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Yuldosheva Mokhinur Murodovna

Study the Zarafshan River water resources`s pollution with heavy metals

THESIS

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Scientific supervisor: Phd Boboev.H

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ABSTRACT

Water pollution is a challenge for sustainable development in many river basins. This study analyzed pollution by heavy metals of Zarafshan River, which originates on the territory of Tajikistan and supplies water for population, industry and irrigation in Uzbekistan. The study estimated changes in the concentration of heavy metals between 2010 and 2018. We found that in most of the cases in the study period the level of heavy metals was within the permissable level. However, copper concentration was higher than the permissible level, which was caused by both, by Tajik enterprises located in the upper reaches of the Zarafshan River, as well as the industry enterprises located in the downstream on the territory of Uzbekistan. Further studies are required to analyze a distribution of heavy metals within the river basin.

Research goal: Assignment of Zarafshan River water resources pollution with heavy metals and development of protection measures.

Objectives:

1.Cortment (regulations) and state of Zarafshan River water pollutions with heavy metals and its treatment

2.Projection of Zarafshan River water by heavy metals.

3.Development of protection measures (senarious of water management)

Scientific novelty:

1. Determination of water quality of selected hydroposts
2. Practical recommendations on the ecological condition of the area to reduce heavy metals in the river

The composition of the dissertation: The dissertation work consists of an introduction, three chapters, conclusion, and a list of references. The main content is presented on * * * pages, including * * figures, * * tables and * * graphics.

Subject and study area: This study consisted of an assessment of surface water contaminants in Zarafshan, in which 8 hydro posts were assessed. These hydro posts are located in Samarkand and Navoi.

Methodology: The main research methods are expert assessment and statistical analysis.

The practical and theoretical significance of this work is to assess the quality of water resources. Provides information on why heavy metals in water exceed the permissible level. The results of this study are mainly used to determine what factors pollute the river and to develop measures against them.

Conclusions and Recommendations: The analysis of water quality of the Zarafshan River for 2010-2018 did show minor changes of concentrations of heavy metals, except copper which is at levels above the permissible due to pollution originating in the river upstream. The study found that the copper concentration along the river bed is above the maximum permissible concentration for all stations on the territory of Uzbekistan, which primary sourced by the industry in the upstream of the river. Special attention is required also for copper concentration below the Navoi city, below the discharges of waste water from the Navoiazot factory. The results of the study indicate needs for establishing an interstate agreement: on permissible levels of heavy metals in the Zarafshan River at the point where the river enters to the downstream state; on environmental flow discharge to be released along the river to maintain suitable water quality. Further studies are required to estimate environmental flow regime and its quality.

Publications:

1.Yuldosheva M., KarimovA., SagitaevJ. 2020.Distribution of heavy metals in the downstream of the Zarafshan river, Central Asia, Central Asian Journal of Water Research, CAREC Institute, Kazakhstan, 8pp.

2.YuldoshevaM., Karimov A., Mamadaliev B. 2020. Distribution of heavy metals in the lower reaches of the Zarafshan River, Central Asia. Collection of articles for the XIX traditional scientific and practical conference on «Modern problems of agriculture and water management», TIIAME, Uzbekistan, 6 pp.

3. Zukhridinova K., Yuldosheva M., Nasimov D. 2020. Groundwater irrigation under conditions of increased mineralization, Collection of articles for the XIX traditional scientific and practical conference on «Modern problems of agriculture and water management», TIIAME, Uzbekistan, 5 pp.

Аннотация

Дарёлар ҳавзаларида сувнинг ифлосланиши барқарор ривожланиш учун муаммо ҳисобланади. Ушбу тадқиқотда Тожикистон ҳудудидан келиб чиққан ва Ўзбекистон аҳолиси, саноат ва суғориш учун сув етказиб берадиган Зарафшон дарёсининг оғир металлари билан ифлосланиши таҳлил қилинди. Тадқиқот 2010 ва 2018 йиллар оралиғида оғир металлар концентрациясининг ўзгаришини тахмин қилди. Биз тадқиқот даврида кўп ҳолатларда оғир металлар даражаси рухсат етилган даражадан ошганлигини аниқладик. Бироқ, захира концентрацияси рухсат етилган даражадан юқори бўлиб, бунга Зарафшон дарёсининг юқори оқимида жойлашган тожик корхоналари, шунингдек, Ўзбекистоннинг қуйи қисмида жойлашган саноат корхоналари сабаб бўлган. Дарё ҳавзасида оғир металларнинг тарқалишини таҳлил қилиш учун қўшимча тадқиқотлар талаб етилади.

Тадқиқот мақсади: Зарафшон дарёси сув ресурсларининг оғир металлар билан ифлосланишини аниқлаш ва ҳимоя чораларини ишлаб чиқиш.

Мақсадлар:

1. Зарафшон дарёсининг сувини оғир металлар билан ифлосланиши ва уни тозалаш ҳолати

2.Зарафшон дарёси сувини оғир металлардан ҳимоялаш

3.Ҳимоя чораларини ишлаб чиқиш

Илмий янгилик:

1. To determine the contamination of selected gidroposts with heavy metals

2. Practical recommendation on the ecological status of the territory for the reduction of heavy metals in the river

Диссертация таркиби: Диссертация иши кириш, уч боб, хулоса ва адабиётлар рўйхатидан иборат. Асосий таркиб, саҳифаларда, жумладан, рақамлар, жадваллар ва графикаларда келтирилган.

Мавзу ва тадқиқот йўналиши: Ушбу тадқиқот Зарафшондаги сатҳи ифлослантирувчи моддаларни баҳолашдан иборат бўлиб, унда 8 та гидропост баҳоланди. Ушбу гидро постлар Самарқанд ва Навоийда жойлашган.

Методология: Асосий тадқиқот усуллари експерт баҳолаш ва статистик таҳлилдир.Ушбу ишнинг амалий ва назарий аҳамияти сув ресурсларининг сифатини баҳолашдир. Сувдаги оғир металлар нима учун рухсат етилган даражадан ошгани ҳақида маълумот беради. Ушбу тадқиқот натижалари асосан дарёни ифлослантирувчи омилларни аниқлаш ва уларга қарши чора-тадбирлар ишлаб чиқаришда қўлланилади.

