcanogenic rocks – basalts, andesite and big fragmental analogies. Carbonate rocks- marl and limestone layers are rarely met in river Ghorjomi and Chirukhistshkai gorge. Ghorjomi division is somehow different which at lower part is represented with massive quartzites and in upper part – with rough fragmental volcanogenic rocks among which are areas of andesite and basalts. In lower part of river Adjaristkhali from river Kokotauri to River Tchorokhi tributary, the river flows at middle eocene volcanic rocks, which are almost similar to above-described rocks: they are also represented with small and big fragmental volcanogenic rocks and lavas. River Tchorokhi which has source in Turkey flows up to Adjara territories in the above-stated rocks, only in Turkey territory the river crosses upper chalking-carbonate rocks – limestone the material of which is many in river-bed and in The Black Sea beach sediments. The rest of rivers – Choloki, Kintrishi, Chakvistskhali, Khorolistskhali and others, cross the same volcanic rocks. In the Black Sea Coastline quaternary age sea and alluvial river sediments are distributed which are structured with materials of above-descripted volcanogenic rocks.

It is noteworthy that some rivers of Adjara flow and washes out ore areas which significantly changes their hydro-chemistry. For example, Murgul Mountainous -Enrichment factory operates in the territory of Turkey, the waste waters of which flow in river Tchorokhi, so river Tchorokhi waters are significantly polluted by copper, plumbum and zinc. The left tributary of river Tchorokhi water is Akavreta, which washes out village Merisi Polyamatal Ore Metals. These metals are not treated yet but the river is significantly polluted with them. River Tbeti and Skhalta wash out sulfur Colchadian (pyrite) rocks, hereby is alunites (alum rock), which is spread at large territory (Tsablana, Khikhadziri, Ghorjomi). They also make influence at hydro-chemical conditions of rivers.

I.6 Agricultural and Industrial Waste Waters as Main Polluters of Natural Waters and Treatment Methods of Them

While talking about water purity we should differentiate those two terms from each other: water treatment and fighting with water pollution. The water taken from river, lake or well must be safe for human health, it should have pleasant taste and it must not have any smells. Water safety is achieved by removing micro-organisms causing diseases and the taste qualities – by removing strange substances, admixtures and turbidity as well. The fight against water polluting substance is directed to the restoration of water quality, which the water has lost as a result of its consumption by a human.

The idea that we can prevent water pollution where agrarian farming and industry intensively develops is absolutely impossible. No economy and no closed industrial circles are able to decrease the demand on pure water so that it is not polluted. We should seek for possibilities which will enable us to keep pure water and to naturally restore already polluted water. Similar to atmosphere, water environment is polluted anthropogenically. We, cannot blame only industrial enterprises in it. The modern agriculture does not have the less important role in polluting the water with its cattle-breeding, fertilizers and the ways to fight with plants pesticides, the majority of which are met in ground and surface waters, after they are used. In total water pollution every-day residual take their part of role. The technical progress made it possible to create a number of such admixtures which very difficultly subordinate to transformation process. The part of them, during transformation, some part during transportation and the basic part of the are met during usage in environment.

The waste waters are called the waters used during industry, communal production and the water used by the population, which consists of various admixtures. According to the place of origin, the waste waters are divided into the following parts: everyday so agricultural – faecal waters; atmospheric waste waters; industrial waste waters.

Industrial waste waters are divided into three groups:

1. The waste waters changing mineral admixtures, which is produced by metallurgical, car-constructing, mineral fertilizers, salts, construction materials and other kinds of factories;

2. The waste waters full of organic substances, which is produced by meat, milk, raw rubber, plastic materials and other factories;
3. The waste waters consisting of mineral and organic admixtures, which are produced by oil factories, oil-chemical, textile, conservation, sugar, vitamin producing factories.

Form the ancient times, fecal waste waters were drawn to fields. This from of water treatment has achieved our epoch as well. Small particles dissolved in fecal are licked in the soil where by the influence of micro-organisms, aerobic dissolving processes of organic substances happen. The rest mineral inserts are used for fertilizing agricultural crops. Removing the fecal has its negative side which is the fact that in soil hardly-dissolving substance is accumulated and it has unpleasant smell. Herewith, parasites causing disease may be distributed, and the risk for polluting ground waters is created.

The main pollution sources of water reservoirs are: waste waters of industry and communal economies; factories of mineral and non-mineral raw materials processing enterprises; the waters coming out from shafts; the first processing products of flax and other technical products, oil-products, heating pollution, radioactive residuals, among those polluters great importance has industrial waste waters, which include various chemical substances, which negatively effect on environment. The sources of every-day waste waters are: shower-rooms, bathrooms, laundries, canteen, etc. they include 55% of organic and 45% mineral substances. The source of atmospheric waste waters is sediments. It is often mixed with every-day and waste waters. The industrial waste waters are the liquid residuals created as a result of finding and processing organic and inorganic raw materials. They differ from each other by the consistency and amount of polluting substances. To its part, the waste waters are divided into the following according to the consistency of various admixtures: waste waters consisting of mineral admixtures; waist waters coming out from metallurgical, car-constructing, mineral fertilizers, salts; waste waters coming out from meat, milk, food, plastic materials and other kinds of enterprises; oil-producing, oil-chemical, conservations, sugar, paper and vitamins. According to hygienic rules and conditions it is forbidden to flow waste waters in water reservoirs without treatment. Though, valid treatment plants in Georgia is not complete technically. According to official data, only 10% of waste waters are treated in the Republic and only 13% of communal and every-day waters (Picture 1).

Picture 1 Sea water pollution by agricultural waste waters

Not only rivers but lakes as well as polluted with waste waters, the majority of which consist of important reserve of fresh waters. The black sea is in hard ecological conditions. Such rivers Dunai, Dnepri, Doni, Rioni and others cause pollution of the Black Sea. These rivers take every day and industrial waste with the waters, which consist of various polluting substances. Because of pollution the Black Sea is under serious risk in the aspect of decrease of species. The main polluter of surface waters is waste waters, so ecologically elaboration of effective treatment methods of waste waters is the important objective.

The main sources of polluting surface waters are water-supply – sewerage sector, heating-energetics and manufacturing. According to the sectors the flow of polluted waste waters is divided into the following: water-supply-sewerage sector-344,1 million m^3/per year (67%) hearing-energetics- 163,8 million m^3/per year (31%); manufacturing - 9,6 million m^3/per year (2%). Hence, the basic pollutant of surface waters is communal sector (sewerage waist waters of cities and populated units) (Picture 2,3). According to the present conditions no water treatment plant is able to provide treatment of waist waters according to the project quality. Biological treatment of water does not happen in any cities. The first-hand mechanical treatment is made only at Tbilisi-Rustavi Regional Treatment Plant (Picture 4).

Picture 2 Sea water pollution by every-day waste waters

Picture 3 Green Cape, waste waters

Picture 4 The waste water of treatment plant

Because of diversity of waist waters various treatment methods are used: mechanical, physical-chemical, chemical, biological and others. The treatment may be carried using one of the combine methods.

During mechanical treatment, wringing out, sedimentation and filtration methods are used during which non-soluble and colloidal residuals are removed from waist waters. The method of wringing out is the first stage of treating waist waters, by which big fractions are omitted and removed. The wringing out takes place in lattices and in the tissue of fibrous threads.

The filtration method is used for removing small dispersive particles (Picture 5-6-7). The sedimentation method is based on precipitation of solid particles in liquid, which is made with the help of sand-catchers and precipitators.

Picture 5 Water filters

Picture 6 Water bio-filter

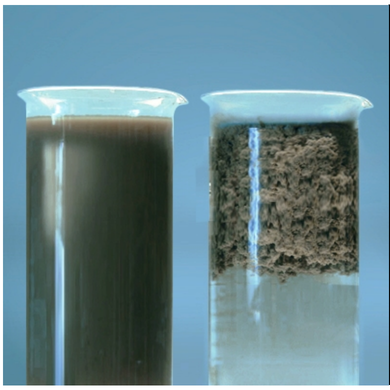
Picture 7 Water filtration

Treatment of waist waters from admixtures is made with physical-chemical methods, in particular: with coagulation, flocculation, flotation, extraction, sorption, neutralization, thermal treatment and ozonizing (Picture 8-9-10-11-12-13-14). Aluminum, plumbum, magnesium salts and other industrial residuals are used as coagulants. Flotation is molecular glueing of particles at omission phases surface. Thermal method which takes place at $100°C$ or under vacuum is used in waist waters for increasing the concentration of salts or for treatment of small amount of high concentrative waist waters. For full treatment of already treated waist waters from bacteria, they are disinfected and after this the waters are drawn in water reservoirs (Picture 15,16).

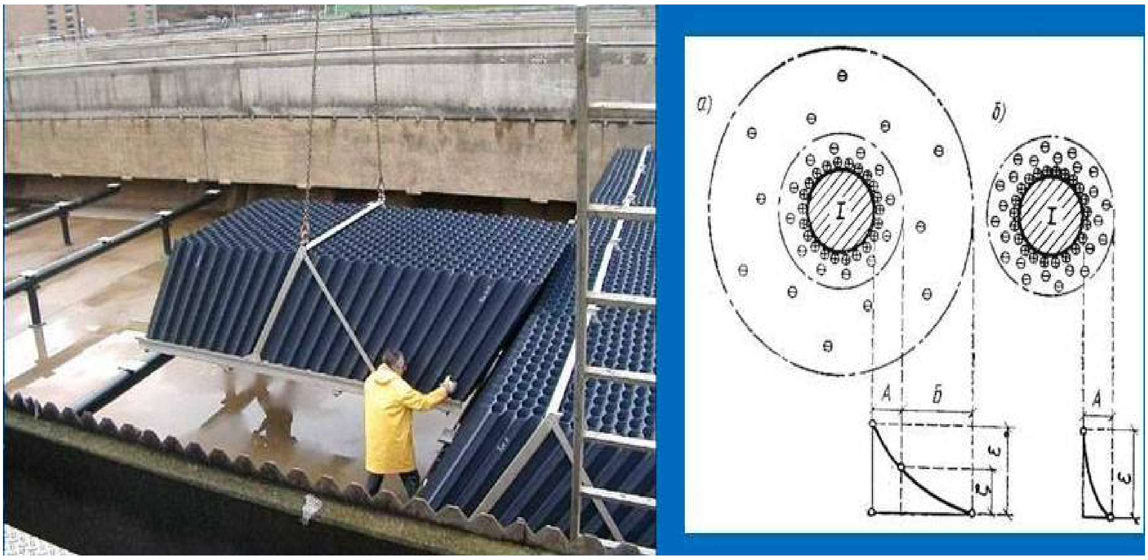
Classical biological-ecological expertise of waters is made via determination method of biochemical oxygen demand. This is the size of amount of nutritious substances for heterotrophic micro-organisms and life conditions for supreme organisms. Parameter of treatment quality implies the amount of water used by one person or the day-night consumption norm. During this time those organic substances are foreseen which happen in waist waters every day. This latter, should not exceed 180 grams per one person. So, total pollution of water with organic substances is evaluated by the spent oxygen which is used by micro-organisms for dissolving (rusting) organic substances. For full rusting of 180 grams of organic mass $20°C$, during 5 days and nights, 60 grams of oxygen is needed. This amount of oxygen is determined as 5 days and nights usage of oxygen. It is expressed per mg O_2/1 l waist water. The consistency of it various in the limits of 97-280 mg O_2/l, for nutritious industry waist waters - more than 5000, mg O_2/l, for cattle-breeding farms waist waters (for urine and stinking mud) - 15300 mg O_2/l.

The water which has passed biological treatment includes nitrates and phosphates besides organic substances, which partly are received as a result of bio-degradation of organic admixtures. It is necessary to remove these admixtures as they activate plants growth process in the treating plant. Nitrogen and phosphorus activate eutrophication (enriching with nutritious products) of lakes and rivers. These admixtures are a serious problem in waist waters. While waste water treatment, nitrates can be transformed in free nitrogen in treatment plant, through the activity of denitrification bacteria. For initial stage nitrogen of organic substances NH_4^+ -removes in the form of ion and then through denitrification (dissolving) bacteria in anaerobic conditions in molecular nitrogen - $N_2 \uparrow$.

Picture 8 Flotation
Picture 9 Flotation device



Picture 10 Water treatment with coagulation **Picture 11** Extraction



Picture 12 Water flocculation

Picture 13 Water ozonizing in pool

Picture 14 Ozonizators

Picture 15 Construction of sewerage treatment plant in Batumi

Picture 16 Adlia wastewater treatment plant

I.7 Legislative Acts of Georgian Government about Technical Regulation of Water-protection Lines of Rivers

In surface waters facilities determination and approving of technical regulation is necessary for these units which carry chemical-ecological expertise activities and herewith they carry flowing the industrial, agricultural – everyday, waist and sewerage waist waters as well as melioration systems waters. Each water user tries to agree the maximal permissible norms to authorized representative of The Ministry of Environmental Protection and natural Resources Protection of Georgia. The background concentration of substances in water facilities is the parameter, which reflects the existing conditions in water facility before the influence of water user.

The maximum permissible concentration norms of certain substances or elements in water facilities are set according to existing background concentration, their assimilation ability and category of water facility. The purposes for preventing surface waters pollution are: maximal protection of natural qualities of water and the environment depended on it; reduction of water pollution level for the purpose of protection health of population; protection of water eco-system; providing industry and agriculture with the proper water quality.

The basic principles for preventing surface water's pollution and fighting with it:

- Norm-setting for water;
- Regulation of flowing polluting substances in surface waters;
- Regulation of economic activity of a human, which with his / her activities makes influence on water conditions;
- Planning water-protection measures;
- Monitoring of surface waters;
- Responsibility for violation of water-protection requirements.

Meeting technical regulation requirements of surface waters is statutory: a) for all acting subjects whose activities make influence on water conditions; b) for project and scientific-research organizations; c) state and private enterprises and organizations.

Norm-setting for surface waters qualities means setting the water concentration parameters and qualities which will securely provide population health and positive ecological status of water facilities. Water consumption categories are: drinking-economic water-consumption, agricultural-every day water-consumption; fish-farming water-consumption. In case, when one water facility is used for various water-consumption at the same time, the strictest requirements are to be set against water concentration and quality. Therefore, special requirements are set against water quality of unique water facilities, which represent ecological, scientific, historical and cultural values.

In surface water facilities, flowing the waste waters which consist of various reagents, industrial residuals, products in the white, soil erosion products, pesticides, mineral fertilizers, every-day residuals and other substances is forbidden. It is not permitted to wash vehicles at water facilities and the alongside territories of their coasts, water pollution form oil-producing facilities as well as flowing sewerage waters from sewerage network of populated units of the city without treatment plants. Especially dangerous substances ecologically in surface waters are: phosphorus-organic admixtures, cadmium, plumbum, mercury and admixtures of them, benzol, simazin, cianides, oils and hydrocarbons of oil origin. Radioactive substances and residuals.

The control of water is carried by the water user himself/herself (self-control) and the state control is carried by state sub-division authority – Environmental Supervision Department. State monitoring of surface waters is carried by LEPL "National Agency of Environment" under the Ministry of Environment and Natural Resources Protection of Georgia. The responsibility for violation of general requirements of Regulation of Surface Waters is set under Georgian legislation (Table 5).

The rivers the length of which from source to tributary does not exceed 75 km belong to category of small rivers of Georgia. For maintaining purity of small rivers their water-protection lines (zones) are allocated. The territory alongside the river is considered to be water-protection line, where special regime is set to protect water resources from pollution, dirt and drying up. The width of water-protection lines of small rivers is calculated from the edge of river-bed to both sides, as follows: a) for river with 25 km length water protection line equals to 10 m; b) for river with 50 km length water protection line equals to 20 m; c) for river with 75 km length water protection line equals to 30 m.

In water protection line of small rivers it is forbidden to construct: construction of manufacturing, transportation, construction, communal and other kinds of facilities; construction of various buildings; spraying with pesticides the perennial plants, crops and forest lands; storage – collection of agricultural and industrial residuals, storage and burying them; Usage chemical and biological preparations for fish farming violating the set norms; cutting the forest and other woods and plants excluding special cases (diseases, drying out) according to the rules set under the laws; carrying explosion works in river-bed; finding inert material and other minerals excluding the cases set under Georgian laws; flowing the used waters causing infectious diseases and consisting of micro-organisms.

Table 5

General requirements about water consistency in water reservoirs and water substances regulation according to water consumption categories

<table>
<tr><th></th><th colspan="4">Water-consumption category</th></tr>
<tr><th rowspan="2">indicators</th><th rowspan="2">for drinking-agricultural purposes of population</th><th rowspan="2">for agricultural-every day purposes</th><th colspan="2">for fish-farming</th></tr>
<tr><th>higher and first category</th><th>second category</th></tr>
<tr><td rowspan="4">suspended particles</td><td colspan="4">the increase of consistency of suspended particles is permitted not more than:</td></tr>
<tr><td>0,25 mg/l</td><td>0,75 mg/l</td><td>0,25 mg/l</td><td>0,75 mg/l</td></tr>
<tr><td colspan="4">for rivers which during low water level Consist if 30 mg/l natural suspended particles, their increase is permitted in the limits of 5%.</td></tr>
<tr><td colspan="3">In case if waste waters consist of suspended particles, the sedimentation speed of which exceeds 0,2 mm/per second, their flow is forbidden in water reservoirs (lakes), and in case if this parameter exceeds 0,4 mm/ per second – in rivers (channels)</td><td></td></tr>
<tr><td>floating materials</td><td colspan="4">at water surface no oil products, oils and fats films must be noted as well as other admixtures</td></tr>
<tr><td rowspan="2">colour</td><td colspan="2">must not be noted at water column</td><td colspan="2">the water should not receive strange colour</td></tr>
<tr><td>20 sm</td><td>10 sm</td><td colspan="2"></td></tr>
<tr><td rowspan="2">smell, taste</td><td colspan="2">the water must not receive taste and smell more than 1 point</td><td colspan="2">The water should not give the fish product strange smell and taste,</td></tr>
<tr><td>directly after the further chlorides or other kind of treatment</td><td>directly</td><td colspan="2"></td></tr>
</table>

temperature	summer water temperature after flowing waste waters must not increase up to 30^0C compared to average monthly temperature of the hottest month during last 10 years.		The water temperature must no increase up to 5^0C compared to natural temperature of water reservoir. Herewith, at water facilities, where cold water loving fishes are residing (salmons and coregonuses) maximal permissible temperature is 20^0C in summer and 5^0C in winter and in the rest water facilities 28^0C in summer and 8^0C in winter	
reaction （*pH*）	must not exceed 6,8-8,5			
water mineralization	not more than 1000 mg/l, including: chlorides – 350 mg/l， sulphates – 500 mg/l	norm-setting is made according to above-stated parameter “taste”	norm-setting is made according to taxation of fish-farming water facilities	
water soluble oxygen	any period of the year it should not be less:			
	4 mg/l	4 mg/l	6 mg/l	6 mg/l
biochemical oxygen demand BOD_5	At $20°C$ temperature it should not exceed:			
	3 mg/l	6 mg/l	3 mg/l	6 mg/l
chemical oxygen demand	must not exceed:			
	15 mg/l	30 mg/l	**-**	**-**
Disease causing	the water must not include the substances causing diseases as well as viable helminthes eggs, damp onco-spheres and the simplest cysts of viable pathogenic intestines			
Lactose-positive intestine Escherichia colis not more than:	10000/per liter	5000/per liter	_	_

The laboratory observation is carried by appropriate services under The Ministry of Environment and Natural Resources Protection of Georgia to provide proper qualitative conditions of small rivers and their tributaries. The requirements for protection of waters from pollution are included in state standards and departmental normative documents. The state control on protection of hygienic rules and norms of surface waters is carried by the Sanitary Supervision Service under The Ministry of Health and Social Protection of Georgia. The Sanitary rules and norms for protection of surface waters from pollution cover all water facilities acting in the territory of Georgia which is used and is intended to be used by the population for various means.

Norms of surface waters are set for each category of water usage, in particular:

First category covers water facilities which are used as the source of centralized drinking-agricultural purposes and for water supply of nutritious industry facilities;

Second category covers water facilities which are used cultural-every day purposes of population. The pollution sources of water facilities of both categories are set by State Sanitary Supervision Service (Table 6).

Table 6

Hygienic classification of water facilities according to pollution quality

Pollution quality	**pollution evaluation parameterfor I and II category water facilities**				
	organoleptic	hygienic regime			pollution index
	smell, taste (in points)	BOD_5 mg/l		soluble oxygen mg/l	
		I	II		
permissible	2	3	6	4	0
average	3	6	8	3	1
high	4	8	10	2	2
especially high	> 4	> 8	> 10	1	3

For each polluting substance maximal permissible concentration is set, while flowing waste waters in surface waters which set water quality protection, according to hygienic rules and norms of water protection. Water users are obliged to provide systematic laboratory control on treatment plant operation, water quality, up to waste waters flowing area and nearest areas to water-usage by the population (in water-protection lines of surface waters).While deteriorating water qualitative parameters of facilities near at surface waters, as well as during emergency situations the water users are obliged to send notice to the State Hygienic Supervision Service as soon as possible. The grounded examinations of maximal permissible concentration of substances are carried according to the methodical instructions and methodical recommendation with the help of which the volume and direction of works to be performed are determined.

Volume II. EXPERIMENTAL PART

II.1 Research Goal, Object, Objectives. Methods of Conducting Research

The plans for water protection measures, as well as project materials of construction objects having influence at chemical consistency of surface waters must be submitted at state-ecological expertise, the rule of carrying which is identified by the Ministry of Environmental and Nature Protection of Georgia. Surface waters monitoring program is approved totally in the limits of Georgia and is carried by the Ministry of Environmental and Nature Protection of Georgia as well as according to the Resolution of Georgian Government about approving Surface Waters Technical Regulation.

Coming out from the above-mentioned, it is vivid how important it is to carry periodic research on organoleptic, physical-chemical microbiological and toxicological parameters of surface waters which gives the possibility to carry monitoring and identify quality of waters for the purpose of providing every day and hygienic safety of population. Determination of chemical consistency of surface waters and identification of maximal permissible concentrations of polluting substances is necessary for the subject carrying expertise activities. Maximal Permissible concentration (MPC) is identified at each parameter taking into account background concentration. Background concentration reflects the water conditions before the influence of a water user. Maximal permissible concentration is a maximal concentration during which the certain substance does not make any direct or indirect influence at health of population or does not worsen hygienic conditions of water consumption.

River water conditions is very complex and changeable, it depends at the peculiarity of water as a dissolvent as well as at soil type, at chemical and biological processes in river basin, at the character of human activity and at climatic factors of that certain area where the river flows.

Foreseeing direct and indirect influence of rivers' waters at the health of our country's population, at hygienic conditions of water consumption, at development of various fields of public economy and at cultural every day goals of a human we have made a goal to carry chemical – expertize research at some small and big rivers of Adjara Black Sea Coastline in order to provide comparative characterization of waters pollution quality, foreseeing seasonal changes dynamics of their basic physical-chemical parameters.

In Adjara territory from the source of river Tchorokhi to the north direction many rivers and their tributaries join The Black Sea. ***The subjects of our research*** are the following rivers: Adjaristskhali, Tchorokhi, Chakvistskhali, Khorolistskhali, Kintrishi, Choloki, Mejinistskhali, Bartskhana, Kubastskhali, Jotchostskhali, Kapreshumistskhali, Periistskhali. The research subject was some everyday, economy and industrial enterprises as well located in the territoris of Batumi, Kobuleti, Adlia, Kvariati, Khelvachauri and Urekhi. The waste waters of which flow in the Black sea. Waste waters coming out from Batumi Oil Treating Central Plant, Batumi Oil Temrinals and from various carwashes of Batumi; waste waters flowing in rivers – Tchorokhi, Kubastskhali, Bartskhana, Khorolistskhali, Mejinistskhali, and Chakvistskhali.

Research objectives were:

I. Determination of the following parameters in the waters of above-stated rivers:

1. From organoleptic parameters: a) smell; b) colour; c) transparency;
2. From physical-chemical parameters: a) temperature; b) pH; c) suspended particles; d) dry residuals; e) oxygen soluble in water; f) biochemical oxygen demand during 5 days and nights (BOD_5); g) permanganate rustiness; h) chlorides and sulphates; i) nitrates and nitrites; ammonium nitrogen; j) phosphates; k) general rigidity; l) dry residual.
3. From toxic elements – plumbum, copper, zinc.

II. To carry comparative research of rivers' waters for the purpose of identification of pollution quality;

III. To carry research of the above-stated parameters in rivers' waters for the purpose of studying their seasonal dynamics.

IV. To carry chemical-ecological expertise researches of waste waters coming out from every day, economy and industrial facilities/ objects for the purpose of identification their pollution quality of Adjara Black Sea Coastline.

Research Methods

It is necessary to take samples for carrying analysis at any kinds of water in order to examine the water quality for discovering any kinds of changes in it. The sample is taken according to the norms of normative document (State Standard 24481-80) under state standard. The water sample is taken in chemically pure vessel which has scrubbed cork. The vessel is poured with analysis water twice before pouring the sample in it, then it is fully filled with water and cork is tightly closed. As soon as water sample is taken organoleptic parameters of it are examined. Identification of the mentioned parameters mostly is made at the place of taking the sample as after some time passes they change in water. While transporting the samples, the vessels must be placed in package in order to prevent their pollution, damage or unnecessary shake.

For the purpose of determination of organoleptic parameters the basic method of storing and conservation of water samples is refrigeration up to 2-5°C and storing in dark place. Maximal recommended dates of storage are as follows: for determination of smell – 6 hours; for determination of colour – 24 hours, for determination of turbidity – 24 hours; the temperature must be determined at the place. While taking the samples the vessel made of such substances which cannot come into reaction with the taken sample. The vessel must be dark in order to avoid negative impact of the light with the admixtures consisting in water.

After placing water of analysis in the vessel, the sample must be made a liable in which the following must be indicated: sample number, sample description, time and place of taking the sample, climatic conditions of environment, the identity of person taking the sample, sample storage and conservation method, Research goal.

The water samples at rivers and springs are taken from the surface at the 20-30 cm depth in some points and the following conditions must be foreseen: the samples at river waters must be taken in various parts and depths; it is desirable to take water samples periodically or seasonally as it is possible to make complete description /view about certain reservoirs and their water quality when the samples are taken 4 times per year (Spring, Summer, Autumn, Winter).

All the procedures of taking the samples must be strictly documented and all the records must be vivid in order to make it simple identification of sample delivered to the laboratory and carrying further analysis on it. When a sample is stored during two-three days it is necessary to make conservation of it by adding 0,5 ml chloroform per each 300 ml sample.

For carrying chemical-expertise examination on rivers selected by us as analysis subject we took samples seasonally. While carrying each type of analysis we were carrying three parallel experiments by the simple arithmetic of results of which average result was achieved in case if permissible deviation among parallel experiments does not exceed 0,02%.

Organoleptic Indicators

In the samples of rivers' waters take for analysis by us smell, colour and transparency was determined from organoleptic parameters according to State Standard 3351-74.

Smell – at the very beginning as soon as he sample was taken we were determining the smell by smelling with 0-5 scale system (Table 7).

Table 7

Water Smell Intensity and Revealing Nature of It

Smell Intensity	*Smell Revealing Nature*	*Smell Intensity in Points*
No	Smell is not noticed	0
Strongly Poor	Customer cannot feel the smell, but the smell is noted during laboratory examination	1
Poor	Customer can feel the smell weakly	2
Noticeable	Smell is felt simply and causes undesirable talks about the water	3
Sharp	The smell attracts the attention vividly	4
Strong	the smell is so strong that the water is un-useful for usage	5

Colour – for determination of water colour we were pouring water in transparent cylinder or in a glass and observing it at day scattering light. We were characterizing water colour quality according to state standard with the following terminology: colourless, poor yellowish, yellowish, green, greenish, greenish-yellowish.

Transparency. We were determining water transparency via using smooth metallic disc. The disc was covered with oil white paint. We were attaching disc in water for measuring until it disappeared from the visible area. Then we were putting out the disc until it became visible. Average size of water depth at the boarder of disappearing and appearing of disc from the visible area was the conditional size of water transparency which is transformed into centimetres (Table 8).

Table 8

Separation of Surface Waters According to Quality of Transparency

#	*Water Transparency in cm*	*Quality of Transparency*
1	> 30	Transparent
2	25-30	Weakly turbid
3	20-25	Averagely Turbid
4	10-20	Turbid
5	< 10	Strongly Turbid

Physical – chemical Parameters

In water samples taken for analysis the following was determined from physical-chemical parameters: temperature, *pH*, suspended particles, dry residual, general rigidity, soluble oxygen, biochemical oxygen demand (BOD_5), permanganate rustiness, nitrates, nitrites, chlorides, sulphates, ammonium, phosphates, sulphides, toxic elements.

The water temperature is the most important factor which makes influence at physical-chemical and biological processes of the river. The water rustiness mode depends at water temperature and the intensity of self-treating processes. Usually water heating in water reservoirs takes place upside-down. In the water reservoirs where there is pollution with waste waters, the increase of water temperature is prohibited above +5°C compared to the natural conditions of it.

pH - is negative decimal logarithm of hydrogen-ion concentration: $pH = -\lg[H^+]$. concentration of hydrogen-ions, so *pH* size in natural waters is stipulated by the correlation of carbonic acid molecules and their ions:

$$CO_2 + H_2O \Leftrightarrow H^+ + HCO_3^- \Leftrightarrow 2H^+ + CO_3^{2-}$$

For surface waters which consist of insignificant amount of CO_2 alkali reaction is typical so *pH* >7.

pH also depends at the process of photo-synthesis s during this time the amount of H_2CO_3 is decreased and *pH* is increased. The source of *pH* is humus acid and hydrolysis of salts which causes water acidity.

In analysis waters *pH* was determined as soon as the sample was taken at the laboratory as this parameter changes in time most rapidly. The water *pH* was determined via Digital *pH* -Meter DpH-2. The mentioned *pH* -meter provides automate calibration of working temperature (20-25°C), selection of buffer solutions (*pH* 4,00; 7,00; 10,00) and determination of fixed result. The pH-meter determines pH from 0 to 14 in interval, the accuracy of apparatus equals to ±*0,2 pH*. Classification of natural waters according to *pH* is represented in Table 9.

Table 9

Classification of Natural Waters according to *pH*

Strongly acid waters	<3	Results of Hydrolysis of salts of heavy metals (waters of mines and ores)
Acid waters	3-5	Carbonic acid, Fulvic acid and other organic acids as a result of dismantling organic admixtures
Lightly acid waters	5-6,5	Humus acids happen in waters from soils and peats (mostly forest zone waters)
Natural waters	6,5-7,5	There is $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$ in waters.
Lightly alkali waters	7,5-8,5	” ——— “
Alkali waters	8,5-9,5	There is Na_2CO_3 or $NaHCO_3$ in waters.
Strongly alkali waters	>9,5	” ——— “

<u>**Suspended Particles.**</u> Suspended particles are called solid substances which are removed from the water during filtration or centrifugation and they are determined with the further drying. Suspended particles existing in natural waters consist of clay, sand, silt, microorganisms and particles of organic and non-organic admixtures. The concentration of suspended particles is connected to season factor as well as river water falling mode and anthropogenic factors.

The water in which there are many suspended particles is not useful for usage in aesthetic aspect as well as it is not useful for everyday and drinking reasons.

The method principle situates in filtration of analysis 250 ml water samples in vacuum device in the filter paper taken to constant weight, under high pressure. We were drying the filter in thermostat at 105°C and we took it up to constant weight.

The suspended particles were calculated as follows:

$$X = \frac{m_2 - m_1 \cdot 1000}{V} \cdot 1000,$$ where:

m_2 – is dried filter paper weight after the filtration;

m_1 - is filter paper weight taken to constant weight;

V - volume of water analysis in ml.

Dry residual. Dry residual is general amount of water soluble mineral and partly non-volatile organic admixtures, which is not diluted at 105°C. Therefore, dry residual is general amount of water soluble substances.

We were determining dry residual in river waters according to State Standard 18164-72. Duration of analysis: we were pouring 250 ml filtered water in dry and porcelain vessel taken to constant weight after which we were evaporating the water at water bath until dry residual is received. Afterwards we were placing porcelain vessel with dry residual in thermostat at 105°C and dried it by taking it to the constant weight. We were calculating dry residual in water samples with the following formula:

$$X = \frac{(g - g_1) \cdot 1000 \cdot 1000}{V},$$ where:

g - is mass of porcelain vessel with dry residual, mg;

g_1 - is mass of porcelain vessel taken to the constant weight, mg;

V - is water volume taken for analysis, ml.

According to dry residual or general mineralization classification of natural waters is represented in the Table 10.

Table 10

Categories of Natural Waters According to General Mineralization (Dry Residual Consistency)

#	*Water Category*	*Mineralization, g/l*
1	Strongly over-salted	> 35
2	Averagely over-salted	10-35
3	Salty	3-10
4	Saltish	1-3
5	Poorly mineralized	0,5-1
6	Fresh	0,2-0,5
7	Ultra-fresh	<0,2

Water soluble oxygen. The more is free oxygen consistency in water the more clean and sound is the quality of it. In natural river water oxygen is in the form of molecule. At the consistency of it the following makes influence: oxygen absorption from atmosphere; omission of oxygen by water-plants in the process of photosynthesis; happening of oxygen in water reservoirs via rainy or snowy waters which are full of oxygen. The speed of oxygen absorption from atmosphere in water is increased by the decrease of temperature, increase of pressure and decreasing the mineralization quality.

The supporting processes for decreasing oxygen in waters are: their omission from water in atmosphere; oxygen demand by bacteria and microorganisms in the rusting process of organic admixtures. In surface waters consistency of soluble oxygen varies from 0 to 14 mg/l and it experiences seasonal changes. In particular the maximal consistency of it is noted in winter when water temperature is minimal.

The consistency of soluble oxygen in surface waters must not be less than 4-6 mg/l. The classification of surface waters pollution according to the qualities is given in Table 11.

Table 11

Pollution level and Quality Class of Surface Waters

#	*Water Pollution Level and Quality Class*	*Soluble Oxygen, mg/l*		
		Summer	*Winter*	*Oxygen Saturation Quality, %*
1	Strongly Clean - I Class	9	14-13	95
2	Clean - II Class	8	12-11	80
3	Moderately polluted -III Class	7-6	10-9	70
4	Polluted - IV Class	5-4	8-5	60
5	Polluted - V Class	3-2	5-1	30
6	Strongly Polluted -VI Class	0	0	0

We were determining water soluble oxygen via classical volume idiometric method at Titrator KF 870 which was titring sample for analysis in automotive mode foreseeing sodium thiosulfate.

For determination of free oxygen we took analysis water with 55 ml bottle and fill it to the end so that no space is left between the water and the cork. Then we were adding 0,5 ml $MnCl_2$ and 0,5 ml $NaOH + KI$ mixture, we were shaking and storing it in dark place for sedimentation for 10-15 minutes. $Mn(OH)_2$ was received in the form of sediment as for surface layer there was transparent water. Afterwards we were adding 1 ml concentrated sulphuric acid for diluting $Mn(OH)_2$ sediment as a result of which yellow liquid was received which was the evidence of free iodine in water, which is equivalent to the existence of free oxygen soluble in water. We were adding 1% of at received liquid amylum 3-4 drops of flour- paste, after which the liquid took the blue colour. After this we were putting the bottle at magnetic mixer of automotive tetrameter and the liquid titration process was started via 0,01N $Na_2S_2O_3$ until the liquid for analysis decolorizes.