Хулосалар ва тавсиялар: Зарафшон дарёсининг сув сифатини таҳлил қилиш 2010-2018 йилларда оғир металларнинг консентрациясининг озгина ўзгаришини кўрсатди, мисдан ташқари, дарёнинг юқори қисмида жойлашган ифлосланиш туфайли йўл қўйиладиган даражадан юқори. Тадқиқот шуни кўрсатдики, дарё бўйида мис концентрацияси дарёнинг юқори қисмида саноат томонидан таъминланадиган Ўзбекистон худудидаги барча станциялар учун рухсат етилган концентрациядан юқори. Шунингдек, Навоий шаҳридан пастроқда, "Навоиязот" заводидан чиқинди сувлар чиқиндиларида қуйиладиган мис концентрациясига алоҳида еътибор берилиши керак. Тадқиқот натижалари давлатлараро келишувни ўрнатиш зарурлигини кўрсатмоқда: Зарафшон дарёсида дарёнинг қуйи оқимигача бўлган нуқтада рухсат етилган оғирлик даражаси; мувофиқ сув сифатини таъминлаш учун дарё бўйидаги атроф-муҳит оқими захиралари бўйича. Атроф-муҳит оқими режими ва унинг сифатини баҳолаш учун қўшимча тадқиқотлар талаб етилади.

Мақолалар:

1. Юлдошева.М Каримов.А Сагитаев.Ж << Зарафшон дарёсининг қуйи оқимида оғир металларнинг тарқалиши, Марказий Осиё >>, Марказий Осиё сув тадқиқотлари журнали, CAPEC институти, Қозоғистон, 8 б.

2. Юлдошева М Каримова. Мамадалиев Б << Зарафшон дарёсининг қуйи оқимида оғир металларнинг тарқалиши, Ўрта Осиё >> XIX қишлоқ хўжалиги ва сув хўжалигидаги замонавий илмий-амалий конференция учун мақолалар тўплами. ", ТИИАМЕ, Ўзбекистон, 6 бет.

3. Зухридинова К., Юлдошева М., Насимов Д., 2020 йил, "Юқори минераллашув шароитида ер ости сувларини суғориш", "Қишлоқ ва сув хўжалигининг замонавий муаммолари" мавзусидаги XIX анъанавий илмий-амалий анжуман учун мақолалар тўплами, ТИИАМЕ, Ўзбекистон, 5 бет.

Content

Chapter I. Study area

1.1 Geomorphology and relief

The surface of the modern and ancient delta of the Zeravshan River is a slightly inclined plain with a general slope to the southwest, the slope of the surface is directed from the upper part of its delta to the lower reaches, in the south towards the Karakul oasis, in the west towards the Amu Darya.[2]

ZERAVSHAN (Persian, gold - gold, af-shon - splashing) - a river flowing through the territory of Tajikistan and Uzbekistan. In the original source of the Avesta, this river is referred to as "Daitia" - "Good Water."

The Zeravshan River begins with the Zeravshan glaciers, adjoining mountain systems of Turkistan, Zeravshan and Alai - Mastchokh (Sinai water) under the name Mastchokh. About 189 km below the mouth of the river, the left of the Fondar flows to it and the river gets the name Zeravshan. About 4,200 tributaries flow to Zerafshan, starting from glaciers and springs. The largest of them are Fondaro, Kushtutdaryo, Magiyendaryo. In the upper course between the mountain ranges and narrow gorges of the valleys, the river flows very quickly. The river bed becomes a little wider only in the places where the tributaries join. The Zeravshan river near the Rawatkhodja dam flows across the border to Uzbekistan and then flows through the territory of Samarkand, Navoi and Bukhara regions.[9]

At the Chuponot Upland, east of Samarkand, the river is divided into two parts - Akdarya (right-bank) and Karadarya (left-bank). They form the island of Miyonkol and then again join near the village of Yangyrabot (Navoi region). Approximately 70-75% of the river flow flows along the Karadarya. In this interval, many sais are formed in the surrounding mountains, however, due to lack of water and a large fence for irrigation, they dry out, not reaching the Zerafshan River. Near the city of Navoi in the interval between the villages of Boykut and Toshrab the river valley narrows significantly, then flows in a south-westerly direction and enters the Kyzylkum desert.

The Zeravshan river then flows through the Bukhara and Karakul region (in this part, before the city of Karakul, the river is also called Karakuldary). With the help of a dam of a hydroelectric facility located 3 km above the city of Karakul, the Zeravshan River is divided into canals (the left, which is called Toykir for the most and the right, Saribozor). Both channels in the upper part are used as irrigation canals. Excess irrigation water and return water along the Toykir channel flow into Lake Dengizkul. The Saribozor Canal also provides water for the Karakul oasis, however, in most cases, the channel remains dry in the lower reaches and the Zerafshan River does not reach the Amu Darya.[14]

The catchment area of the Zeravshan River is high. The land mark on the site above the bridge averages 3100 m. Accordingly, there are numerous glaciers and snow. In the basin of the Zeravshan River, 424 glaciers with an area of 1 ha or more were registered, their total area is 557 km2.[1]

The Zeravshan River is fed by the waters of glaciers, eternal and seasonal snow cover and springs. In the mountainous part of the river basin Zeravshan meets more than 80 lakes. The flood of the Zerafshan River is observed in the period April - September. During this period, 80–85% of the river's annual flow occurs, the remaining part (low-water period) falls on the autumn-winter period (October-March). The largest river flow occurs in the July – August months.[Figure 1][3]

The Zeravshan River, the total length of which, taking into account the tributaries, is 781 km, is the third river in Central Asia, and only Amu Darya and Syr Darya in terms of water availability. The catchment area of the river is 11722 km2. In the river basin, in the part covering only the territory of the Republic of Uzbekistan, about 4 million people currently live, of which more than 3 million people are the rural population.The level of vegetative flow of water in the valley on the territory of the Republic of Uzbekistan is 2.9-4.3 km3.

The river flow is regulated by the hydraulic system in the head part, and in the end part with the help of the Kattakurgan and several small reservoirs. In the basin there are water bodies of special state significance. Chuponatinsky and Dagbidsky municipal water intake facilities with a capacity of 300 thousand m3 per day, providing drinking water to Samarkand. Damhodzhinsky water intake, supplying clean drinking water to the Bukhara and Navoi regions in the amount of 400 thousand m3 per day.[7]