We were determining free oxygen soluble in water with the following formula:

$$X = \frac{a \cdot 0{,}08 \cdot 1000}{V - V_0},$$ where:

X - is consistency of free oxygen in water, mg/l;

a - is 0,01N $Na_2S_2O_3$ solution amount spent for titration;

0,08 - is indicator that each 1 ml 0,01N $Na_2S_2O_3$ solution is equal to 0,08 mg O_2;

1000 - is a coefficient for transferring from liter to milliliters;

V - is amount of water taken for analysis, ml (55 ml);

V_0 - is total amount of reagents added to water, ml (2 ml).

Biochemical Oxygen Demand (BOD$_5$). For determination of Biochemical Oxygen Demand we were storing one part of water during 5 days and nights at 20°C in incubator, during which biochemical rusting of organic admixtures took place in water. After the mentioned period passed we were determining amount of free oxygen via idiometric titration method. This is the oxygen which stays unused in vital activity process of aerobic microorganisms. Hence Biochemical Oxygen Demand$_5$ is the amount of oxygen which is necessary for rusting organic admixtures by micro-organisms in water until nitrification process is started. According to the difference between the primary consistency of free oxygen in water and oxygen amount after the incubation process we found indicator of Biochemical Oxygen Demand$_5$ during 5 days and nights which made an impression about the quality of water purity.

Permanganate rustiness. Permanganate rustiness is the rusting ability of organic substances in water. The organic substances exist in water with this or that amount. A big amount of organic substances is the indicator of water pollution as this time more oxygen is spent for rusting organic substances.

We were determining water rustiness according to State Standard 23268.12-78. Determination took place with potassium permanganate solution0,01N (*$KMnO_4$)*. Potassium permanganate in acid area emits free oxygen which is spent for rusting organic substance existing in water, therefore, according to amount of milliliters of 0,01N $KMnO_4$ solution, spent for titration, rustiness is calculated. The method principle situates in the fact that 0,01N $KMnO_4$ with the participation of sulfuric acid while water boiling rusts organic substances in water and it is transformed into Manganese Sulphate and by taking big amount of 0,01N $KMnO_4$ in water oxalic acid is restored; the titration of potassium permanganate is made via adding big amount of oxalic acid:

$$2KMnO_4 + 3H_2O_4 \rightarrow K_2SO_4 + 3H_2O + 50.$$
$$2KMnO_4 + 5C_2O_4H_2 + 3H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 10CO_2 + 8H_2O.$$

For carrying the analysis we were pouring 100 ml water sample in 250 ml conus vessel, adding to it 5 ml 1:3 mixed sulfuric acid and 20 ml of 0,01N $KMnO_4$ solution. We were putting the vessel at hot heater and the solution was boiling during 10 minutes. Afterwards we were getting the vessel off the fire and adding 20 ml of 0,01N oxalic acid solution to a hot solution $(H_2C_2O_4)$ and we were tiring the material in hot conditions with 0,01N $KMnO_4$ until light pink was received.

We were determining permanganate rustiness in water with the following formula:

$$X = \frac{[(A_1 + A_2)K - B] \cdot 0{,}01 \cdot 8 \cdot 1000}{V}, \text{ where:}$$

A_1 and A_2 - is the amount of $KMnO_4$, ml spent before and in the process of titration;
K - is $KMnO_4$ correlation coefficient;
B - is amount of oxalic acid solution, ml;
V - is water sample amount for determination, ml.

0,01N $KMnO_4$ for identifying the coreection coefficient we were adding 0,01N oxalic acid 20 ml in the same vessel after which the solution decolorized. After this we were titrating the solution with 0,01N $KMnO_4$ until receiving light reddish-pinkish colour and according to the $KMnO_4$ spent at titration process we were calculating the correction coefficient of its titre with the following formula:

$K = \frac{20}{a}$, where:

20 - is added 0,01N $H_2C_2O_4$ solution, ml;

a - is the amount of 0,01N $KMnO_4$ spent at titration, ml .

Nitrates. Existence of nitrates in natural waters is connected to nitrification process of ammonium ions in aerobic and oxygen conditions via influence of nitrification bacteria. In surface waters nitrates are with opened form. In clean surface waters concentration of nitrate ions does not exceed tenth microgram per liter (according to nitrogen calculation). In the other way nitrates and nitrites are called biogenic compounds the increase of which in water reservoirs indicates at their pollution level.

For preparing basic standard solution, we were weighting 0,7218 g KNO_3 we were drying it at 105^{0}C, dissolved it at distil water, we were adding to it 1 ml chloroform and we were taking it to 1 ml via distilled water. 1 ml of standard solution prepared this way consists of 0,1 mg NO_3^-.

For preparing standard working solution, we were mixing 10 m of basic standard solution in 100 ml of distilled water, 1 ml of such water of 0,01 mg NO^-_3.

For preparing whole series of standard solutions, we were putting 0,0; 0,5; 1,0; 2,0; 3,0; 4,0; 6,0 and 10,0 ml of standard working solution in 10 ml colorimetric vessels and we were taking to the marked line with distilled water. Nitrogen consistency of nitrates in these solutions equals to 0,0; 0,5; 1,0; 2,0; 3,0; 4,0; 6,0 and 10,0 mg/l. Afterwards we were moving it to the porcelain vessels, adding to Sodium solution 1 ml of salicylic acid and evaporating it at water bath. Optic solidity of colored solutions, we were determining via photo-colorimeter, using violet color filter, the length of light absorption wave $\lambda = 440$ nm, via 30 ml capacity ditches.

Nitrates. The method, principle is based on the ability of nitrites to make diazotization of sulfamic acid (NH_2SO_3H), as a result of which red paint is created - 1-Naphthylamine diazo compound ($C_{10}H_7NH_2$)

The color intensity is proportional to the consistency of nitrites in water, the concentration of which is determined per photo-colorimeter.

For preparation of basic standard solution, we were weighing 1,497 g $NaNO_2$ and dissolving it in 1 liter of distilled water. We were conserving the solution via adding 1 ml of chloroform. 1 ml of basic standard solution prepared this way consists of 1 mg NO_2^-. For working standard solution, we took 1 ml of basic standard solution and took it to 1 liter of distilled water. 1 ml of this solution consists of 0,001 mg NO_2^-. For preparation of series of standard solutions, we were putting 0; 0,1; 0,2; 0,5; 1,0; 2,0; 5,0; 10,0; 0,20 and 0,30 mg/l standard working solution in 50 ml measuring vessels and carrying photo-metering of them. Based on received results we were drawing calibration curves.

Chlorides. Chlorides are met in water often in the form of $NaCl$. The water enriches with chlorides from the soil. Increase of chlorides in water is caused by the fecal drainage of humans and animals: fecal drainage and urine, so increase of chlorides in water is permissible up to 350 mg. If chlorides are more than 500 mg per 1 litre, the water has bitter taste.

We were determining consistency of chlorides in samples of rivers' waters according to the rule of Moris, so via argentometric titration method:

$$NaCl + AgNO_3 \rightarrow AgCl \downarrow + NaNO_3$$

For analysis we took 100 ml analysis water, adding 1ml 10% K_2CrO_4 solution and we were titrating the sample wia constant shaking with 10% $AgNO_3$ solution until reddish-brick coloured is received.

We were calculating amount of chlorides in analysis water with the foloowing formula:

$$X = \frac{a \cdot 1000}{V},$$

where: a - is amount 10% $AgNO_3$ spent for titration, ml;

V - is water amount/volume taken for analysis, ml.

Sulfates. We were determining sulfates in analysis water via idiometric titration method for which we were pouring 100 ml analysis solution and adding 45 ml 0,1N $BaCl_2$ solution with energetic shaking. Afterwards, we were filtering the solution in 100 ml measuring vessel and collecting exactly 100 ml filtrates. We were transferring solution from measuring vessel into conical vessel for titration, adding to the solution 10% KI solution 10 ml and 5 ml concentrated KHI. We were locking the vessel and waiting for 10-15 minutes. After this we were titrating emitted iodine with 0,1N $Na_2S_2O_3$ solution until light yellow colour was received. as soon as the mentioned colour appeared we were adding 1 ml amylum solution and continuing titration until the blue colour is received.

The amount of sulfates in water was calculated according to the following formula:

$$X = \frac{a \cdot k \cdot 1000}{V},$$ where:

a -is amount of $Na_2S_2O_3$ spent for titration of analysis water, ml;

k - correction coefficient of $Na_2S_2O_3$;

V - volume / amount of analysis water, ml.

Setting 0,1N $Na_2S_2O_3$ Titre (Correlation coefficient): We were putting 10 ml 10% KI solution in conical wessel and mixing it wkth 50 ml distilled water. Then, we were adding to it 15 ml 0,1N $K_2Cr_2O_7$ and 10 ml mixed HCl (2:1) with measuring pipette. We were shaking the content of vessel and titrating with 0,1N $Na_2S_2O_3$ until yellow colour was received.

We were calculating correction coefficient with the following formula: $K = \frac{10}{a}$, where:

10- is amount of KI taken for analysis, ml;

a - is amount of 0,1N $Na_2S_2O_3$ spent for titration, ml.

Toxic Elements. We were determining plumbum and copper in samples of research water via atomic-absorption method at AAS 1N. the method is based on at water mineralization via dry and wet incineration method and determination of element concentration in mineralization solution. We were taking 250 ml of analysis water, transferring it into porcelain vessel and drying it at water bath until dry residual was received. Then we were adding 50 ml HCl slightly sour water (1:3) to dry residual and determining optic solidity of solution on atomic-absorption meter.

For preparation of Pb Basic Standard Solution, in which concentration of it is 0,1 mg/ml, we were weighting it 0,159 gr crystallized $Pb(NO_3)_2$, we were dissolving it in little distilled water, moving it into 1 litres measuring vessel, adding to it 5 ml concentrated HCl and we were filling the vessel up to the end with distilled water. From the basic plumbum solution we were preparing medium standard solution for which we were mixing the basic solution 10 times with 1% HCl. Finally, we were preparing series of medium standard solutions with increasing concentrations and we were determining their optical solidity at atomic absorptiometer at λ= 228,8 nm wave length.

For preparation of Cu Basic Standard Solution, in which concentration of Cu is 1 mg/l, we were weighting 3,929 gram crystilized alum $(CuSO_4 \cdot 5H_2O)$, we were dissolving it in little distilled water, moving it into 1 liter measuring vessel, adding to it 1 ml 1,84 g/cm^3 solidity H_2SO_4 and we were filling the vessel up to the end with the distileld water. Afterwards we were preparing medium standard solution via mixing basic solution 10 tmes with 1% of HNO_3. Finally we were preparing a series of medium standard solutions with increasing concentration and determining their optical solidity at atomic absorptiometer at λ= 324,8 nm wave length.

II.2 General description of Rivers in The Black Sea of Adjara Coastline and Their Ecological Conditions

Adjara is the oldest part of Georgia. It is located in the extreme south-west part of Georgia and mostly it occupies the south coast of the Black Sea of Georgia. Adjara is very reach in hydro resources. From the inside waters the rivers are worth mentioning, which belong to the type of mountainous rivers. In fact, there is no place where there is not several springs or streams. All of them are fresh and useful for drinking. Almost all the rivers flow in the black sea. Only river Kvabliani and the tributaries of it Dzindzisu and Beshumi's Water belong to the basin of Caspian Sea.

According to data of Adjara Hydro-meteorological Department there are 1564 small and big rivers in Adjara the length of which is more than 5 km. Their general length equals to approximately 8600 km. River Tchorokhi creates great chain of rivers. Tchorokhi flows over 20 km length in Adjara territory. The main tributary of it is river Adjaristskhali, the length of which is 90 km and the basin area is 1450 km^2. To its part river Adjaristskhali is joined by the rivers: Skhatistskhali, Chirukhistskhali, Tchvanistskhali, Akavreta and others. Herewith, it is worth mentioning Kintrishi, Chakvistskhali and Khorolistskhali which are not distinguished with their length but they are watery, because of plenty of precipitation. The module of their runoff waters exceeds 4-45 l/per second and at the slopes of coastline ridges it exceeds 80-90 l/per second. Adjara rivers have got rich source of hydro-energy.

The main catchment river of Adjara is Adjaristskhali with its tributaries. The rivers Kintrishi, Choloki, Chakvistskhali, Khorolistskhali join the Black Sea.

River Chorokhi. Is the biggest river with its length not only in Adjara but in whole west of Georgia. The length of it is 438 km. It originates from Turkey and at 7 km distance joins the Black Sea at south-west from Batumi. River Tchorokhi basin area is 22130 sq. km. Length is 438 km. It flows over 26 km in Village Maradidi in the territory of Georgia and flows into the Black Sea. The territories from River Tchorokhi source to the tributary are characterized with very different geographical physical conditions which makes great influence to hydrological regime of the river. During the snowmelt and in spring during big rains Tchorokhi characterizes with swellings and freshets. The first tributary of river Tchorokhi entering Georgia is Matchakhlistskhali. It originates from Turkey at Karchkhali slope. In the below flow the tributaries of river Tchorokhi are: Makhos Tskhali, Tcharnali, Jotchostskhali and Adjaristskhali (picture 17). In the coastline Adjara from river Tchorokhi tributary to the south of Georgia until Turkey boarder there are not met important rivers. There are some little streams.

Picture 17 Confluence of rivers Adjaristskali and Chorokhi

River Bartskhana originates from north-west slope of Akhalsheni. The length of it is 8,6, the area of catchment basin -16,9 sq. m, average annual expense – 1,3 m^3/ per second. The river has got tributaries – Akhalshenistskhali, Periistskhali and other small streams.

River Khorolistskhali originates from south-west slope of Mtirala ridge and its length is 13 km (Picture 18). the river joins The Black Sea at Tamar Settlement. Khorolistskhali provides drinking water for Batumi Population for a long time now. The important tributaries of it are Khalvashebistskhali, Lechistskhali and multiple of unnamed streams.

Picture 18 River Khorolistskhali

From the tributary of river Tchorokhi to the north direction multiple of big and small rivers join the Black Sea from which **Mejinistskhali** is worth mentioning, which originates from Kakhaberi lowland, flows over 9 km and joints the Black Sea between the airport and Batumi City. During Intensive rains th river is characterised with swelling.

River Chakvistskhali with its length and high water level is the third river in Adjara coastline (Picture 19). It originates from east of Terati mountain, Chakvi ridge west slope, at 1280 m height from the sea level and near at Chakvi it joins The Black Sea. The length of river is 21 km. the length of river from Khinostsjkhali source is 22 km, basin area is 170 sq.m. Chakvistskhali mostly is nourished by rains and underground waters which are many in the form of springs in the basin of it. Chakvistskhali has got many tributaries. The gorges of upper flow tributaries are covered with dense forest. From the tributaries of it Khalistavistskhali, and Saporchkhelas Tskhali are worth mentioning.

Picture 19 River Chakvistskhali

The main catchment rivers of Adjara is **Adjaristskhali** with its tributaries: Tchvanis tskhali, Akavreta, Chirukhis Tskhali, Skhalta, etc. Adjaristskhali is the biggest rivers in Adjara with its area and length. It is reasonably considered as one of the main arteries of Adjara. The area of its basin is 1540 sq. m. Length is 95 km, the river originates from Arsiani ridge west slopes at green lake areas, at 2379 meters high from the sea level. The annual expenses to the river source 52,5 m^3. It joins river Tchorokhi at river Adjaristskhali. It flows in narrow, in deep gorge, it has developed waterfalls in upper line, the river has multiple big and small tributaries, it widens at the tributary. The river nourishes with various springs and mostly with the rain waters. The river is characterized with swellings during all the period of the year. Adjaristskhali hydroelectric power plant is constructed at river Adjaristskhali.

River Kintrishi is the biggest rivers of Adjara Black Sea coastline (Picture 20). The area of its basin is 334 sq.m, length is 49 km. the river originates from Adjara-Guria Ridge near at Khino mountain, at 2599 meters high from the sea level and it joints the Black Sea near at village Kobuleti. Length is 45 km, area of basin is 291 sq.km. the river nourished with rain, underground and snow waters. The river is characterized with fluids in spring; it is well-watered even in Autumn, the river is not well-watered in winter and in summer. Average annual expenses at tributary - 17,3 m^3/per second. River Kintrishi takes in to the Sea 540 million m^3 water annually.

Picture 20 River Kintrishi

Besides, the above-stated rivers, many other rivers flow in Adjara Black Sea Coastline, from which some directly join the sea, such rivers are: Dekhva, Ochkhamuri, Mejinistskhali, Bartskhanistskhali and others, which with their hydrological regime are similar to the above described rivers. Adjara Rivers belong to the type of rivers which mostly are nourished by rain waters, but in highland areas the role of snowmelt waters and underground waters is big. These rivers are characterized by two maximums of the level – spring and autumn: in Spring - because of intensive snowmelt in mountains and in Autumn – because of rains. The minimum of Adjara rivers comes in summer. This time they are mostly nourished by underground waters which are flowing out like rich springs.

River Choloki – river in west of Georgia, the left tributary of river Natanebi (Picture 21). It originates from Meskheti Ridge North-West slope, at 803 m height. Length is 29,5 km, the area of basin is 159 km^2, the river is nourished by rain, underground and snowmelt waters. The river is characterized by fluids as a result of heavy rains during all the time of the year especially in autumn and winter. Average annual expenses at tributary – 9,5 m^3/per second. The river is crossed by Automobile Highway of Georgia. It is the boarder of Kobuleti and Ozurgeti municipalities.

Picture 21 River Choloki

River Matchakhlistskhali – originates from Turkey, at the south slope of Shavsheti Ridge, at 2285 meters height from sea level. It joins river Tchorokhi, in the right at river Matchakhlispiri. The length 37 km, basin area is – 369 sq. km. the river is nourished by rain, snowmelt and underground waters. The river is charachterized by fluids in spring, swellings – in autumn, the river is not well-watered in winter. Average annual expenses at river tributary – 20,8 m^3/per second.

River Merisi – originates from Shavsheti ridge north slope, at 2236 meters from the sea level. It joins River Adjaristskhali near at Keda. Length is – 19 km, the area of basin is – 134 sq. km. The river is nourished by rain, snowmelt and underground waters. The river is characterized by fluids in Spring, the river is not well-watered in summer and winter. Average annual expenses near at tributary is – 1,6 m^3 / per second.

River Kubastskhali - originates from mountainous System of Adjara-Guria, Length is – 5,4 km, area of catchment basin is – 7,2 sq. km, minimal expenses – 0,25 m^3 / per second, maximal expenses ~ 80-100 m^3 / per second.

River Tcharnali - river in Georgia, in Khelvachauri Municipality, Autonomous Republic of Adjara, the left tributary of river Tchorokhi. Length is – 12,3 km, the area of basin is - 25,3 sq. km. the river originates from North Slope of Ponto Ridge at 1142 meters height. The river is nourished by rain, snowmelt and underground waters. The river is characterized by fluids during all the time of the year, especially in Autumn, Average annual expenses at tributary is - 1,6 m^3 / per second.

The water is intensively polluted in rivers from industrial facilities, populated units and agricultural land plots (by the waste waters of pesticides and fertilizers). For this reason the water quality in almost all the facilities of surface waters is unreliable and in frequent cases it is not safe for human health and eco-systems as well. The water is a blood of a landscape. Natural waters are in inter-connection with the organisms, mountainous rocks, and atmosphere and therefore many chemical elements are migrated in water solutions in the form of ions, molecules and colloids.

Coming out from the goal of our activities, some chemical parameters of some big and small rivers waters of Adjara flowing in The Black Sea has been studied (Table 12, Table 13).

Table №12

Chemical Indicators of Waters of Adjara Big Rivers

Indicators / **Rivers**	**Tchorokhi**	**Adjaristskhali**	**Khorolistskhali**	**Choloki**	**Kintrishi**	**Chakvistkhali**
pH (MPC **6-9**)	8	9	8	6	8	8
Suspended Particles (MPC 0,25-0,75 mg/dm^3)	9	10	19	14	11	10
BOD_5 (MPC 3-6 mg/0_2/dm^3)	7	6	10	5	6	4
Ammonia, mg/dm^3 (MPC -2 mg/dm^3)	0,7	0,6	2,5	0,7	0,04	1
Nitrites (MPC -3,3 mg/dm^3)	0,06	0,04	0,3	0,02	0,06	0,1
Nitrates (MPC -45 mg/dm^3)	12	22	28	18	18	15
Ammonium (MPC - 2 mg/dm^3)	0,6	0,8	3,2	0,2	0,1	0,2
Phosphates (MPC -3,5 mg/dm^3)	1,2	2	2,6	3	3	30
Sulphide, mg/dm^3 (not permitted)	12	10	16	7	6	9
General Rigidity (MPC- 7 mg/dm^3)	6	5	6	4	4	4
Copper (MPC - 1 mg/dm^3)	0,07	0,08	0,08	0.07	0.07	0.06
Plumbum (MPC - 0,03 mg/dm^3)	*ND*	*ND*	*ND*	*ND*	*ND*	*ND*
Zinc (MPC - 3-5 mg/dm^3)	<0.02	<0,02	0.07	0,03	*ND*	*ND*

Table №13

Chemical Indicators of Waters of Adjara Small Rivers

Indicators / Rivers	Bartskhana	Mejinistskhali	Kubastskhali	Zedaghele
pH	8	8	7	8
Suspended Particles, mg/dm^3	18	8	12	8
BOD, $mg/0_2/dm^3$	8	3	8	5
Ammonia, mg/dm^3	0,8	*ND*	0,2	0,6
Nitrite, mg/dm^3	0,2	0,04	0,06	0,04
Nitrate, mg/dm^3	22	20	22	18
Ammonium, mg/dm^3	3	0,4	3	0,6
Phosphates, mg/dm^3	0,2	0,1	0,4	0,1
Sulfide, mg/dm^3	8	*ND*	6	*ND*
General Rigidity, mg/dm^3	6	4	5	3
Copper, mg/dm^3	1,5	*ND*	2,1	*ND*
Plumbum, mg/dm^3	*ND*	*ND*	*ND*	*ND*
Zinc, mg/dm^3	1,6	*ND*	1,7	*ND*

According to the received results, in the waters of all discussed rivers the consistency of nitrates are above maximal permissible concentration norm and the parameters of other rest parameters are in the limits of maximal permissible concentration norms. The poorest conditions are in rivers Khorolistskhali, Bartskhana and Kubastskhali, in the waters of which the mentioned parameters are beyond maximal permissible concentration norm. the dynamics of ammonium in Adjara rivers averagely equals to 0,013 mg/l. herewith, minimal consistency of it was fixed in the period from late autumn to mid of Spring, as for maximal consistency, it was fixed from the period - late spring until the first months of Autumn.

The state rivers join The Black Sea, herewith, rivers Khorolistskhali and Chakvistskhali are used for agricultural means, everyday life and fish-farmings, as a result of which polluted water jeopardizes the environment and human health as well. The ecological conditions of small rivers are worth attention as well. They are small part of hydrographical chain and they give 75% of annual waste waters.

II.3 Organoleptic and Physical-Chemical Indicators of Some Rivers in Khelvachauri Region

The character of Khelvachauri Municipality, as well as the character of totally inside waters of Adjara, including rivers, is stipulated by complex geological structure, relief and peculiarities of climate. Subtropical character and nature of Khelvachauri Municipality climate is stipulated by geographical location and the proximity to the Black Sea. The above-stated conditions makes influence at the rapidity, speed, and annual energy and of course at chemical consistency of waters. In Khelvachauri mostly the rivers of mountainous type are met. Because of hard separation of relief, the length of rivers is short and the area of basin they occupy is small. No river of municipality is originated from constant glacier or snowy territories. They are mostly nourished by underground, rain and snowmelt waters for this reason they are characterized by fluids in Spring and Autumn. In some parts the rivers flow in narrow and deep gorges, they create rapids and waterfalls. All the rivers which exist in the territory of Khelvachauri Municipality flow into the Black Sea. From the tributary of river Tchorokhi to the north direction multiple of rivers join the Black Sea and their tributaries as well, from which the following are worth mentioning: Mejinistskhali, Bartskhana, horolistskhali,, Chakvistskhali, Kapreshumistkhali, Jotchostskhali, Periistskhali, etc.

The consistency of river water is very complex and changeable, it depends on the peculiarity of water as a dissolvent, as well as on the soil type, on chemical and biological processes existing in the river basin, type of activity and climatic conditions of that certain area where the river flows. Taking into account direct and indirect influence of rivers' waters on the health of our country's population, on hygienic conditions of water consumption, development of various fields of public economy, as well as on cultural- everyday goals of a human, we aimed to carry physical-expertise research, at some small rivers of Khelvachauri Municipality, in order to provide comparative description of pollution quality of the mentioned rivers' waters, foreseeing seasonal changes of dynamics of their basic physical-chemical parameters.

Research subjects are the following rivers: Mejinistskhali, Jotchostskhali, Kapreshumistskhali, Periistskhali which belong to Khelvachauri Municipality and they belong to the second category of water consumption.

River Mejinistkhali originates from Kakhaberi lowland, the length of it is 9 km and it joins the Black Sea between the Airport and Batumi city.

River Jotchostskhali is the right tributary of river Tchorokhi, it is located in Sharabidzeebi community, at 160 m height above sea level and it is at 15 km's distance from Batumi, the length of it is 6 km.

River Periistskhali is 2,5 km's length, it is the tributary of river Bartskhana.

River Kapreshumistskhali is 2,8 km's length. it is the tributary of river Khorolistskhali. Water protection lines of all four rivers are densely populated in the most of their territories. In the samples of rivers'' waters totally 32 samples have been taken for carrying chemical-expertise research (8-8 samples per each season).

Sample N 1. River Jotchostskhali. Near at headwater. It is at 3 km's distance from village Upper Jotcho. The territory is almost unpopulated. The relief is hilly-tuberous, Kolkhetian forests is the plant coverage of the area.

Sample N 2. River Jotchostskhali. Near at pullution source. The samples have been taken nearby village Erge territories, under the central bridge, where Beer Bar and Gulf Petrol Station were located. The water was polluted by everyday residuals.

Sample N 3. River Mejinistskhali, near at headwater. The samples were taken at 1 km's distance from village Sharabidzeebi.

Sample N 4. River Mejinistskhali, near at pollution source. The samples were taken at village Mejinistskhali, under central bridge alongside of which there was located car-wash station. Sewage, washing and other kinds of waste waters were pouring from collector directly in the river.

Sample N 5. River Kapreshumistskhali near at headwater, the samples were taken at 1 km's distance from Zeda Kapreshumi. The relief is hilly – tuberous, almost unpopulated.

Sample N 6. River Kapreshumistskhali near at pollution source. The samples were taken from village Kapreshumi center. The water was polluted by every day and construction residuals and the sewage waters were directly flowing into the river. The territory is densely populated.

Sample N 7. River Periistskhali, near at headwater, the samples were taken at 3km's distance from Peria Center, Relief is hilly – tuberous, it is almost unpopulated. Landscape – is sparce forest.

Sample N 8. River Periistskhali, near at pollution source. The samples were taken from Peria Center near at main road. The nearby territory is densely populated. The rivers' water was polluted by everyday residuals, the sewage waters were flowing in the river's water directly.

In the water samples taken by us, organoleptic indicators were determined according to the state standard 3351-74. The mentioned indicators were determined seasonally and we were comparing them to each river between the samples taken from two points of the river. (near at source and near at pollution source).

The alarming conditions according to the smell was detected in Mejinistskhali and Periistskhali sampled which have been taken near at pollution source. The pollution source in Mejinistskhali is car-wash station, the washing waste waters coming out from car-wash station were flowing from collector into the river directly as well as pollution source is every day residuals. In Periistskhali the pollution source was considered the proximity to the central main road for the purpose of which the water was vividly polluted by every day and other kinds of waste.

The degree of water smell in the mentioned sampled (№4, № 8) equalled to 3-4 points, so the pollution quality was varying in the limits of the "moderate" to "high".

According to the seasonal dynamics the increase of smell was noted in all the samples in summer period by 1-2 points compared to the other seasons which is connected to importance temperature increase in summer and decrease of atmospheric precipitation.

Contrast difference according to the smell was obvious between the samples taken from the source of rivers and from the pollution sources. The smell was not felt only at the source of River Jotchoskshali – 0 points at all four seasons (Table 14).

During all the seasons the samples taken from river Jotchostskhali source was colorless (Table 15). The samples taken from river Mejinistskhali and Periistskhali pollution sources, especially in Summer and Autumn seasons (from greenish- yellowish – to dark green) were distinguished by non-typical color for surface waters.

Transparency or light capacity in natural waters is stipulated by their color and turbidity. The rough dispersive particle in water causes its pollution and therefore, decrease of their transparency. According to the transparency data it was identified that in samples taken near at river sources Jotchostskhali as distinguished by the best quality of transparency - 50-60cm. River Kapreshumistskhali was lagging behind with this parameter to Jotchostskhali and therefore the indicator was - 40-50 cm. next was Periistskhali with – 35-45 cm and finally Mejinistskhali with – 30-35cm.

In samples near at pollution sources the following regulation was fixed, River Jotchostskhali was distinguished with maximal transparency, Periistskhaliw as averagely turbid and Mejinistskhali was turbid.

The water transparency was high in all the samples in winter season compared to the summer season (Table 16).

As soon as samples were taken from rivers'' waters we were determining the temperature via thermometer (Scale from 10°C to 35°C). According to the analysis of temperature analysis it was identified that minimal temperature at all four seasons was fixed at river Jotchostskhali near at source, in particular, from +2°C to +10°C, maximal temperature was fixed in Mejinistskhali – near at pollution source +26°C (Table 17). According to general regulated requirements for the second category facilities of water consumption maximal permissible temperature in summer is from +20°C to + 28°C and in winter from +5°C to +8°C.

It is noteworthy that in Summer in Mejinistskhali and Periistskhali near at pollution sources (Sample № 4, № 8), increase of temperature by +6-7°C is noted as a result of happening waster waters in rivers compared to the samples taken at the sources of same rivers natural temperature which is not permissible according to the regulated norms.

Seasonal research of temperature dynamics showed that rivers' waters temperature in June from+8°C to +17°C was exceeding temperature in December.

According to our experimental data it was identified that the pH of all research rivers' waters was less in winter compared to Summer season (Table 18). It is caused by the fact that in winter as a result of increase of temperature, the solubility of airs in water is significantly enhanced. And the concentration of hydrogen-ions or the importance of pH in natural waters is stipulated by the correlation of carbon-dioxide molecules and its ions. In winter season by the decrease of temperature in river water solubility of CO_2 is increased, according to this H_2CO_3 concentration is increased which to its part causes pH decrease.

pH of waters near to rivers'' sources is neutral at all the seasons which is the indicator of their purity as for pH near at pollution sources pH is deviated from neutral area to the waters of all samples.

As for river Mejinistskhali pH of it near at pollution source is in the limits of regulated norms, in particular, it varies from poor alkali to alkali area (pH 7,7 – 9,0) as for Periistskhali pH is Poor acid – pH 5,6-6,5.

According to the general requirements of water consistency and substances in water reservoirs increase of suspended particles is permissible in the limits of 5%, compared to their natural consistency, or background (Clean samples). In this case, clean samples are considered the samples taken at rivers' sources. In waters of all four rivers near at pollution sources the consistency of suspended particles exceeded 5%'s increase compared to samples taken at river sources (natural consistency) (Table 19).

The seasonal dynamics research showed that in winter season the consistency of suspended particles was more compared to other seasons. It is stipulated by happening large amount of remain material in rivers. The samples taken near at pollution sources were sharply distinguished from the samples taken near at rivers' sources with this parameter as the increase of suspended particles in waters was obvious by the pollution reason.

The consistency of dry residual in the waters of all four rivers was maximal in winter. According to this parameter sharp difference was fixed between the samples taken at rivers'' sources and pollution sources. It is noteworthy that in waters of all four rivers the mentioned parameter is in the limits of regulated norm – not more than 1000 mg/l (Table 20).

In surface waters the consistency of oxygen varies in wide interval up to 0-14 mg/l. it subordinates seasonal and day-night changes. Seasonal changes depend at intensity of their consumption processes. The lack of soluble oxygen most frequently is noted in the water facilities where high concentration of polluting organic admixtures are fixed, as well as great number of biogenic admixtures and humus substances. The minimal consistency of soluble oxygen which is necessary for normal vital activity of live organisms equals to 5 mg O_2/l, the decrease of it 2 mg /l causes massive death of live organisms.

Oxidation-restoration potential in waters depend on soluble oxygen concentration as well as speed of chemical and biochemical oxidation processes of organic and inorganic admixtures.

As it is known, by the decrease of temperature, the solubility of airs in water is increased. In any periods of year in all the samples taken until 12 hour of a day the consistency of soluble oxygen must not be less than 4-6 mg/l. In water samples taken for analysis by us the consistency of soluble oxygen was determined according to ISO 5813-83, via Winkler's Iodometric method.

The data of water soluble oxygen verified that the mentioned parameter was maximal in winter (12,27 mg/l) and in summer it was minimal (3,81 mg/l). The samples taken at river Jotchostskhali source during all the seasons were distinguished by high consistency of O_2 (9,88 – 12,27 mg/l).

In all the samples taken near at pollution sources the decrease of soluble oxygen was fixed compared to the samples taken at rivers' sources. This regulation was especially fixed at river Mejinistskhali in all the seasons (3,81-4,18 mg/l) and in Periistskhali in summer (3,92 mg/l), which verifies the high pollution quality of the mentioned rivers once more (Diagram 1, 2).

The water pollution quality of any reservoirs is stipulated by the consistency of organic admixture in it for the oxidation of which certain amount of water soluble oxygen is spent via aerobic microorganisms. This process is called biochemical oxygen demand. From the organic admixture in water the rusting admixtures are: alcohols, phenol, formaldehyde, etc. the mid conditions take Pyrocatechines, Naphtolies, Resorcinols, etc. the hardly rusting organic admixtures are: hydrochinon, surface active admixtures, etc. the parameter, which determines water pollution quality with organic admixtures is called biochemical oxygen demand during 5 days and nights, the size of which in surface waters varies in the limits of 0,5-4mg /l and it experiences seasonal and day and night changes.

In the water samples taken for analysis by us biochemical oxygen demand 5 was determined according to the seasons, for which we, were placing one part of water samples in incubator at +20°C temperature for 5 days and nights, in parallel with determination of oxygen consistency soluble in water samples for further identification of their biochemical oxygen demand. This indicator gave us possibility to create an impression about water pollution quality.