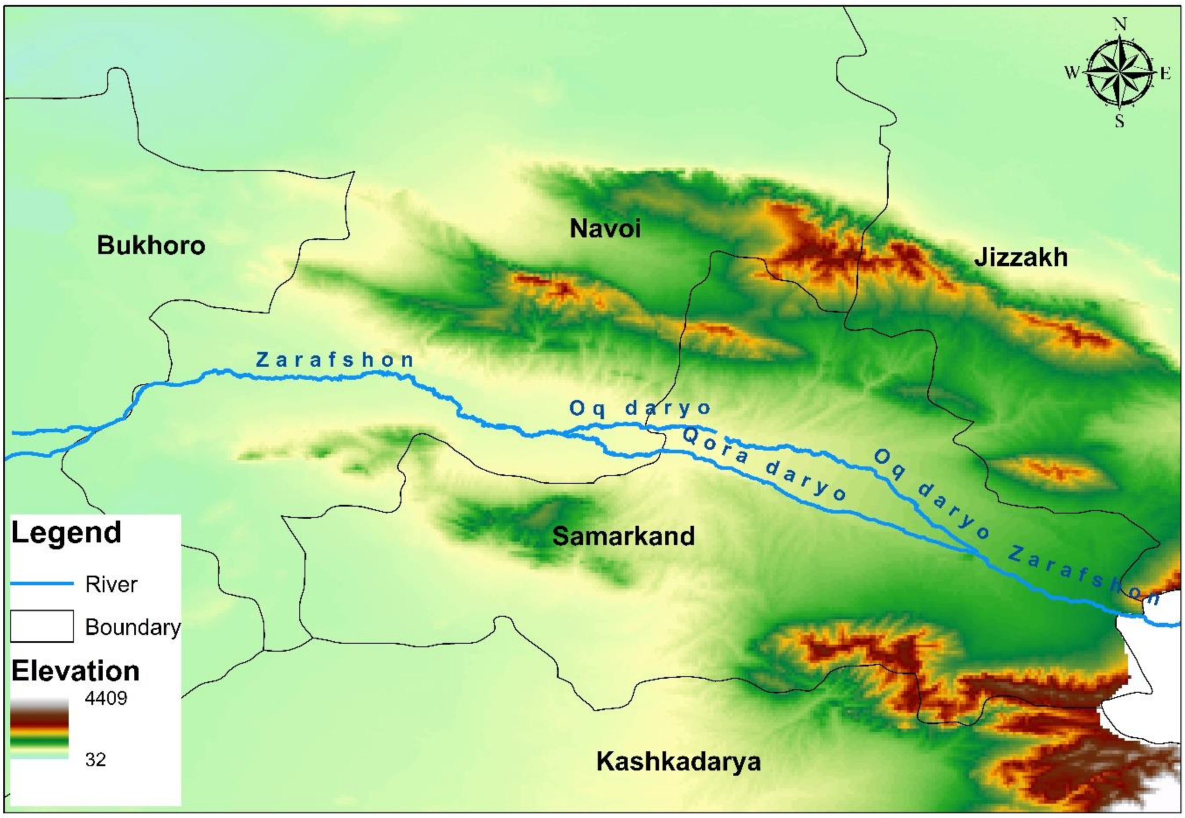


Figure 1.Location of Zarafshan River

1.2. Climate

Climate of Samarkand

At an average temperature of 26.2 °C | 79.2 °F, July is the hottest month of the year. January has the lowest average temperature of the year. It is 1.3 °C | 34.3 °F. Between the driest and wettest months, the difference in precipitation is 67 mm | 3 inch. During the year, the average temperatures vary by 24.9 °C | 76.8 °F.

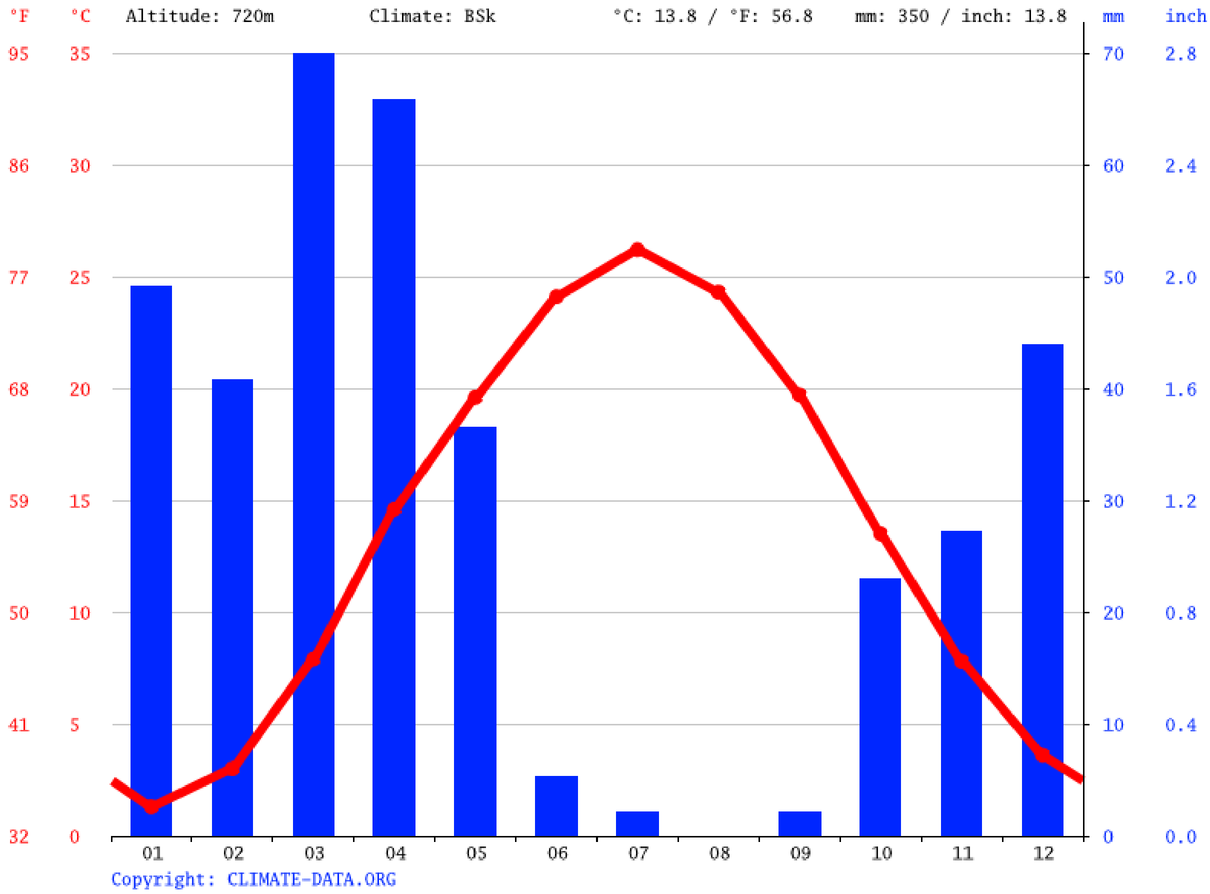


Figure.2. Weather by moths in Samarkand https://en.climate-data.org/asia/uzbekistan/samarkand-province/samarkand-2776/

The Samarkand lies on 720m above sea level Samarkand's climate is a local steppe climate. In Samarkand, there is little rainfall throughout the year. This location is classified as BSk by Köppen and Geiger. The average annual temperature is 13.8 °C | 56.8 °F in Samarkand. In a year, the rainfall is 350 mm | 13.8 inch. Precipitation is the lowest in August, with an average of 0 mm | 0.0 inch. With an average of 67 mm | 2.6 inch, the most precipitation falls in March.

Climate of Navoi

During the month of April and October you are most likely to experience good weather with pleasant average temperatures that fall between 20 degrees Celsius (68°F) and 25 degrees Celsius (77°F).On average, the warmest month(s) are June, July and August.The months of March have a high chance of precipitation.

Navoi has dry periods in June, July and August.The warmest month is July with an average maximum temperature of 33°C (91°F).The coldest month is January with an average maximum temperature of 6°C (26°F).December is the most wet month. This month should be avoided if you are not a big fan of rain.August is the driest month.

The temperatures are highest on average in July, at around 28.4 °C | 83.1 °F. January is the coldest month, with temperatures averaging 0.3 °C | 32.5 °F.

The Navoiy lies on 372m above sea level The climate in Navoiy is referred to as a local steppe climate. During the year there is little rainfall. According to Köppen and Geiger, this climate is classified as BSk. The temperature here averages 14.6 °C | 58.2 °F. The rainfall here is around 200 mm | 7.9 inch per year.

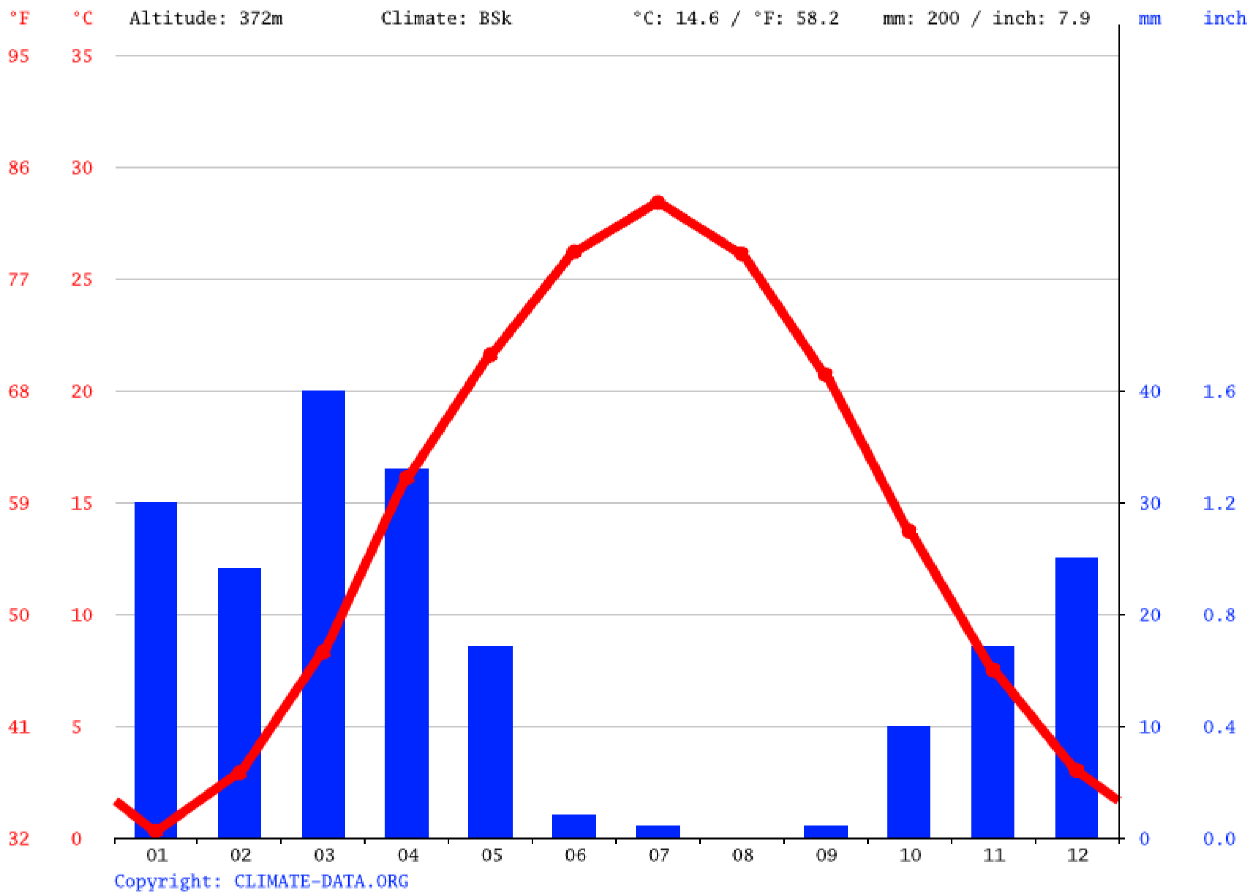


Figure.3.Weather by months in Navoi https://en.climate-data.org/asia/uzbekistan/navoiy-province/navoiy-2873/#temperature-graph

1.3. Hydrology and Hydrogeology

To date, the work on measuring the water consumption of the Zarafshan River has been carried out by the Uzgidromet in 16 punches (Ravotkhuja,Ongirdag channel (Tuyattar), Dargum channel, Qaradaryo: the White-Karadaryo water ayirgichi, the Central Miyonkul Canal, the Kurbanabad channel, faragkanali, Karadaryo: Khatirchi, Ziyotdin, Navoi city, Khazora, Akdaryo: the White-Karadaryo water ayirgichi, Zarafshan: Khatirchi, a channel that is poured into the kattakurgan water stream, a channel that receives water from the kattakurgan water stream, a sink channel) is carried out. In the Zarafshan river itself, 5 punks, in Akdaryo 1 punks, in the Black Sea 2 punks, in the rest - in the channels (Table 1.1) [gologologich. Ejegodnik Uzgidromet]. 70-75% of Zarafshan water flows through the Karadarya

1.1-table

Zarafshan River flow, Ravotkhuja dam,м^3/c *

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2012	47,3	44,8	24,4	26,8	34,9	145	192	120	63,8	14,1	11,9	45,3
2013	56,8	34,8	20,6	20,1	31,5	181	136	111	50,7	15,7	9,36	41,9
2014	43,5	40,2	26,3	21,2	24,9	121	120	81,5	48,8	17,4	38,5	52,5
2015	33	39,7	23,5	10,8	46	158	232	89,4	18,6	14,6	16,4	3,3
2016	2,77	-	-	-	156	262	212	89,6	34,6	12,1	11,2	12,7
Kashkadarya, White-Kashkadarya water ayirgichi,м^3/c *												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2012	46,6	40,6	30	7,29	4,01	81,4	147	70,1	38	0,072	1,28	34,9
2013	44,8	27,8	2,73	2,25	14,2	104	90,3	76,1	24,7	-	2,53	25,3
2014	28,5	27	13,1	3,43	2,76	72,7	91,2	64,3	43,8	10,8	20,5	23,5
2015	25,7	32	15,4	0,522	20,4	119	186	67,4	4,05	2,83	10,8	2,29
2016	5,68	12,1	3,15	7,63	82,8	142	118	36,4	7,49	-	1,69	6,17
Kashkadarya, Khatirchi,м^3/c *												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2012	3,04	13	8,8	5,46	12,8	29,6	73,6	27,6	23,8	11,9	23,8	3,04
2013	4,58	4,31	3,78	3,76	14,2	30,7	29,8	29,9	24,7	24,1	12,2	3,75
2014	4,58	4,31	3,78	3,76	14,2	30,7	29,8	29,9	24,7	24,1	12,2	3,75
2015	3,69	5,01	3,65	7	20,8	22	61,6	33	21,5	19,3	6,67	5,13
2016	5,06	20,7	8,58	7,78	25,1	51,4	61,2	22,8	16,1	13	10,1	3,21
Zarafshon, Ziyotdin,м^3/c *												