Table 14

Smell evaluation of rivers' water in points

#	**Sample #**	**River name and location**	**Smell, point,**				***Permissible concentration***
			Spring (March)	**Summer (July)**	**Autumn (September)**	**Winter (December)**	
I	1	Jotchostskhali (at headwater)	0	0	0	0	**Not more than 1-2 point**
	2	Jotchostskhali (at pollution source)	1	2	2	1	
II	3	Mejinistskhali (at headwater)	1	1	1	0	
	4	Jotchostskhali (at pollution source)	3	4	4	2	
III	5	Kapreshumistskhali (at headwater)	0	1	1	0	
	6	Kapreshumistskhali (at pollution source)	2	3	2	1	
IV	7	Periistskhali (at headwater)	1	1	1	0	
	8	Periistskhali (at pollution source)	3	3	3	2	

Table 15

Rivers' water colour according to seasonal dynamics

#	Sample #	River name and location	*Colour 0-10 cm in water column*				*Permissible concentration*
			Spring (March)	Summer (July)	Autumn (September)	Winter (December)	
I	1	Jotchostskhali (at headwater)	-	-	-	-	**The water should not receive strange colour. The colour must not be noted at 10-20 cm water column**
	2	Jotchostskhali (at pollution source)	Greenish - Yellowish	Weak Yellowish	Greenish	Greenish	
II	3	Mejinistskhali (at headwater)	Yellowish	Greenish	-	-	
	4	Jotchostskhali (at pollution source)	Greenish-Yellowish	Greenish - Yellowish, in some places dark green	Greenish - Yellowish	Greenish	
III	5	Kapreshumistskhali (at headwater)	-	Yellowish	Week Yellowish	-	
	6	Kapreshumistskhali (at pollution source)	Yellowish	Greenish - Yellowish	Greenish	Greenish - Yellowish	
IV	7	Periistskhali (at headwater)	Greenish-Yellowish	Greenish	Weak Yellowish	-	
	8	Periistskhali (at pollution source)	Yellowish	Greenish - Yellowish	Yellowish	Yellowish	

Table 16

Seasonal data of rivers' water transperancy

#	Sample #	River name and location	Measuring unit, cm				Transperancy	*Permissible concentration*
			Spring (March)	Summer (July)	Autumn (September)	Winter (December)		
I	1	Jotchostskhali (at headwater)	55	50	50	60	Transperant	**Not Defined**
	2	Jotchostskhali (at pollution source)	30	25	25	30	Light turbid	
II	3	Mejinistskhali (at headwater)	35	30	30	35	Transperant	
	4	Jotchostskhali (at pollution source)	15	10	15	20	Turbid	
III	5	Kapreshumistskhali (at headwater)	45	40	40	50	Transperant	
	6	Kapreshumistskhali (at pollution source)	25	20	25	30	From averagely turbid to light turbid	
IV	7	Periistskhali (at headwater)	40	35	35	45	Transperant	
	8	Periistskhali (at pollution source)	25	20	20	25	Averagely turbid	

Table 17

Seasonal data of temperature samples of river's water

#	Sample #	River name and location	Temperature ^{0}C				Maximal permissible temperature
			Spring (March)	Summer (July)	Autumn (September)	Winter (December)	
I	1	Jotchostskhali (at headwater)	6	10	7	2	$+28^{0}C$ – in summer, $+8^{0}C$ – in winter
	2	Jotchostskhali (at pollution source)	10	14	11	5	
II	3	Mejinistskhali (at headwater)	13	19	17	8	
	4	Jotchostskhali (at pollution source)	18	26	20	10	
III	5	Kapreshumistskhali (at headwater)	10	16	14	6	
	6	Kapreshumistskhali (at pollution source)	14	20	18	7	
IV	7	Periistskhali (at headwater)	12	17	15	4	
	8	Periistskhali (at pollution source)	16	23	18	8	

Table 18

***pH* of River Waters and Reaction Area**

#	**Sample #**	**River name and location**	***pH***				**Area reaction**	***Permissible Norm***
			Spring (March)	**Summer (July)**	**Autumn (September)**	**Winter (December)**		
I	1	Jotchostskhali (at headwater)	7,2	7,5	7,5	7,1	Neutral	**Should not exceed 6,5-7,5**
	2	Jotchostskhali (at pollution source)	6,2	6,4	6,2	6,1	Weak acid	
II	3	Mejinistskhali (at headwater)	7,3	7,5	7,4	7,1	Neutral	
	4	Jotchostskhali (at pollution source)	8,6	9,0	8,9	7,7	From weak alkali to alkali	
III	5	Kapreshumistskhali (at headwater)	7,3	7,5	7,4	7,2	Neutral	
	6	Kapreshumistskhali (at pollution source)	7,7	7,9	7,8	7,6	Weak alkali	
IV	7	Periistskhali (at headwater)	6,8	7,5	7,2	6,6	Neutral	
	8	Periistskhali (at pollution source)	5,8	6,5	6,2	5,6	Weak acid	

Table 19

Consistency of suspended particles and their seasonal dynamics

#	Sample #	River name and location	Spring		Summer		Autumn		Winter		Increase of permissible concentration
			Mg/l	Permissible increase mg/l	Mg/l	Permissible increase mg/l	Mg/l	Permissible increase mg/l	Mg/l	Permissible increase mg/l	
I	1	Jotchostskhali (at headwater)	6,4	0,32	1,6	0,08	5,6	0,28	8,8	0,54	**Increase of concentration is permissible in the limits of 55 compared to the natural background**
	2	Jotchostskhali (at pollution source)	7,8	>1,08	2,4	>0,72	6,8	>0,92	9,6	>0,66	
II	3	Mejinistskhali (at headwater)	17,2	0,86	12,4	0,62	14,8	0,74	24,6	1,23	
	4	Jotchostskhali (at pollution source)	23,2	>5,14	16,2	>3,18	20,2	>4,66	31,6	>5,77	
III	5	Kapreshumistskhali (at headwater)	8,8	0,44	2,8	0,14	9,2	0,46	10,4	0,52	
	6	Kapreshumistskhali (at pollution source)	10,8	>1,56	4,4	>1,46	12,0	>2,34	13,2	>2,28	
IV	7	Periistskhali (at headwater)	12,8	0,64	9,2	0,46	10,4	0,52	15,0	0,75	
	8	Periistskhali (at pollution source)	16,8	>2,56	11,2	>1,54	14,2	>3,28	19,6	>3,85	

Table 20

The results of determination the dry residuals in rivers' waters

#	Sample #	River name and location	Dry residuals, mg/l				*Permissible limit*
			Spring (March)	Summer (July)	Autumn (September)	Winter (December)	
I	1	Jotchostskhali (at headwater)	350,4	227,6	298,4	363,4	not more than 1000 mg/l
	2	Jotchostskhali (at pollution source)	475,4	305,2	418,6	480,6	
II	3	Mejinistskhali (at headwater)	442,1	398,7	427,2	459,4	
	4	Jotchostskhali (at pollution source)	594,8	543,5	586,8	632,6	
III	5	Kapreshumistskhali (at headwater)	360,5	356,6	305,2	372,7	
	6	Kapreshumistskhali (at pollution source)	491,3	466,2	439,6	494,8	
IV	7	Periistskhali (at headwater)	411,6	387,8	402,1	438,9	
	8	Periistskhali (at pollution source)	552,1	513,6	549,2	591,3	

The concentration of O_2 soluble in water according to seasons of the year

Diagram 1

The concentration of O_2 soluble
at the river's headwater
(***Permissible norm*** **not more than 4-6 mg/l)**

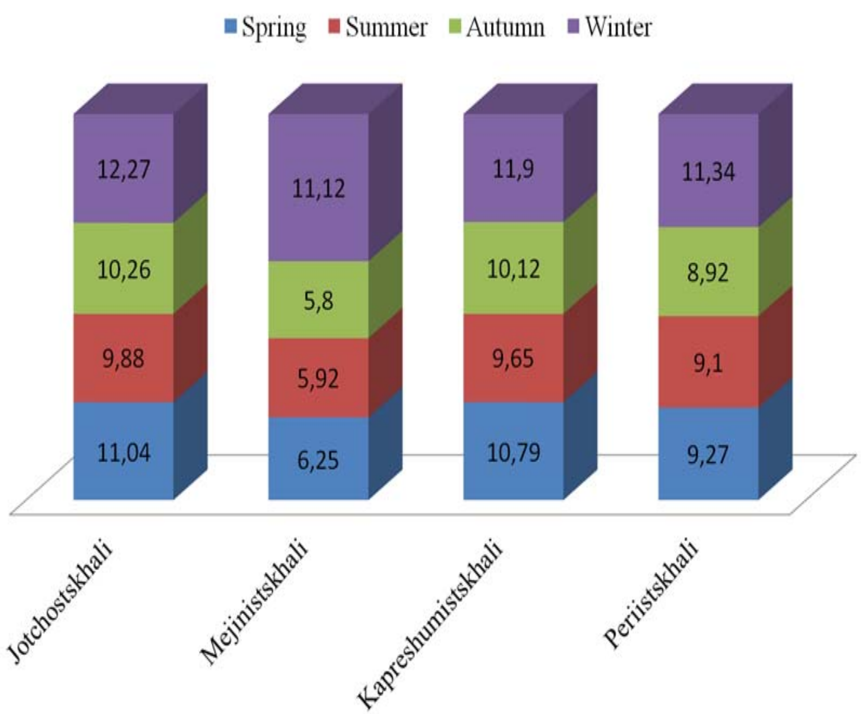
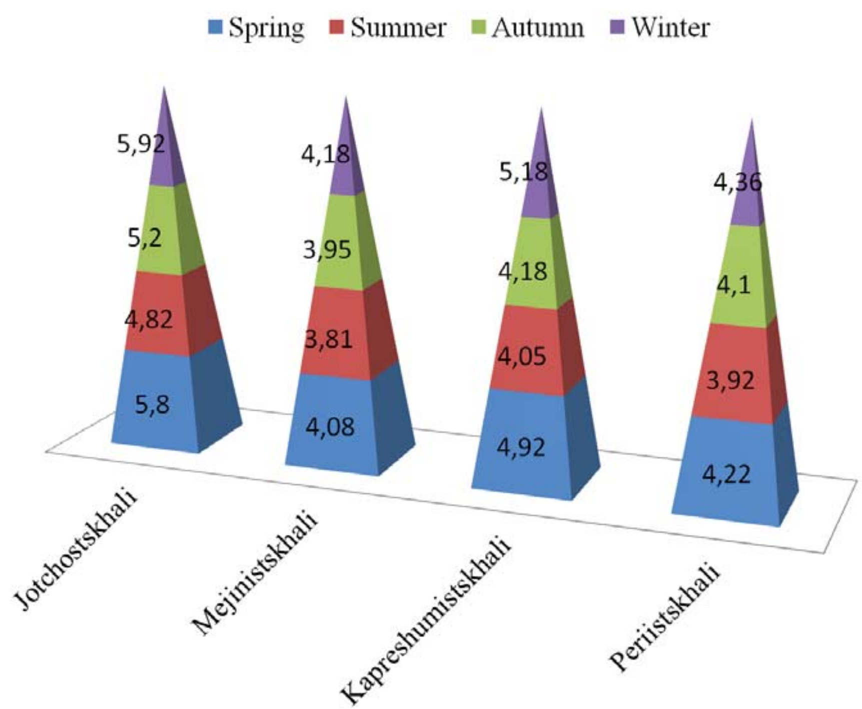


Diagram 2

The concentration of O_2 soluble
at the river's pollution source
(***Permissible norm*** **not more than 4-6 mg/l)**



In water samples taken at river sources the indicator of biochemical oxygen demand were in the limits of permissible norms (from 0,89 to 1,63-mg/l). Near at pollutions sources this indicator exceeded permissible norms in Mejinistskhali (3,31-3,54 mg/l) and in Periistskhali – in summer and autumn (3,01–3,09 mg/l). According to the seasonal dynamics the amount of this indicator was decreasing in winter and increasing in summer which was caused by seasonal changes of temperature and according to this to the decrease of vital activity of micro-organisms in winter period (Table 21).

Rustiness/oxidation is called the ability of oxidizing/rusting organic substances in water and large amount of organic substance in water means that the water is polluted as during this period more amount of oxygen is spent for oxidation of them. The results of rustiness determination in analysis water showed that the samples taken near at Jotchostskhali source were the best, the water was full of oxygen and oxidation was very low (1,22-1,88 mg/l). According to seasonal dynamics the rustiness was increasing in waters in summer period which was connected to the increase of organic substances during this period. High indicator of rustiness was fixed in this aspect in Mejinistskhali as well, near at pollution source during all four seasons (4,01-6,44 mg/l) which was caused by high pollution quality by accumulating organic admixtures and low consistency of soluble oxygen (Table 22).

The Consistency of nitrate-ions in natural waters is caused by the following reasons: a) nitrification of ammonium ions, by the participation of nitrification bacteria at underground processes and oxygen; b) atmospheric precipitation in which the consistency of nitrate-ions achieve 0,9-1 mg/l; c) industrial and everyday waste waters when the nitrates concentration can achieve 50 mg/l; d) waste waters from agricultural land plots which are enriched with nitrogen fertilizers.

The main processes causing decrease of nitrates concentration their usage by phytoplankton and denitrificator bacteria, which during lack of oxygen are used for rusting organic admixtures in nitrates.

We have determined consistency of nitrates in the waters of research rivers. The progress of analysis is as follows: we were placing 10 ml analysis water in porcelain vessel, adding to it 1 ml salicylic acid sodium solution and evaporating it at water bath until it is fully dried out. After cooling, we were moistening dry residuals with 1 ml concentrated sulphuric acid and waiting for 10 minutes. Then we were dissolving with 5-10 ml distilled water and moving it into 50 ml measuring vessel, adding to it 7ml 1N $NaOH$ and taking it to the marked line with distilled water. We were determining sample color intensity via photometric method (Table 23).

We have determined consistency of nitrates in the waters of research rivers. The progress of analysis is as follows: we were adding 2 ml Grace reagent to analysis solution 50 ml (mixture of 1-Naphthylamine, Sulfinyl and tartaric acids), we were shaking and waiting for 40 minutes, afterwards we were carrying photometry at green color filter, $\lambda = 520$ nm. We were finding massive concentration of nitrites via calibrated curve which we were drawing based on series of standard solution (Table 24).

As it seems from the received results, in the samples taken from rivers' sources the consistency of nitrate and nitrite-ions were in the limits of permissible hygienic-toxicological norms: for nitrates 45 mg/l, for nitrites - 0,08 mg/l.

As for the samples taken near at pollution sources, during their analysis it was identified that the consistency of nitrites in some cases was above permissible hygienic-toxicological norms. In particular, it was noted at river Mejinistskhali in Summer and Winter (0,085–0,092 mg/l) and in Periistskhali - in Winter (0,085 mg/l).

Table *21*

Results of determination the Biocemical Oxigen Demand (BOD_5)

in the waters of research rivers

№	**River name and location**	**BOD_5, mg/l**	***Permissible norm***			
		Spring (March)	**Summer (July)**	**Autumn (September)**	**Winter (December)**	
1	Jotchostskhali (at headwater)	1,16	1,32	1,18	0,89	**not more than 3 mg/l at 20^0C-**
2	Jotchostskhali (at pollution source)	2,06	2,32	2,12	2,02	
3	Mejinistskali (at headwater)	1,38	1,63	1,40	1,32	
4	Jotchostskhali (at pollution source)	2,87	3,54	3,31	2,73	
5	Kapreshumistskali (at headwater)	1,19	1,35	1,22	1,16	
6	Kapreshumistskali (at pollution source)	2,34	2,73	2,54	2,29	
7	Periistskhali (at headwater)	1,26	1,44	1,31	1,21	
8	Periistskhali (at pollution source)	2,65	3,09	3,01	2,51	

As it was expected, maximal consistency of nitrate and nitrite-ions were fixed in the wares of all rivers in Winter season:

NO_2^- - 0,092 mg/l, NO_3^- - 9,15 mg/l. It is caused by the fact that organic admixtures are strongly dissolved in Winter and Nitrogen in them is intensively moving from organic forms to mineral ones.

We have determined the consistency of chlorides and sulfates in one season – in summer. According to received results it was verified that maximal accumulation of the mentioned parameter near at pollution sources was noted in rivers Mejinistskhali and Periistskhali where undesirable organoleptic and physical-chemical indicators were fixed not once during the whole analysis. In particular, in Mejinistskhali concentration of chlorides equaled to 130,8 mg/l, in Periistskhali 102,6 mg/l, which is 2/3 times more than the same indicator in Jotchostskhali and Kapreshumistskhali (Diagram 3, 4, 5, 6).