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2012	33	51,1	101	201	39,2	51,7	102	43,7	36	31,3	31	30,1
2013	42,7	49,4	45,2	42,9	34,3	44	47,2	44,1	33,5	32,4	30	29,7
2014	28,4	36,8	35,3	36,7	31,7	31,7	31,8	30,7	29,3	26,4	30,7	29
2015	30,3	55	49,8	35,1	30,4	38,1	70,9	46,2	29,9	32,7	33,9	32,8
2016	32	47,9	32,2	31,7	53,2	80	68,6	41,9	31,7	31,1	35,8	34
Zarafshon, Navoiy city, м^3/с *												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2012	35,2	76	98,5	28,8	19,4	20,9	65,9	6,05	25,6	23,8	31,3	40,9
2013	42,1	57,3	50,2	28,7	14,6	22,3	10,3	11	13,8	16,6	26,4	41,7
2014	27,1	42,6	17,5	11,6	8,41	5,23	3,09	2,82	4,63	17,6	23,9	40,8
2015	18,2	44,8	48,1	23,1	3,52	4,53	22,7	10,1	15	17,7	27,3	28,5
2016	25,6	47	17,1	37,5	34,1	58,2	27,5	11,7	14,9	20,2	24	32,5
Zarafshon, Xazora,м^3/с *												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2012	#	#	#	#	#	#	#	#	#	#	#	#
2013	37,2	39,3	34,1	22,8	6,38	15,9	10,2	12,5	13,3	14,9	17,7	28,5
2014	-	-	-	-	-	-	-	-	-	-	-	-
2015	-	-	-	0,037	0,2	0,2	0,3	0,4	0,29	0,14	0,065	-
2016	0,095	0,083	0,2	0,22	0,2	0,39	0,4	0,4	0,26	0,4	0,29	-

* Source: Uzgidromet, about the regime of surface water resources and annual data, 2012-2016 yy.

- Water consumption is not calculated.

The information has not been recorded.

1.4. Water use

The Zarafshan river basin is one of the most densely populated areas in Central Asia. The current social and economic situation in the region requires a significant increase of water supply to communal and household needs, developing industry, irrigated agriculture and other fields of national economy. At the same time a tense situation with water utilization and ecology is developing which no doubt manifests itself in the sanitary and hygienic conditions in the region. The situation is also worsening because a certain number of residents in the rural area use water from open reservoirs and canals for household needs and drinking. The level of water provision of population in the Navoi province with centralized water supply (50,6%), tube-wells (28,3%), water brought in tanks (15%) and utilization of water from open reservoirs for household needs and drinking (6,1%) shows how high the risk of intestinal infection is in this area.[18]

The river Zarafshan runs through the territory of the Samarkand, Navoi and Buchara provinces. It is one of the main sources of water consumption of the population, including economic, cultural, household and drinking use. Recently the quality of the Zarafshan water has sharply deteriorated due to the antropogenic press.

The Zarafshan River being the sole source of potable water supply receives communal, household, industrial and agricultural sewage in the Leninabad province of Tadjikistan, the Samarkand and Navoi provinces of Uzbekistan. The quality of water in the examined part of the river Zarafshan is formed by dropping industrial and municipal sewage of the cities Samarkand, Kattakurgan, Navoi, Pendjikent and towns Bulungur, Dzhambai as well as by agricultural sewage from the rural area.All these significantly worsen the sanitary and hygienic situation in the region. The most contaminated water is in the area below Navoi-city, i.e., in the investigated area. Here the Sarafshan receives the sewage from the chemical plant "Navoiazot" (Navoi-nitrogen), where the main contaminating components are acids, ammonium, nitrates, cyanides, organic substances, and phenols.[28]

Effects of heavy metals on the environment and human health

It is important to study the pollution of the environment with heavy metals. This is because heavy metals in the environment (air, water, soil) can accumulate in plants and animals and pass from one organism to another through "food chains". According to some scientists, metals with an atomic mass greater than 50 are heavy metals. However, among these metals are metals that are widely used in various industrial processes and pose a serious threat to living organisms due to their biological activity and toxicity.

Heavy metals are toxic to soil, plants, aquatic life and human health if their concentration is high in the compost. Heavy metals exhibit toxic effects towards soil biota by affecting key microbial processes and decrease the number and activity of soil microorganisms.

Certain metal salts and heavy metals including arsenic, mercury, bismuth, lithium, thallium, cadmium, and gold are poisonous, and can cause hair loss as a result of prolonged inhalation in industrial environments or by ingestion.

Mercury. Mercury is considered the most toxic heavy metal in the environment. Mercury poisoning is referred to as acrodynia or pink disease

Such metals include lead (Pb), mercury (Hg), cadmium (Cd), zinc (Zn), cobalt (Co), nickel (Ni), copper (Cu), manganese (Mn), chromium (Gr), molybdenum (Mo) and others. Metals found in natural waters can be divided into two classes: metals commonly found in nature (Fe, Mn, Cu, Zn, Co, Mo, etc.) and anthropogenic "pollutants" (Hg, Cd, Cr, Pb, Sn, Ni). and so on). According to their danger, metals that pollute the environment (water, soil, river sediments) are divided into 3 classes: Class 1 is the most dangerous: cadmium (Cd), mercury (Hg), lead (Pb), zinc (Zn); Class 2: cobalt (Co), nickel (Ni), copper (Cu), chromium (Gr), molybdenum (Mo); Class 3: manganese (Mn).[31]

Sources of contamination of surface and groundwater with heavy metals are galvanic plants, mining, ferrous and nonferrous metallurgy, machine-building enterprises. Heavy metals are also found in fertilizers and pesticides and can fall into water bodies with runoff from agricultural fields. One of the main sources of pollution with heavy metals is thermal power plants. Combustion of fossil fuels (coal) releases mercury, cadmium, cobalt and other metals into the atmosphere. Pollutants released into the atmosphere "sink" into the environment, resulting in soil and water pollution.

One of the sources of soil and water pollution is industrial wastewater. Atmospheric emissions and effluents from industrial enterprises eventually cause heavy metals to fall into soil, groundwater and open water bodies, river sediments, plants and animals.[63]

Heavy metals that fall into water bodies are dispersed in suspended particles and then precipitate in the form of river sediments. Heavy metals in the aquatic ecosystem eventually accumulate in river sediments and biota. Due to the accumulation of heavy metals, suspended particles and river sediments in the water come first, followed by plankton, benthos and fish. Heavy metals in fish can enter the human body and poison them. This was followed by the poisoning of humans by fish from mercury in the sewage of a chemical plant in Japan. An example is Itay-itay, where food poisoning from cadmium in the wastewater of Minamata and the mining and metallurgical enterprise has been observed.

The effect of the granular composition of river sediments on the contamination of river sediments with heavy metals was studied on the example of the Dnieper cascade of reservoirs [3]. During the transition from sands to turbid sediments, the average amount of metals increases (Mn - 10 times, Cd - 8 times, Co, Cu, Pb and Zn - 2-5 times). The authors attribute this to the importance of turbid sediments carrying substrates that bind metals. Based on the analysis performed, the following forms of metals were identified: exchangeable (I), carbonates (II), Fe and Mn (III), organic substances (IV), and metals bound to the crystal lattice of minerals (V).

Form I is more suitable for hydrobionts, where the transition of the metal to the aquifer occurs at room temperature. Metals associated with carbonates, oxides and organic matter (III-IV) are suitable for hydrobionts, so a stronger effect is required to separate them. The metals that make up the lattice structure are almost unsuitable for hydrobionts and form a reserve part of them that is stored at the bottom of the water. Thus, redistribution of individual metals between substrates occurs with increasing turbidity of sediments depending on the granular composition. An increase in Cd mobility and a decrease in Cu are observed; the amount of Mn in the oxide forms also increases.

For some river sedimentary species, there is a difference in the strength of the binding strength of the metals to the substrates. The largest differences were identified for sandy and loamy sediments.

Since the more mobile forms of the elements are represented by the sum of the alternating and carbonate forms, the decrease in the mobile properties occurs in the following order.

Cd > Co ≥ Mn> Pb> Zn≥ Cu.

A.M. Tsvetkova and her colleagues studied the anthropogenic contamination of river sediments of the largest and last Kakhovka reservoir by volume with heavy metals in the Dnieper cascade. The water basin, which is characterized by minimal water exchange and flow in the cascade, is characterized by the accumulation of suspended particles and substances. The low flow in it allows the spread of turbid sediments at the bottom of the reservoir (up to 80% of the area). These turbid sediments belong to a type of organogen. In addition, the amount of heavy metals in this watershed has increased from sands to muddy years.According to the analysis of the results of the study, the level of contamination of river sediments of the Kakhovka reservoir with heavy metals in 1991 increased compared to 1968. The contribution of metals such as Mn, Zn, Pb and Cd has increased in sediments in the reservoir, in residual rock elements.[31]

The most active collectors of heavy metals in river sediments are 0.1 mm particles. The observed part of the high concentrations of heavy metals in river sediments testifies to anthropogenic sources of their formation. In this case, the city of Zaporozhye may be a source of erosive and turbid additions from sewage or water intake parts.

The work on the examples of the migration of substances in natural waters is also of great interest. It was found that this process takes place in three main forms - dissolved, colloidal and suspended. The boundary between them cannot be conditionally and clearly defined. The colloidal form of heavy metal migration is the least studied. Particles of disperse colloidal form that bind heavy metals in natural waters can be of mineral or natural origin.

In lake waters, a certain proportion of metals are associated with inorganic colloidal substances. They are mainly composed of high quality clay minerals. Colloids have high absorption properties and to some extent sorb microelements, including heavy metals. Solutions can coagulate as water changes pH and retains other components. This can increase the storage of sorbed microelements or vice versa - elements in ionic form. The factors that determine the form of heavy metal migration in natural waters are not only the storage of minerals and organic matter. This includes the interdependence between them.

Under natural conditions, mineral particles, like colloids and organic substances, form some organo-mineral complexes. A certain part of micronutrients is connected with them. Studies have shown that the amount of heavy metals in river sediments depends on the nature of the sediment and the storage of organic matter in it.

The difficulty in determining the contamination of heavy metals in river sediments is the simultaneous accumulation of metals of anthropogenic and natural origin [6]. The authors sought to demonstrate anthropogenic contamination with heavy metals by means of Li-mediated methods of heavy metal concentration and multidimensional area statistics of the upper Volga reservoir bottom. Physico-chemical studies of the characteristics of river sediments with the main components and cluster analysis allowed to draw such a conclusion.

The authors [7] conducted a mathematical modeling of chemical migration in a water-river sediment system in a more theoretical study. The main directions of the studied problem are as follows: 1) natural observation of water bodies; 2) laboratory experiments by modeling the natural processes of transfer of substances from river sediments to water and vice versa. The proposed mathematical model allows the concentration of chemicals to be separated in river sediments as well as in water. Many of the above studies have been conducted in almost identical reservoirs. They are, as a rule, characterized by low retention of suspended mineral particles and high retention of organic components. In our area, it is known that there are many mountain rivers, which are characterized by high levels of suspended pests, which form a type of organic humus with mineral ions. In this regard, the mechanism of interaction of sediments with contaminant components has several special features.[18]

Unfortunately, such research is almost non-existent in Uzbekistan. Some of the work done by a group of researchers in Uzbekistan was to study the forms of heavy metals present in the Amudarya and Syrdarya rivers. The elements in the tested waters have been shown to migrate in suspended, colloidal, cationic, anionic, and neutral forms. At the same time, depending on the type of water and the physicochemical properties of the elements, the relationship between them changes. According to perennial data, the retention of heavy metals in colloidal form is in the range of 5-10%. This indicates that the amount of high molecular weight dissolved organic matter in the humic acid type is very low. When examining the physical and chemical condition of mercury, zinc, cadmium, cobalt, chromium and antimony, which have more toxic (toxic) properties, moving in the dissolved state in the water under test, differences were found in the available forms. For example, mercury migrates in anionic, neutral, and colloidal forms. Calculations show that mercury migrates in the form of chlorine and hydrocomplexes, as well as in the form of organomineral compounds in river waters. The main part of Zn and Co in the water under test is the opposite cation in the form of: Zn2 +, ZnOH-, CO2 + and ZnSO4, CoSO4 complex; the anionic proportion is not significant. For driving, Sb (OH) in the form of a hydroxycomplex is characterized by migration in the form of 6 anions. River water also contains the anionic form of chromium, GrO2-4.[23]

Based on the results of natural research data and theoretical modeling experiments, the authors [8] determined that inorganic ligands, such as OH-, SO2-, Cl-, play a major role in the surface waters of arid zones. Unfortunately, no systematic research has been conducted on the detection of heavy metals in river sediments in our region. This requires additional special checks. Let’s take a look at the ways in which heavy metals are released into the environment, particularly surface water and river sediments, as discussed in the study.