Table 22

Rustiness of river's waters according to the seasons

№	*Sample №*	**River name and location**	**Permanganate rustiness, mg/l**				*Permissible norm*
			Spring (March)	**Summer (July)**	**Autumn (September)**	**Winter (December)**	
I	1	Jotchostskhali (at headwater)	1,40	1,88	1,64	1,22	**Nor more than 3 mg/l**
	2	Jotchostskhali (at pollution source)	2,84	2,92	2,90	2,48	
II	3	Mejinistskali (at headwater)	2,17	2,42	2,31	2,09	
	4	Jotchostskhali (at pollution source)	5,58	6,44	6,26	4,01	
III	5	Kapreshumistskali (at headwater)	1,55	2,06	1,46	1,30	
	6	Kapreshumistskali (at pollution source)	3,15	3,48	3,18	3,01	
IV	7	Periistskhali (at headwater)	2,12	2,39	2,04	1,72	
	8	Periistskhali (at pollution source)	3,48	3,74	3,65	3,15	

Table 23

Seasonal research results of Nitrates concentration

№	Sample №	River name and location	NO_3^-, mg/l				MPC, mg/l
			Spring (March)	Summer (July)	Autumn (September)	Winter (December)	
I	1	Jotchostskhali (at headwater)	-	-	-	0,20	45
	2	Jotchostskhali (at pollution source)	2,58	1,03	1,80	3,50	
II	3	Mejinistskali (at headwater)	0,36	0,20	0,25	0,40	
	4	Jotchostskhali (at pollution source)	7,35	5,10	6,25	9,15	
III	5	Kapreshumistskali (at headwater)	0,20	-	-	0,30	
	6	Kapreshumistskali (at pollution source)	3,25	1,35	2,86	4,35	
IV	7	Periistskhali (at headwater)	0,25	-	0,20	0,35	
	8	Periistskhali (at pollution source)	4,58	2,20	3,90	6,50	

Table 24

Seasonal research results of Nitrites concentration

№	*Sample №*	**River name and location**	NO_2^-, *mg/l*				*MPC, mg/l*
			Spring (March)	**Summer (July)**	**Autumn (September)**	**Winter (December)**	
I	1	Jotchostskhali (at headwater)	-	-	-	0,04	**0,08**
	2	Jotchostskhali (at pollution source)	0,049	0,027	0,23	0,060	
II	3	Mejinistskali (at headwater)	0,056	0,040	0,045	0,070	
	4	Jotchostskhali (at pollution source)	0,085	0,055	0,072	0,092	
III	5	Kapreshumistskali (at headwater)	0,022	-	-	0,06	
	6	Kapreshumistskali (at pollution source)	0,053	0,030	0,238	0,067	
IV	7	Periistskhali (at headwater)	0,050	-	0,037	0,06	
	8	Periistskhali (at pollution source)	0,077	0,038	0,058	0,085	

Diagram 3

The concentration of chlorides at the river's headwater (***MPC - 350 mg/l***)

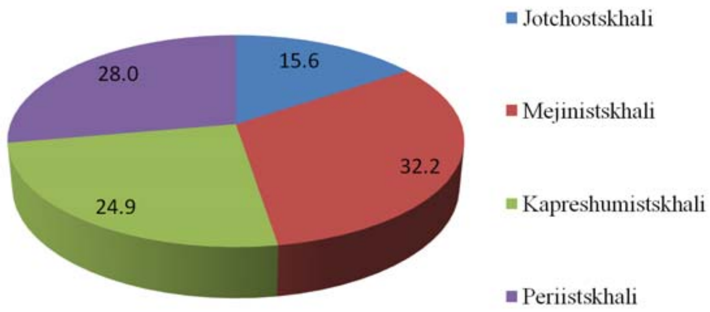


Diagram 4

The concentration of chlorides at the river's pollution source (***MPC - 350 mg/l***)

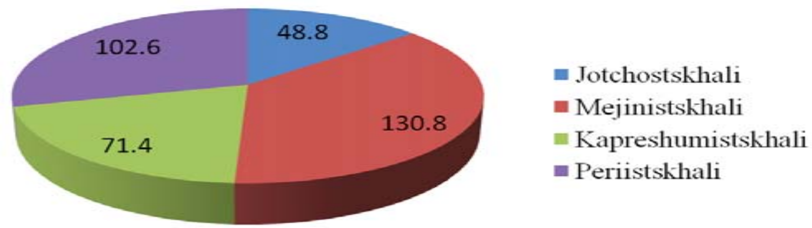


Diagram 5

The concentration of sulfates at the river's headwater (***MPC - 500 mg/l***)

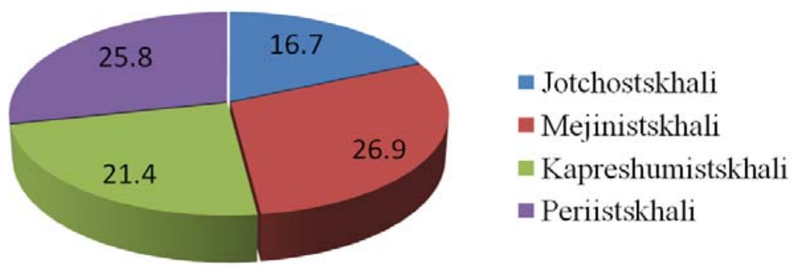
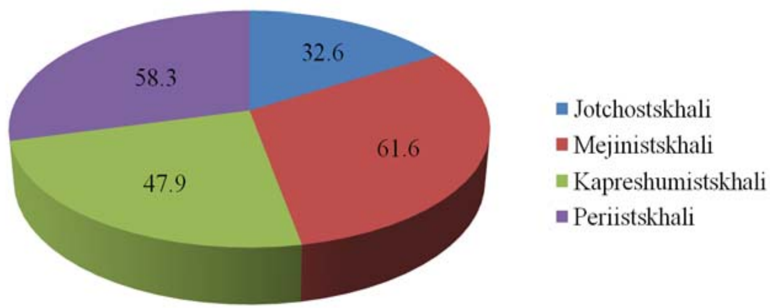


Diagram 6

The concentration of sulfates, at the river's pollution source (***MPC - 500 mg/l***)



The consistency of sulfates in Mejinistskhali was 61,6 mg/l in Periistskhali, 58,3 mg/l, which is 1,2-1,8 times more to the same indicators of the other rivers. Thought, it is noteworthy that the consistency of chlorides and sulfates were not beyond maximal permissible concentration in the waters of any rivers (Chlorides – 350 mg/l, Sulfates – 500 mg/l).

The consistency of plumbum was not discovered in water samples taken near at rivers' headwater. As for pollution sources concentration of this element was fixed compared to the rivers' sources. Near at pollution sources in river Jotchostskhali Plumbum concentration was the lowest compared to other rivers – 0,02 mg/l, and the highest concentration of plumbum was fixed in river Mejinistskhali, near at pollution source – 0,025 mg/l (Table 25, Diagram 7).

Copper concentration was not fixed in rivers Jotchostskhali and Kapreshumistskhali headwaters. The same results was received at pollution sources as in the case of Plumbum. In particular, Copper concentration was minimal in river Jotchostskhali – 0,040 mg/l and maximal in river Mejinistskhali – 0,150 mg/l (Table 25, diagram 8).

It is noteworthy that in no samples of rivers' waters toxic elements did not exceed maximal permissible concentration norm, in particular: *Pb* <0,1 mg/l, *Cu* <1,0 mg/l.

The results of chemical-expertise research of four small rivers of Khelvachauri (Jotchostskhali, Mejinistskhali, Kapreshumistskhali and Periistskhali) are represented in experimental protocols (Protocol 1 – protocol 8). In the protocols the data of carried research is summarized, which gives the possibility to have clear view about modern ecological conditions and pollution quality of the above-stated rivers.

Table 25

Concentration of plumbum and copper in the waters of research rivers

№	*Sample №*	**River name and location**	***Summer (June)***			
			Pb, **Mg/l**	***MPC, mg/l***	*Cu*, **Mg/l**	***MPC, mg/l***
I	1	Jotchostskhali (at headwater)	-	**0,03**	-	**1,0**
	2	Jotchostskhali (at pollution source)	0,020		0,040	
II	3	Mejinistskali (at headwater)	-		0,055	
	4	Jotchostskhali (at pollution source)	0,025		0,150	
III	5	Kapreshumistskali (at headwater)	-		-	
	6	Kapreshumistskali (at pollution source)	0,022		0,100	
IV	7	Periistskhali (at headwater)	-		0,064	
	8	Periistskhali (at pollution source)	0,023		0,090	

Diagram 7

Plumbum concentration in river waters, mg/l

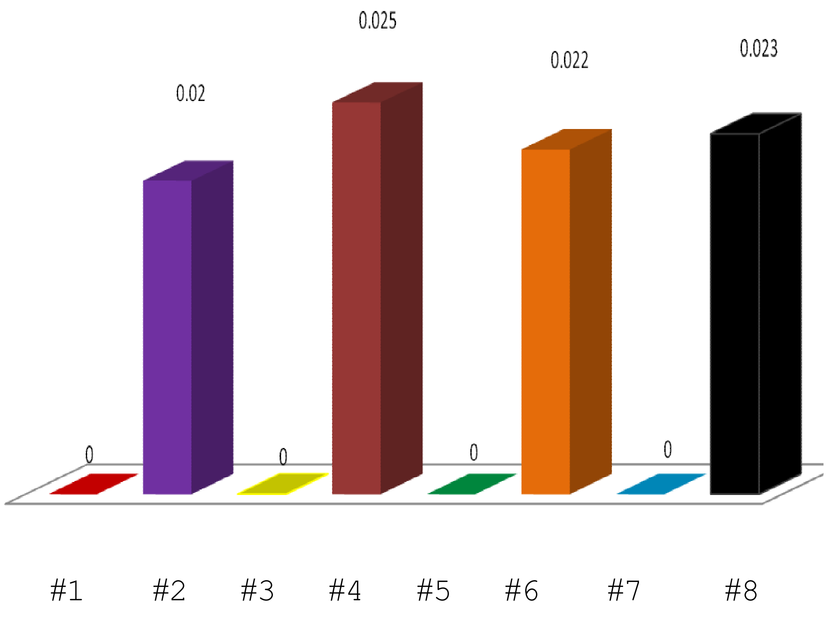
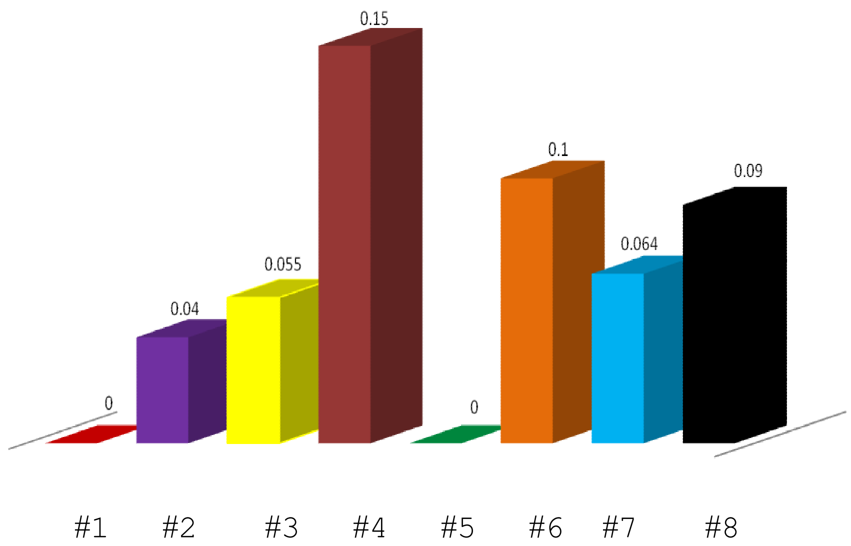


Diagram 8

Copper concentration in river waters, mg/l



#1 – Jotchostskhali (at Headwater)
#2 – Jotchostskhali (at pollution source)
#3 – Mejinistskhali (at Headwater)
#4 – Mejinistskhali (at pollution source)

#5 – Kapteshumistskhali (at Headwater)
#6 – Kapreshumistskhali (at pollution source)
#7 – Periistskhali (at Headwater)
#8 – Periistskhali (at pollution source)

II.4 Ecological Conditions of Agricultural and Industrial Waste Waters

As a result of studying sources of all water-lines and their feeding sources in Adjara it was identified that ecological conditions of these objects did not satisfy the minimal requirements set udner exploitation terms. In particular, no objects had strict regime zones of hygyenic protection, water catchment objects are unuseful and they are in emergency situation (Table 26, 27). At present state hydrological network consist of 86 rivers and 8 lakes guardpost where treatment works are not carried at all. The total volume of polluted and improperly treated waste waters equals to 398 million m^3. Together with waste water suspended material 13,4 thousands of tone, 743 tones of oil products, 0.95 tones of heavy metals atc. are met at The Black Sea Basin rivers and coastline of it. It is worth mentioning that at present observations at sea stations are terminated.

Table 26

The flow conditions of waste water according to the municipality (thousand m^3)

M **Municipality**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
BBatumi	22420	21200	19825	25880	24287	22416	23016	23316	25195
Kobuleti	1620	1410	1218	1340	1180	1320	1285	1658	2183
Khelvachauri	200	301	320	167	195	344	140	160	544
Keda	209	210	294	288	268	195	140	182	606
Shuakhevi	212	240	289	255	264	250	220	248	560
Khulo	240	264	225	205	165	347	313	244	628

Table 27

Statistics of flow of waste water in Adjara region

	2000	**2001**	**2002**	**2003**	**2004**
The flow of waste water totally, (m^3)	17933	22322	18954	21630	22580
• **Polluted**	16847	20843	17022	19730	19903
• **normally cleaned**	1086	1479	1932	1900	2677

According to Decree N 130 dated 17.09.1996 of the Minister of Environment and Natural Resources of Georgia "Requirements of Protection Rules for Surface Waters Pollution of Georgia" maximal permissible concentration of the mentioned indicators in waste waters is as follows in 1 litres of water: Biochemical Oxygen Demand - 6 mgO_2, concentration of phosphates – 4 mg, concentration of ammonium – 0,27 mg, concentration of nitrates – 45 mg, concentration of nitrites – 3,5 mg, concentration of suspended particles – 20 mg, concentration of ammonium, sulphide – is not permitted.

One of the priority directions of Autonomous Republic of Adjara is monitoring of performance of requirements of appropriate environmental laws in active polluting focal areas of The Black Sea Coastline water and atmospheric air (Picture 22). Such active plluting focal areas are hotel complexes located in the balck sea coastline, as a result of chemical analysis, carried by us, of every day waste waters from two of the above-stated coastline hotel complexes the following was identified: In waste waters of Hotel Complex "Oasis" (Chakvi) concentration of ammonium exceeds maximal permissible concentration by 5 times, as for biochemical oxygen demand it exceeds the permissible nor mby 1,5 times. In waste waters of hotel complex "Kvariati 2005" (Kvariati) the importance of *pH* is deviated to average alkali, concentration of ammonium exceeds maximal permissible concentration norm by 17 times, biochemical oxygen demand exceeds the norm by 1,3 (Table 28). In waste waters of both hotel complexes increased concentrations of ammonium and sulphides are noted (accordingly 1,8-12,0 and 4,0-15,0 mg/dm^3).

Table 28

Chemical indicators of domestic waste water

Objects	*pH*	**BOD_5**	**indicators, mg/dm^3**						
			Suspended particles	**Ammonia**	**Nitrite**	**Nitrate**	**Ammonium**	**Phosphate**	**Sulphide**
Hotel complex "Oasis" (Chakvi),	8,0	9,0	14,0	1,4	0,2	30,0	1,8	2,0	12,0
Hotel complex "Kvariati 2005" (Kvariati)	9,0	8,0	10,0	4,5	0,3	35,0	4,0	3,0	15,0

Analysing chemical indiccators of waste waters from some Batumi car washes showed that pH was increased in all of them (*pH* 9 (Picture 24)). As well as increase of biochemical oxygen demand, ammonium and suphide concentrations was noted in most of waters (Table 29).

Chemical analysis of waste waters from industrial enterpises showed that *pH* was deviated to alkali reaction (*pH* 8-9), as for biochemical oxygen demand is exceeded maximal permissible concentration (7-20 mg/dm^3), the waste waters were polluted with suphides and ammonium nitrogen (Table 30), (Picture 23,25).

Picture 22 Pollution of the river Bartskhana with domestic wastewater

Picture 23 Pollution of the river Khorolistskhali with oil products (waste from the oil terminal)

Picture 24 Car wash along the river Mejinistskali

Picture 25 Landfill near the river

Table 29

Chemical Indicators of Batumi car wash waste water

Location	*pH*	BOD_5	Indicators, mg/dm^3						
			Suspended particles	A Ammonia	Nitrite	Nitrate	Ammonium	F Phosphate	Sulphide
Angisa-1	9,0	8,0	20,0	0,04	0,02	12,0	0,04	0,1	4,2
Angisa-2	9,0	4,0	10,0	*ND*	*ND*	6,0	0,02	0,1	6,0
Angisa-3	9,0	8,0	20,0	0,02	0,02	9,0	0,06	0,2	10,0
Angisa-4	9,0	7,0	20,0	0,04	0,02	9,0	0,1	0,1	8,0
Angisa-5	9,0	8,0	10,0	*ND*	*ND*	6,0	0,06	0,04	2,0
Bartskhana	9,0	3,0	7,0	*ND*	*ND*	9,0	0,02	0,15	2,0

Table 30

Chemical Indicators of industrial enterprises waste water

Objects	pH	BOD_5	Indicators, mg/dm^3						
			Suspended particles		Suspended particles		Suspended particles		Suspended particles
"Purkombinati" Ltd, Khelvachauri Borough	9	6	22	ND	0,06	16	0,2	0,8	8
"Urekhi" Ltd, Flour-milling Plant "Bashak"	6	10	16	1	0,1	19	2	1,4	12
Ltd "Granite"	9	9	8	ND	ND	9	ND	0,4	10
Ltd "Sanitary cleaning "	9	8	12	1,8	0,1	25	2,2	3	12
Ltd "Breakstone"	9	10	8	ND	0,04	9	ND	0,2	4
Ltd "Zimo-7"	8	10	10	ND	0,04	22	0.06	0,2	4
Ltd "Arena"	9	7	9	ND	0.04	12	0,2	0,8	6
Ltd "Road "	7	1	6	ND	0,04	8	0,02	ND	ND
Adlia waste water treatment plant	8	20	35	12,5	0,5	40	10	3,5	28

In most of waste waters of Batumi oilholding stations biochemical oxygen demand indicator is high (9,6-17,0 mgO_2/dm^3), which is the evidence of hogh pollution of the mentioned waters (Table 31). The mentioned indicator is especially increased in waste waters coming out from Bartskhana oiholding reservoir, Batumi Oil Refinery factory and Batumi Oil Terminal.