Lead (Pb). The main sources of lead pollution in the environment are emissions from car engines. Since 1923, about 80 mg / l antidetonator - tetramethyl or tetraethyl lead - has been added to most gasoline. As a result of the movement of cars, depending on the driving conditions, 25 to 75% of the lead is released into the atmosphere, the bulk of which falls to the ground, but a certain amount also remains in the air. Lead dust not only falls on the surface of large roads and around and into the soil of industrial cities, but can also be found on glaciers.

For example, in the glaciers of Northern Greenland, lead levels were 20mkg / t in 1956, 50mkg / t in 1960, and 210mkg / t in 1965. An active source of lead pollution is power plants and coal-fired farms.

It turns out, coffee is made of chemical components that are really good at trapping heavy metals like mercury and lead, which are common water pollutants, and poisonous in high or sustained doses.

Many metals, particularly heavy metals are toxic, but some heavy metals are essential, and some, such as bismuth, have a low toxicity. Most often the definition of toxic metals includes at least cadmium, manganese, lead, mercury and the radioactive metals.

Lead is not a necessary element for life, it is toxic and belongs to the class 1 hazard group. Its inorganic compounds disrupt metabolism and are inhibitors of enzymes [9]. The most detrimental effect of lead inorganic compounds is its chronic poisoning over a long period of time, which takes place instead of calcium in the bones. In poisoning with organic compounds of lead, high levels of it are detected in the blood. As a result of global pollution with lead, it is found everywhere and in almost all food and feed. Plants contain more lead than animals.

Cadmium and zinc. A potential source of cadmium contamination is mineral fertilizers. In doing so, cadmium falls on plants that humans consume as food and eventually enters the human body during the chain. Cadmium and zinc are easily absorbed into sea and ocean water through surface and groundwater. They accumulate in certain organs of animals (especially the liver and kidneys).

Zinc is more toxic than all the heavy metals listed above. The physiological effect of zinc is manifested in its action as an activating enzyme. Cadmium is more toxic than zinc. It and its compounds belong to the I-hazard class, which is stored in the human body for a long time. 8 hours of inhalation with a dose of 5mg / m3 of cadmium can be fatal. Chronic cadmium poisoning results in the formation of protein in the urine and an increase in blood pressure.

The most effective way to prevent the entry of cadmium and zinc into the body is to control their amount in the environment, that is, the metals in industrial wastes.

However, certain heavy metals are of grave concern as they can harm different organs even at low exposure levels. Other heavy metals found in drinking water such as lead, mercury, arsenic, and cadmium has no beneficial effects on your body. In fact, their accumulation inside the body can cause severe health problems.

If your levels of heavy metal are low, but you still have symptoms of exposure, your health care provider will likely order more tests. Some heavy metals don't stay in the bloodstream very long. These metals may stay longer in urine, hair, or other body tissues.

Copper. Copper belongs to class II according to its hazard, its toxic properties are poorly studied. When copper enters the human body in large quantities, it causes pilson's disease in humans, in which the main part of copper accumulates in brain tissue, skin, liver, pancreas.

Copper bracelets are thought to help ease the aches and pains of stiff and sore joints. Proponents of the treatment suggest that the skin absorbs tiny particles of copper. This is then said to help reduce inflammation in the joints, as copper is a vital nutrient that serves this purpose in the body.

Food sources with high levels of copper include coffee, chocolate, avocado, soy, shellfish, pecans and other nuts, beans ,legumes, whole grains, and the drinking water in some areas. ... Vegetarians and others who consume high amounts of soy or soy protein beware as these products contain high amounts of copper.

Any of the following conditions could cause your test result to be high: Copper toxicity from taking in too much copper, perhaps through water or dietary supplements. Anemia. Biliary cirrhosis, a liver disease.

Heavy metals are among the main pollutants that need to be controlled in all areas. Therefore, experts on environmental pollution and environmental monitoring today include more than 40 elements in the periodic table of D.I. Mendeleev: V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Mo, Cd, Sn, Hg, Pb, Bi and others.

The term heavy metal refers to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations. Examples of heavy metals include mercury (Hg), cadmium (Cd), arsenic (As), chromium (Cr), thallium (Tl), and lead (Pb)[31]

Arsenic, beryllium, cadmium, chromium, lead, manganese, mercury, nickel, and selenium are some of the metals called 'heavy' because of their high relative atomic mass which persist in nature and can cause damage or death in animals, humans, and plants even at very low concentrations (1 or 2 micrograms in some cases).

These elements are mainly situated in the last 3 periods of the periodic table.[fig.2]

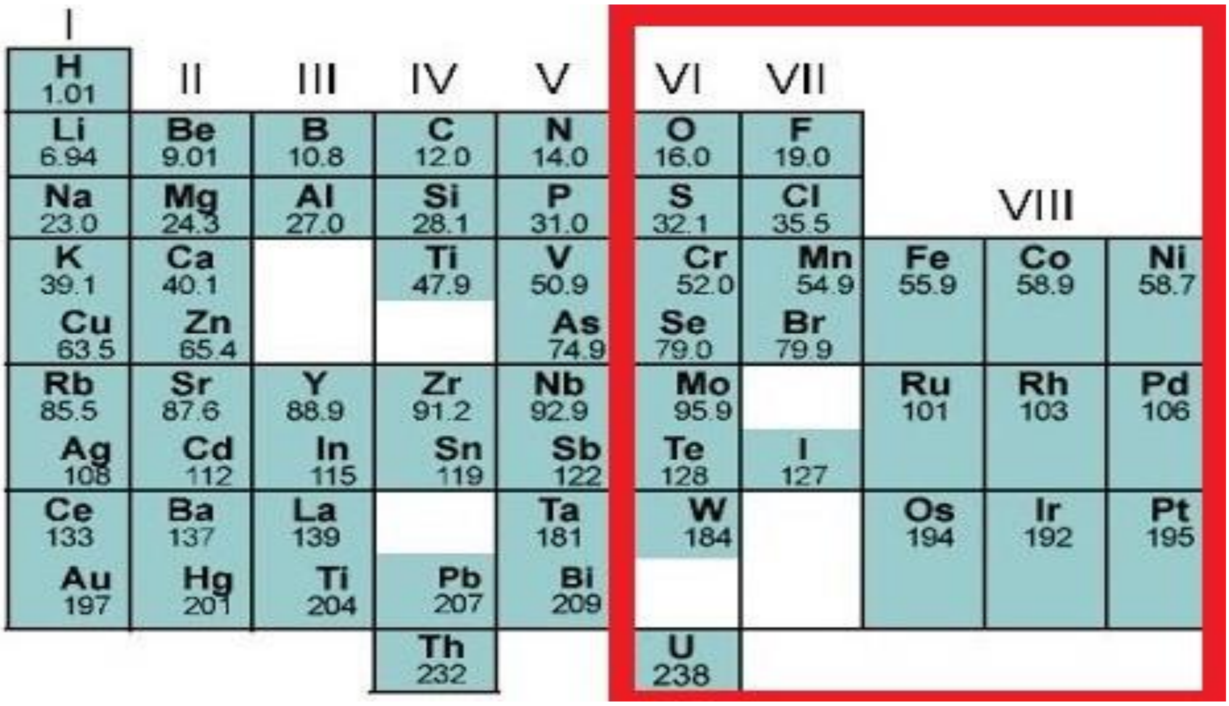


Figure.6. Heavy metals in periodic table

In classifying heavy metals, special attention is paid to the following properties: their high toxicity (toxicity) to living organisms at appropriate low concentrations, as well as bioaccumulation and biomagnetization properties.