Table 31

Chemical Indicators of Oil terminal waste water (Batumi area)

Objects	BOD_5, mg O_2 /dm^3
Central oilholding reservoir	0,2
Bartskhana oiholding reservoir	16,0
Bartskhana reservoir,	9,6
Batumi Oil Refinery factory oil holding reservoir	12,0
"Oil Terminal" diesel oil holding reservoir (Batumi)	3,0
Diesel oil holding reservoir (Batumi oil terminal №2)	0,5
Batumi oil terminal №1	17,0

Volume III. CHEMICAL –EXPERTISE EXAMINATION PROTOCOLS

III.1 Examination protocols of Adjara big and small rivers samples

Protocol №1

The place of taking sample – river Jotchostskhali, at headwater
Date and time: 24.03.2018; 28.06.2017; 20.09.2017; 19.12.2017; 28.05.2017;10:00-12:00
Examination purpose: chemical-expertise examination

№	*Indicators*	*Results of the analysis*				*Permissible limit*
		March	*June*	*Septem-ber*	*Decem-ber*	
1	2	3	4	5	6	7
I	***Organoleptic:***					
	1. Smell, points	0	0	0	0	not more than 1-2 points
	2. Color	-	-	-	-	it should not be noted at 0-20 cm water column.
	3. Transperancy, cm	55	50	50	60	is not regulated
II	***Physical-chemical:***					
	3. t, ^0C	6	10	7	2	+28^{0}C- in summer , +8^{0}C –in winter
	4. *pH*	7,2	7,5	7,5	7,1	6,5-8,5
	5. Suspended particles, mg/l	6,4	1,6	5,6	88	Increase not more than 5 % compared to the background.
	6. Dry residue, mg/l	350,4	227,6	298,4	363,4	not more than 1000 mg/l
	7. soluble oxygen O_2 ,mg/l	11,04	9,88	10,26	12,27	>4 mg/l
	8. BOD_5, mg/l	1,16	1,32	1,18	0,89	3 mg/l at 20^{0}C
	9. Rustiness, mg/l	1,10	1,88	1,64	1,22	< 3 mg/l
	10. Nitrates, mg/l	-	-	-	0,20	45 mg/l
	11. Nitrites, mg/l	-	-	-	0,04	0,08 mg/l
	12. Chlorides, mg/l		15,6			<350
	13. Sulfates, mg/l		16,7			<500
	Toxic Elements:					
	14. *Pb* , mg/l					<0,03
	15. *Cu* , mg/l					<1,0

Protocol №2

The place of taking sample – river Jotchostskhali, at pollution source.

Date and time: 24.03.2018; 28.06.2017; 20.09.2017; 19.12.2017; 28.05.2017;10:00-12:00
Examination purpose: chemical-expertise examination

№	*Indicators*	*Results of the analysis*				*Permissible limit*
		March	*June*	*Septem-ber*	*Decem-ber*	
1	2	*3*	*4*	*5*	*6*	*7*
I	***Organoleptic:***					
	1. Smell, points	1	2	2	1	not more than 1-2 points
	2. Color	Gree-nish-yello-wish	weak yello-wish	Gree-nish	Gree-nish	it should not be noted at 0-20cm water column.
	3. Transperancy, cm	30	25	25	30	is not regulated
II	***Physical-chemical:***					
	3. t, ^{0}C	10	14	11	5	+28^{0}C- in summer , +8^{0}C –in winter
	4. *pH*	6,2	6,4	6,2	6,1	6,5-8,5
	5. Suspended particles, mg/l	7,8	2,4	6,8	9,6	Increase not more than 5 % compared to the background.
	6. Dry residue, mg/l	475,4	305,2	418,6	480,6	not more than 1000 mg/l
	7. soluble oxygen O_2 ,mg/l	5,80	4,82	5,20	5,92	>4 mg/l
	8. BOD_5, mg/l	2,06	2,32	2,12	2,02	3 mg/l at 20^{0}C
	9. Rustiness, mg/l	2,84	2,92	2,90	2,48	< 3 mg/l
	10. Nitrates, mg/l	2,58	1,03	1,80	3,50	45 mg/l
	11. Nitrites, mg/l	0,049	0,027	0,23	0,060	0,08 mg/l
	12. Chlorides, mg/l		48,8			<350
	13. Sulfates, mg/l		32,6			<500
	Toxic Elements:					
	16. *Pb* , mg/l		0.20			<0,03
	14. *Cu* , mg/l		0,064			<1,0

Protocol №3

The place of taking sample – river Mejinistskali, at headwater
Date and time: 24.03.2018; 28.06.2017; 20.09.2017; 19.12.2017; 28.05.2017;10:00-12:00
Examination purpose: chemical-expertise examination

№	*Indicators*	*Results of the analysis*				*Permissible limit*
		March	*June*	*Septem-ber*	*Decem-ber*	
1	*2*	*3*	*4*	*5*	*6*	*7*
I	*Organoleptic:*					
	1. Smell, points	1	1	1	0	not more than 1-2 points
	2. Color	Yello-wish	Gree-nish	-	-	it should not be noted at 0-20cm water column.
	3. 3. Transperancy, cm	35	30	30	35	is not regulated
II	*Physical-chemical:*					
	4. t, ^0C	13	19	17	8	$+28^0C$- in summer , $+8^0C$ – in winter
	5. *pH*	7,3	7,5	7,4	7,1	6,5-8,5
	6. Suspended particles, mg/l	17,2	12,4	14,8	24,6	Increase not more than 5 % compared to the background.
	7. Dry residue, mg/l	442,1	398,7	427,2	459,4	not more than 1000 mg/l
	8. soluble oxygen O_2 ,mg/l	6,25	5,92	5,80	11,12	>4 mg/l
	9. BOD_5, mg/l	1,38	1,63	1,40	1,32	3 mg/l at 20^0C
	10. Rustiness, mg/l	2,17	2,42	2,31	2,09	< 3 mg/l
	11. Nitrates, mg/l	0,36	0,20	0,25	0,40	45 mg/l
	12. Nitrites, mg/l	0,056	0,040	0,045	0,070	0,08 mg/l
	13. Chlorides, mg/l		32,2			<350
	14. Sulfates, mg/l		26,9			<500
	Toxic Elements:					
	15. *Pb* , mg/l		-			<0,03
	16. *Cu* , mg/l		0,055			<1,0

Protocol №4

The place of taking sample – river Mejinistskali, at pollution source.
Date and time: 24.03.2018; 28.06.2017; 20.09.2017; 19.12.2017; 28.05.2017;10:00-12:00
Examination purpose: chemical-expertise examination

№	*Indicators*	*Results of the analysis*				*Permissible limit*
		March	*June*	*Septem -ber*	*Decem-ber*	
1	2	3	4	5	6	7
I	***Organoleptic:***					
	Smell, points	3	4	4	2	not more than 1-2 points
	1. Color	Gree-nish-yello-wish	Greenish-yelowish, at a number of places dark green	Gree-nish-yello-wish	Gree-nish	it should not be noted at 0-20cm water column.
	3. Transperancy, cm	15	10	15	20	is not regulated
II	***Physical-chemical:***					
	1. t, ^{0}C	18	26	20	10	+28^{0}C- in summer , +8^{0}C –in winter
	2. *pH*	8,6	9,0	8,9	7,7	6,5-8,5
	3. Suspended particles, mg/l	23,2	16,2	20,2	31,6	Increase not more than 5 % compared to the background.
	4. Dry residue, mg/l	594,8	543,5	586,8	632,6	not more than 1000 mg/l
	soluble oxygen O_2 ,mg/l	4,08	3,81	3,95	4,18	>4 mg/l
	BOD_5, mg/l	2,87	3,54	3,31	2,73	3 mg/l at 20^{0}C
	Rustiness, mg/l	5,58	6,44	6,26	4,01	< 3 mg/l
	Nitrates, mg/l	7,35	5,10	6,26	9,15	45 mg/l
	Nitrites, mg/l	0,085	0,055	0,072	0,092	0,08 mg/l
	Chlorides, mg/l		130,8			<350
	Sulfates, mg/l		61,6			<500
	Toxic Elements:					
	Pb , mg/l		0,025			<0,03
	Cu , mg/l		0,150			<1,0

Protocol №5

The place of taking sample – river Kapreshumistskali, at headwater.
Date and time: 24.03.2018; 28.06.2017; 20.09.2017; 19.12.2017; 28.05.2017;10:00-12:00
Examination purpose: chemical-expertise examination

№	*Indicators*	*Results of the analysis*				*Permissible limit*
		March	*June*	*Septem-ber*	*Decem-ber*	
1	*2*	*3*	*4*	*5*	*6*	*7*
I	***Organoleptic:***					
	1. Smell, points	0	1	1	0	not more than 1-2 points
	2. Color	-	Yello-wish	weak yello-wish	-	it should not be noted at 0-20cm water column.
	3. 3. Transperancy, cm	45	40	40	50	is not regulated
II	***Physical-chemical:***					
	4. t, ^{0}C	10	16	14	6	+28^{0}C- in summer , +8^{0}C –in winter
	5. *pH*	7,3	7,5	7,4	7,2	6,5-8,5
	6. Suspended particles, mg/l	8,8	2,8	9,2	10,4	Increase not more than 5 % compared to the background.
	7. Dry residue, mg/l	360,5	356,6	305,2	372,7	not more than 1000 mg/l
	8. soluble oxygen O_2 ,mg/l	10,79	9,65	10,12	11,90	>4 mg/l
	9. BOD_5, mg/l	1,19	1,35	1,22	1,16	3 mg/l at 20^{0}C
	10. Rustiness, mg/l	1,55	2,06	1,46	1,30	< 3 mg/l
	11. Nitrates, mg/l	0,20	-	-	0,30	45 mg/l
	12. Nitrites, mg/l	0,022	-	-	0,06	0,08 mg/l
	13. Chlorides, mg/l	7,3	24,9			<350
	14. Sulfates, mg/l	8,8	21,4			<500
	Toxic Elements:					
	15. *Pb* , mg/l		-			<0,03
	16. *Cu* , mg/l		-			<1,0

Protocol №6

The place of taking sample – river Kapreshumistskali, at pollution source.
Date and time: 24.03.2018; 28.06.2017; 20.09.2017; 19.12.2017; 28.05.2017;10:00-12:00
Examination purpose: chemical-expertise examination

№	*Indicators*	*Results of the analysis*				*Permissible limit*
		March	*June*	*Septem-ber*	*Decem-ber*	
1	*2*	*3*	*4*	*5*	*6*	*7*
I	***Organoleptic:***					
	1. Smell, points	2	3	2	1	not more than 1-2 points
	2. Color	Yello-wish	Gree-niwh-yelo-wish	greenish	Gree-niwh-yelo-wish	it should not be noted at 0-20cm water column.
	3. Transperancy, cm	25	20	25	30	is not regulated
II	***Physical-chemical:***					
	t, ^0C	14	20	18	7	$+28^0C$- in summer , $+8^0C$ –in winter
	pH	7,7	7,9	7,8	7,6	6,5-8,5
	Suspended particles, mg/l	10,8	4,4	12,0	13,2	Increase not more than 5 % compared to the background.
	Dry residue, mg/l	491,3	466,2	439,6	494,8	not more than 1000 mg/l
	soluble oxygen O_2 ,mg/l	4,92	4,05	4,18	5,18	>4 mg/l
	BOD_5, mg/l	2,34	2,73	2,54	2,29	3 mg/l at 20^0C
	Rustiness, mg/l	3,15	3,48	3,18	3,01	< 3 mg/l
	Nitrates, mg/l	3,25	1,35	2,86	4,35	45 mg/l
	Nitrites, mg/l	0,053	0,030	0,238	0,067	0,08 mg/l
	Chlorides, mg/l		71,4			<350
	Sulfates, mg/l		47,9			<500
	Toxic Elements:					
	Pb , mg/l		0,022			<0,03
	Cu , mg/l		0,100			<1,0

Protocol №7

The place of taking sample – river Periistskhali, at headwater.
Date and time: 24.03.2018; 28.06.2017; 20.09.2017; 19.12.2017; 28.05.2017;10:00-12:00
Examination purpose: chemical-expertise examination

№	*Indicators*	*Results of the analysis*				*Permissible limit*
		March	*June*	*Septem-ber*	*Decem-ber*	
1	*2*	*3*	*4*	*5*	*6*	*7*
I	***Organoleptic:***					
	1. Smell, points	1	1	1	0	not more than 1-2 points
	2. Color	Gree-nish-yelo-wish	Gree-nish	weak yello-wish	-	it should not be noted at 0-20cm water column.
	3. Transperancy, cm	40	35	35	45	is not regulated
II	***Physical-chemical:***					
	t, ^0C	12	17	15	4	+28^{0}C- in summer , +8^{0}C –in winter
	pH	6,8	7,5	7,2	6,6	6,5-8,5
	Suspended particles, mg/l	12,8	9,2	10,4	15,0	Increase not more than 5 % compared to the background.
	Dry residue, mg/l	411,6	387,8	402,1	438,9	not more than 1000 mg/l
	5. soluble oxygen O_2 ,mg/l	9,27	9,10	8,92	11,34	>4 mg/l
	6. BOD_5, mg/l	1,26	1,44	1,31	1,21	3 mg/l at 20^{0}C
	7. Rustiness, mg/l	2,12	2,39	2,04	1,72	< 3 mg/l
	8. Nitrates, mg/l	0,25	-	0,20	0,35	45 mg/l
	9. Nitrites, mg/l	0,050	-	0,037	0,06	0,08 mg/l
	10. Chlorides, mg/l		28,0			<350
	11. Sulfates, mg/l		25,8			<500
	Toxic Elements:					
	12. *Pb* , mg/l		-			<0,03
	13. *Cu* , mg/l		0,040			<1,0

Protocol №8

The place of taking sample – river Periistskhali, at pollution source.

Date and time: 24.03.2018; 28.06.2017; 20.09.2017; 19.12.2017; 28.05.2017;10:00-12:00
Examination purpose: chemical-expertise examination

№	*Indicators*	*Results of the analysis*				*Permissible limit*
		March	*June*	*Septem-ber*	*Decem-ber*	
1	*2*	*3*	*4*	*5*	*6*	*7*
I	***Organoleptic:***					
	1. Smell, points	3	3	3	2	not more than 1-2 points
	2. Color	Yello-wish	Gree-nish	Yellowish	Yello--wish	it should not be noted at 0-20cm water column.
	3. Transperancy, cm	25	20	20	25	is not regulated
II	***Physical-chemical:***					
	t, ^0C	16	23	18	8	+28^{0}C- in summer , +8^{0}C –in winter
	pH	5,8	6,5	6,2	5,6	6,5-8,5
	Suspended particles, mg/l	16,8	11,2	14,2	19,6	Increase not more than 5 % compared to the background.
	Dry residue, mg/l	552,1	513,6	549,2	591,3	not more than 1000 mg/l
	soluble oxygen O_2 ,mg/l	4,22	3,92	4,10	4,36	>4 mg/l
	BOD_5, mg/l	2,65	3,09	3,01	2,51	3 mg/l at 20^{0}C
	Rustiness, mg/l	3,48	3,74	3,65	3,15	< 3 mg/l
	Nitrates, mg/l	4,58	2,20	3,90	6,50	45 mg/l
	Nitrites, mg/l	0,077	0,038	0,058	0,085	0,08 mg/l
	Chlorides, mg/l		102,6			<350
	Sulfates, mg/l		58,3			<500
	Toxic Elements:					
	3. *Pb* , mg/l		0,023			<0,03
	4. *Cu* , mg/l		0,090			<1,0

Protocol #9

Chemical indicators of big and small rivers of Adjara based on chemical indicators of waste water

Indicators	***MPC***	***Choro-khi***	***Kubas-tskali***	***Barts-khana***	***Korolistskali***	***Mejinis-tskali***	***Chakvis-tskali***
pH	6,5-8,5	9,0	7,0	8,0	6,0	8,0	8,0
Suspended particles, mg/dm^3	60,0	12,0	12,0	10,0	18,0	8,0	12,0
BOD_5, mgO_2 / dm^3	2,5	7,0	8,0	3,0	10,0	3,0	8,0
NH_3, mg/dm^3	2,0	0,6	0,2	0,8	2,5	*ND*	1,0
NO_2^-, mg/dm^3	0,2	0,02	0,06	10,2	0,3	0,04	0,1
NO_3^-, mg/dm^3	50,0	26,0	22,0	18,0	28,0	20,0	24,0
NH_4^+, mg/dm^3	2,0	0,8	0,3	0,2	3,0	0,04	1,2
PO_4^{3-}, mg/dm^3	2,0	2,0	0,4	0,2	2,0	0,1	3,0
S^{2-}, mg/dm^3	not permit-ted	12,0	6,0	8,0	11,0	3,0	9,0
Date of taking sample		***31.08.2017***	***13.08.2017***	***15.08.2017***	***14.07.2017***	***23.06.2017***	***08.09.2017***

Note: *ND* is lower than discovered norm. Weather – sunny. Volume of samples – 1 liter Examinations were carried based on Decree N 130, dated 17.09.1996 of the Minister of Environment and Natural Resources of Georgia, “Protection Rules for Surface Waters Pollution of Georgia”.

III.2 Examination protocols of every day waste waters in Adjara rivers

Protocol #1 of waste water in rivers Tchorokhi and Kubastskali

Indicators	***Result of the analysis***		***MPC***
	Tchorokhi	**Kubastskali**	
pH	9,0	7,0	6,5-8,5
Suspended particles, mg/dm^3	12,0	12,0	60,0
BOD$_5$, mgO_2/ dm^3	7,0	8,0	2,5
NH_3, mg/dm^3	0,6	0,2	2,0
NO_2^-, mg/dm^3	0,02	0,06	0,2
NO_3^-, mg/dm^3	26,0	22,0	50,0
NH_4^+, mg/dm^3	0,8	0,3	2,0
PO_4^{3-}, mg/dm^3	2,0	0,4	2,0
S^{2-}, mg/dm^3	12,0	6,0	not permitted
Date of taking sample	31.08.2017	13.08.2017	
Note: Weather – sunny. Volume of samples – 1 liter. Examinations were carried based on Decree N 130, dated 17.09.1996 of the Minister of Environment and Natural Resources of Georgia, "Protection Rules for Surface Waters Pollution of Georgia", sanitation norms and rules 2.1.4.000.00.			

Protocol #2 of waste water in river *Bartskhana*

Indicators	*MPC*	*Result of the analysis*
pH	6,5-8,5	8,0
Suspended particles, mg/dm^3	60,0	10,0
BOD$_5$, mg O_2 / dm^3	2,5	3,0
NH_3, mg/dm^3	2,0	0,8
NO_2^-, mg/dm^3	0,2	0,2
NO_3^-, mg/dm^3	50,0	18,0
NH_4^+, mg/dm^3	2,0	0,2
PO_4^{3-}, mg/dm^3	2,0	0,2
S^{2-}, mg/dm^3	not permitted	8,0
Date of taking sample		13.08.2017
Note: Weather – sunny. Volume of samples – 1 liter. Examinations were carried based on Decree N 130, dated 17.09.1996 of the Minister of Environment and Natural Resources of Georgia, "Protection Rules for Surface Waters Pollution of Georgia", sanitation norms and rules 2.1.4.000.00.		

Protocol #3 of waste water in river *Korolistskali*

Indicators	*MPC*	*Result of the analysis*
pH	6,5-8,5	6,0
Suspended particles, mg/dm^3	60,0	18,0
BOD$_5$, mg O_2 / dm^3	2,5	10,0
NH_3, mg/dm^3	2,0	2,5
NO_2^-, mg/dm^3	0,2	0,3
NO_3^-, mg/dm^3	50,0	28,0
NH_4^+, mg/dm^3	2,0	3,0
PO_4^{3-}, mg/dm^3	2,0	2,0
S^{2-}, mg/dm^3	not permitted	12,0
Date of taking sample		14.07.2017

Note: Weather – sunny. Volume of samples – 1 liter. Examinations were carried based on Decree N 130, dated 17.09.1996 of the Minister of Environment and Natural Resources of Georgia, "Protection Rules for Surface Waters Pollution of Georgia", sanitation norms and rules 2.1.4.000.00.

Protocol #4 of waste water in rivers *Mejinistskali and Chakvistskali*

Indicators	*Result of the analysis*		*MPC*
	Mejinistskali	*Chakvistskali*	
pH	8,0	8,0	6,5-8,5
Suspended particles, mg/dm^3	8,0	12,0	60,0
BOD_5, mgO_2/ dm^3	3,0	80	2,5
NH_3, mg/dm^3	*ND*	1,0	2,0
NO_2^-, mg/dm^3	0,04	0,1	0,2
NO_3^-, mg/dm^3	20,0	24,0	50,0
NH_4^+, mg/dm^3	0,04	1,2	2,0
PO_4^{3-}, mg/dm^3	0,1	3,0	2,0
S^{2-}, mg/dm^3	*ND*	9,0	not permitted
Date of taking sample	23.03.2017	08.09.2017	

Note: *ND* is lower than discovered norm. Weather – sunny. Volume of samples – 1 liter. Examinations were carried based on Decree N 130, dated 17.09.1996 of the Minister of Environment and Natural Resources of Georgia, "Protection Rules for Surface Waters Pollution of Georgia", sanitation norms and rules 2.1.4.000.00.

Protocol #5 of waste waters coming from various Batumi car wash stations

Indicators	*MPC*	**Car wash stations in Batumi territory (Angisa Settlement)**			
		1	***2***	***3***	***4***
pH	6,5-8,5	9,0	9,0	9,0	9,0
Suspended particles, mg/dm^3	60,0	20,0	10,0	25,0	10,0
BOD_5, mg O_2 / dm^3	2,5	8,0	4,0	4,0	8,0
NH_3, mg/dm^3	2,0	0,04	*ND*	0,02	*ND*
NO_2^-, mg/dm^3	0,2	0,02	*ND*	0,02	*ND*
NO_3^-, mg/dm^3	50,0	12,0	6,0	6,0	6,0
NH_4^+, mg/dm^3	2,0	0,04	0,02	0,06	0,06
PO_4^{3-}, mg/dm^3	2,0	0,1	0,1	0,08	0,04
S^{2-}, mg/dm^3	not permitted	4,2	6,0	2,0	2,0
Date of taking sample		**18.10.2017**	**31.08.2017**	**27.09.2017**	**3.10.2017**
Note: *ND* is lower than discovered norm. Weather – sunny. Volume of samples – 1 liter Examinations were carried based on Decree N 130, dated 17.09.1996 of the Minister of Environment and Natural Resources of Georgia, “Protection Rules for Surface Waters Pollution of Georgia”.					

III.3 Examination protocols of every day and industrial waste waters in Adjara Black Sea Coastline rivers

protocol #1

Indicators	*MPC*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
pH	6,5-8,5	9,0	<->	8,0	7,0	9,0	6,0	7,0	9,0	<->	8,0
Suspended particles, mg/dm^3	60,0	18,0	25,0	38,0	22,0	12,0	16,0	14,0	10,0	25,0	25,0
BOD_5, mg O_2 / dm^3	2,5	7,0	0,54	6,0	2,0	8,0	10,0	9,0	8,0	40,0	6,0
NH_3, mg/dm^3	2,0	0,2	20,0	*ND*	*ND*	1,8	1,0	0,8	4,5	<->	0,1
NO_2^-, mg/dm^3	0,2	0,06	1,5	*ND*	0,06	0,1	0,1	0,2	0,3	<->	0,08
NO_3^-, mg/dm^3	50,0	16,0	90,0	10,0	16,0	25,0	19,0	30,0	35,0	<->	12,0
NH_4^+, mg/dm^3	2,0	0,2	<->	*ND*	0,2	2,2	2,0	0,7	4,0	<->	0,1
PO_4^{3-}, mg/dm^3	2,0	0,1	<->	*ND*	0,8	3,0	1,4	1,0	3,0	<->	0,2
S^{2-}, mg/dm^3	not permitted	6,0	<->	10,0	*ND*	12,0	12,0	12,0	25,0	<->	2,0
Date of taking sample		**18.08.07**	**04.07.07**	**13.02.08**	**15.03.07**	**10.12.07**	**13.11.07**	**08.10.07**	**10.07.07**	**11.01.08**	**29.03.07**

Note: ***1.*** Adlia Customs Terminal ”Toria;
2 - Ltd ”Batumi Water Channel (Adlia Treatment plant);
3 – Railway buffer capacity;
4 – Khelvachauri borough ”Bread-Products” Ltd;
5 - Ltd Sanitary cleaning
<-> has not been measured
6 – Urekhi, Flour-milling plant ”Bashaki”;
7 – Hotel Complex ”Oasis”;
8 - Hotel Complex ”Kvariati-2005”;
9 - Central Agricultural market;
10 – Batumi Airport (treatment plant).
ND is lower than discovered norm

Decree N 130, dated 17.09.1996 of the Minister of Environment and Natural Resources of Georgia, “Protection Rules for Surface Waters Pollution of Georgia”; Sanitation norms and rules 2.1.7.000-00; Sanitation norms and rules 2.1.4.000.00.

Protocol #2 of waste water examination coming out from central building of Batumi oil-treatment plant

Indicators	*MPC*	*Result of the analysis*	
pH	6,5-8,5	8,5	8,0
Suspended particles, mg/dm^3	60,0	8,0	10,0
BOD_5, mgO_2/ dm^3	2,5	2,0	3,0
NH_3, mg/dm^3	2,0	*ND*	0,1
NO_2^-, mg/dm^3	0,2	0,08	0,1
NO_3^-, mg/dm^3	50,0	18,0	26,0
NH_4^+, mg/dm^3	2,0	*ND*	0,2
PO_4^{3-}, mg/dm^3	2,0	*ND*	*ND*
S^{2-}, mg/dm^3	not permitted	*ND*	*ND*
Date of taking sample		**25.01.2018**	

Note: *ND* is lower than discovered norm Weather – sunny
Volume of samples – 1 liter

Examinations were carried according to sanitation norms and rules 2.1.4.000.00

protocol #3. Biochemical Oxygen Demand (BOD_5) concentration is not permited in waste waters coming out from Batumi oil terminals

№	*Object name*	*Result of the analysis*	*MPC, mgO_2/dm^3*
1	"Oil Terminal" diesel oil holding reservoir (Batumi)	3,0	2,5
2	Central oilholding reservoir	0,2	
3	Bartskhana oiholding reservoir	16,0	
4	**Diesel oil holding reservoir**	0,5	
Date of taking sample		**27.05.2017**	

Note: Weather – sunny Volume of samples – 1 liter
Examinations were carried according to sanitation norms and rules 2.1.4.000.00

Examination protocol #4 of waste waters coming out from Batumi Construction Companies

Indicators	*MPC*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
pH	6,5-8,5	8,0	7,0	8,0	9,0	9,0	9,0	9,0	9,0
Suspended particles, mg/dm^3	60,0	12,0	6,0	10,0	8,0	8,0	12,0	8,0	8,0
BOD_5, $mg\,O_2/dm^3$	2,5	2,0	1,0	5,0	7,0	4,0	8,0	10,0	9,0
NH_3, mg/dm^3	2,0	0,04	*ND*	*ND*	*ND*	0,04	0,08	*ND*	*ND*
NO_2^-, mg/dm^3	0,2	0,06	0,04	0,04	0,04	0,02	0,02	0,04	*ND*
NO_3^-, mg/dm^3	50,0	18,0	8,0	22,0	12,0	12,0	16,0	9,0	9,0
NH_4^+, mg/dm^3	2,0	0,1	0,02	0,06	0,2	0,08	0,1	*ND*	*ND*
PO_4^{3-}, mg/dm^3	2,0	0,06	*ND*	0,04	0,8	0,1	1,0	0,2	0,4
S^{2-}, mg/dm^3	Not permitted	*ND*	*ND*	*ND*	6,0	4,0	8,0	4,0	10,0
Date of taking sample		**23.06.17**	**23.06.17**	**23.06.17**	**06.08.17**	**06.08.17**	**11.08.17**	**11.08.17**	**04.09.17**

Note: *ND* is lower than discovered norm

Examinations were carried according to sanitation norms and rules 2.1.4.000.00

1 – Ltd Batumi "Construction-Refurbishment Company";
2 - Ltd "Road ";
3 - Ltd "Road ";
4 - Ltd "Arena";
5 – Ltd "Ementi Buildign Company";
6 – Ltd "Batumi builder";
7 - Ltd "Breakstone";
8 - Ltd "Granite".

Conclusions

I. The character of Adjara inside waters are stipulated by complex geological structure, relief and peculiarities of climate, which make influence at the speed of surface waste and chemical consistency of waters. From Adjara inside waters, rivers have got the main place, which belong to mountainous rivers type. Because of hard separation of small territory and relief of Adjara, the length of majority of rivers is short (about 75 km), the exception is river Tchorokhi (Length- 438 km). Almost all rivers of Adjara belong to the Black Sea Basin. The water-protection lines/zones of The Black Sea Zone Rivers of Adjara are densely populated at the most territory and at these zones it is prohibited to flow waste waters without appropriate license which is issued by state environmental protection authorities according to the rules set under the laws.

II. The modern chemical-ecological conditions of big and small rivers waters of Adjara Black Sea Coastline are studied (Tchorokhi, Adjaristskhali, Khoroloistskhali, Choloki, Kintrishi, Chakvistskhali, Bartskhana, Mejinistskhali, Kubastskhali, Zeda Ghele). In waters of all studied rivers' waters the consistency of suspended particles importantly exceeds maximal permissible concentration norm (0,25-0,75 mg/dm^3) and it varies in the limits of 8-19 mg/dm^3. The rivers – Tchorokhi, Khorolistskhali, Bartskhana, Kubastskhali are distinguished with the increased consistency of biochemical oxygen demand (BOD5) to maximal permissible concentration (7-10 mg/dm^3). High concentrations of ammonia and ammonium are fixed in Khorolistskhali, Bartskhana and Kubastskhali. The amount of phosphates has exceeded maximal permissible concentration norm almost by 9 times in Chakvistskhali and as for sulphides, almost all examined and studied rivers' waters were polluted by them. From small rivers Bartskhana and Kubastskhali were distinguished by the increased consistency of copper - 1, 5-2, 1 mg/dm^3 (maximal permissible concentration 1 mg/dm^3). The rivers Khorolistskhali, Bartskhana and Kubastskhali are in especially deplorable conditions in the waters of which the majority of discussed indicators are above maximal permissible concentration norm. dynamics of ammonium in Adjara rivers is as follows: the minimal consistency of it is fixed from the period late Autumn to the mid of Spring and the maximal consistency is fixed – from the late spring to the first months of Autumn.

III. According to the analysis of organoleptic indicators of four small rivers of Khelvachauri - Jotchostskhali, Mejinistskhali, Periistskhali and Kapreshumistskhali it was identified that undesirable conditions were in rivers Periistskhali and Mejinistskhali according to their smell near at pollution source (3-4 points). The samples of Jotchostskhali taken near at river source were distinguished by maximal purity (0 points - in all four seasons). The smell intensity was increased in rivers in summer season compared to the winter season. The samples of Jotchostskhali were colourless at river source. Periistskhali and Mejinistskhali water samples taken near at pollution source were distinguished by unusual colour for surface waters. According to the transparency, the comparative advantage of Jotchostskhali was revealed compared to the other rivers. The water transparency was increased in rivers in summer season. In summer in Periistskhali and Mejinistskhali waters near at pollution source the temperature increase by +6-7°C was noted compared to the natural river temperature which is prohibited according to the regulation norms and which indicates the high pollution quality of the mentioned rivers. The water *pH* in all seasons is natural near at river sources. In the samples taken at pollution sources *pH* of Periistskhali and Mejinistskhali were beyond regulated norms. The consistency of suspended particles in the waters of all four rivers was beyond the regulated norm in all the seasons of the year and their concentration was maximal in winter season. This kind of regularity was revealed according to the consistency of dry residuals, though the mentioned parameter in the waters of all four rivers is in the limits of regulated norms. The samples taken from the river Jotshostskhali source were distinguished by high consistency of soluble oxygen in water. The decrease of the mentioned parameter was fixed at pollution source in river Mejinistskhali in all the seasons of the year and in Periistskhali in summer only. At river sources BOD5 was in the limits of regulated norms. The BOD5 near at pollution sources was beyond permissible norms in summer and autumn in Mejinistskhali and Periistskhali. The minimal indicator of permanganate oxidation was fixed near at source of river Jotchostskhali and high indicator was fixed in Mejinistskhali – near at pollution source in all four seasons. The concentration of nitrate-ions and nitrite-ions was in the limits of maximal permissible concentration norm at sources of all rivers. The concentration of nitrites near at pollution source was beyond maximal permissible concentration norm in river Mejinistskhali in summer and winter and in Periistskhali in winter only. The maximal accumulation of chlorides and sulphates was fixed in rivers Mejinistskhali and Periistskhali near at pollution source. The concentration of toxic elements are not above maximal permissible concentration norm in neither samples of river waters taken for analysis (Pb <0,03mg/l, Cu <1mg/l). It is noteworthy, that the concentration of heavy metals near at pollution sources was minimal in river Jotchostskhali. Hence, based on organoleptic and physical-chemical parameters research the advantage of Jotchostskhali was revealed in chemical-ecological aspect compared to Kapreshumistskhali, Mejinistskhali and Periistskhali. Especially undesirable conditions were fixed in river Mejinistskhali - near at pollution source. It is necessary to carry systematic research of chemical consistency of rivers' waters and periodic monitoring to this direction for the purpose of identifying their pollution quality. This issue acquires special actuality for the small rivers as they are densely populated and therefore, real risk is created for the everyday life of population and environmental pollution as well.

IV. Hotel Complexes located in the Black Sea Coastline from which on two of them chemical analysis was made by us at everyday waste waters and the following was identified: Hotel Complex "Oasis" (Chakvi) the consistency of ammonium in waste water exceeds maximal permissible concentration by 5 times as for the biochemical oxygen demand it exceeds the nor by - 1,5 times. In the waters of Hotel Complex "Kvariati-2005" (Kvariati) the indicator of *pH* is deviated to average alkali, as for the ammonium consistency, it exceeds the permissible concentration norm by 17 times and the BOD5 exceeds the norm by 1,3 times. In the waters of both Hotel Complexes increased consistencies of ammonium and sulphides is noted (therefore, 1,8-12,0 and 4,0-15,0 mg/dm^3).

V. The analysis of chemical indicators of waste waters of some car wash stations of Batumi showed that *pH* indicator was increased in all of them (*pH 9*). Besides, the increase of BOD5, ammonium and sulphides concentration was noted in most of the examined waters.

VI. The analysis of chemical indicators of waste waters of industrial enterprises such as (Purkombinati, Flour-Milling Plant, Sandasuptaveba, Water Treatment Plant, Private Construction Companies) showed that in *pH* was deviated to alkali reactions (*pH 8-9*), as for biochemical oxygen demand, it exceeded the norm (7-20 mg/dm^3). The waters were polluted with sulphides and ammonium nitrogen.

VII. In the waste waters of Batumi Oil Holding Stations biochemical oxygen demand indicator is high (9,6-17,0 mg/dm^3), which proves the fact of their high pollution. The mentioned parameter is especially increased at oil holding stations of Bartskhana and Batumi Oil Refinery facrtory settlements and in waste waters coming out from Batumi Oil Terminal.

VIII. Hence, chemical consistency of most waste waters of enterprises located in the territory of Adjara does not satisfy requirements determined under International Standards. According to the received results it is vivid that enterprises located in the Black Sea Coastline are not equipped with appropriate treating facilities or they do not work with full time mode and the waste waters coming from them, pollute on one hand The Black Sea water and on the other hand the environment. Therefore it is necessary to perform the following: improving water quality and amount as well as consumption structure monitoring; increasing efficacy of water consumption in all the sectors through introduction of necessary technique and technologies for water economy; improving industrial and everyday waste waters treatment systems; improving water quality for the purpose of preventing pollution of river sources.

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