Almost all metals belonging to this species (except for lead, mercury, cadmium and bismuth, whose biological significance is currently unknown), are actively involved in biological processes and are part of many enzymes.[68]

The main mechanism of heavy metal toxicity include the generation of free radicals to cause oxidative stress, damage of biological molecules such as enzymes, proteins, lipids, and nucleic acids, damage of DNA which is key to carcinogenesis as well as neurotoxicity.

Many people get a buildup of heavy metals in their system because of the foods they eat. Some studies suggest you can prevent overexposure to these toxins by avoiding certain foods.

Reported sources of heavy metals in the environment include geogenic, industrial, agricultural, pharmaceutical, domestic effluents, and atmospheric sources . Environmental pollution is very prominent in point source areas such as mining, foundries and smelters, and other metal-based industrial operations

Thus, many elements are suitable for heavy metals. However, according to researchers involved in the practical activities of environmental condition and pollution control, the compounds of these elements are not equally important as pollutants. If toxicity is taken into account, hazardous contaminants accumulate in the external environment in addition to their stability and ability, in addition, the scale of distribution of these metals is not very large. Therefore, in most cases, various changes occur in the determination of heavy metals. For example, Hg, Pb, Cd, As are among the heavy metals detected in the natural environment in the background stations of biosphere reserves by Yu.A.Izrael. On the other hand, according to the decision of the group working on the separation of heavy metals, only Zn, As, Se and Sb were included in the heavy metals. They collect analytical data on pollutant emissions in European countries and work under the auspices of the UN Economic Council for Europe. According to R. Reimers, heavy metals include particularly rare and rare metals, namely Pb, Bi Co, Ni, Cu, Zn, Sb, Sn, Hg, Cd. In some works, Pt, Ag, W, Fe, Au, Mn are often added to the list of heavy metals.[71]

While our bodies need small amounts of some heavy metals — such as zinc, copper, chromium, iron, and manganese — toxic amounts are harmful. If your body's soft tissues accumulate too much of heavy metals, the resulting poisoning can cause serious damage.

Others can enter the body by inhalation while others such as lead can be absorbed through the skin. Most heavy metals are distributed in the body through blood to tissues . Arsenic is distributed in blood and accumulates in heart, lung, liver, kidney, muscle and neural tissues and also in the skin, nails and hair.

While our bodies need small amounts of some heavy metals — such as zinc, copper, chromium, iron, and manganese — toxic amounts are harmful. If your body's soft tissues accumulate too much of heavy metals, the resulting poisoning can cause serious damage.

Heavy metal toxicity can lower energy levels and damage the functioning of the brain, lungs, kidney, liver, blood composition and other important organs. ... Repeated long-term exposure of some metals and their compounds may even cause cancer.[18]

As root vegetables, carrots and sweet potatoes tend to absorb more heavy metals from the soil than other kinds of produce.

The heavy metals most commonly associated with poisoning of humans are lead, mercury, arsenic and cadmium. Heavy metal poisoning may occur as a result of industrial exposure, air or water pollution, foods, medicines, improperly coated food containers, or the ingestion of lead-based paints.

Unlike organic pollutants, heavy metals once introduced into the environment cannot be biodegraded. They persist indefinitely and cause pollution of air, water, and soils. Thus, the main strategies of pollution control are to reduce the bioavailability, mobility, and toxicity of metals.

Although heavy metals are naturally occurring elements that are found throughout the earth's crust, most environmental contamination and human exposure result from anthropogenic activities such as mining and smelting operations, industrial production and use, and domestic and agricultural use of metals and metal.

The three pesticides analysed show similar Cd contents and the highest levels of Fe, Mn, Zn, Pb and Ni are found in the herbicides. The most significant additions of heavy metals as impurities that soil receives from agricultural practices, are Mn, Zn, Co and Pb.[51]

Heavy metals occur naturally in soils and in source materials used to manufacture fertilizers. Risk assessments conducted by the US Environmental Protection Agency and others have concluded that the hazardous constituents in inorganic fertilizers generally do not pose risks to public health or the environment.

In manufacturing activities, more attention is paid to metals that pose a serious risk in terms of biological activity and toxic (toxic) properties as a result of their accumulation in the natural environment in a certain volume and widely used. These include lead, mercury, cadmium, zinc, bismuth, cobalt, nickel, copper, tin, lead, vanadium, bismuth, manganese, chromium, molybdenum, and arsenic. Heavy metals found in natural waters can be conditionally divided into 2 groups:

• biometals of natural origin (V, Mn, Fe, Co, Cu, Zn, Mo, etc.);

• "Pollutants" of anthropogenic origin (including Hg, Cd, Cr, Ni, Pb, Sn, etc.).

Chemicals entering water, soil, river sediments are classified according to the hazard class. They are divided into three (3) classes, with class 1.1 being more dangerous.[31]

Table 1.1. Hazard class of chemicals that fall into water, soil, river sediments

Safety class	**Chemicals**
1	As,Cd, Hg, Pb, Zn
2	Co, Ni, Cu, Cr
3	Mn

The following metals are most needed for the survival of aquatic organisms: Zn, which is part of the enzyme carbon dioxide, Fe, which is part of hemoglobin, Cu, which is part of hemocyanin, and Ni, which affects the growth and reproduction of organisms. High concentrations of metals bound to amorphous oxides and Fe, Mn hydroxides are more biologically hazardous. The following is a classification of metals.

Depending on their ability to adsorb on low and high molecular weight associates, as well as suspended particles and river sediments, heavy metals play different roles in aquatic ecosystems. In this case, the more mobile metal in the classified series is Mn and the less mobile metal is Cu. As for the soil, currently the MAC in it contains only mercury (2.1 mg / kg), mobile forms of copper (3.0 mg / kg), nickel (4.0 mg / kg), zinc (23.0 mg / kg), arsenic. (2.0 mg / kg).
Unfortunately, no standards have been developed for water body sediments. Typically, the amount of metals in river sediments dating back to the beginning of the industrial age is used to assess the natural background.[40]

The main characteristic of aquatic ecosystems is river sediments. When metals, radionuclides, and highly toxic organic matter accumulate, river sediments, on the one hand, allow the aquatic environment to self-clean, and on the other hand, cause constant secondary pollution of water bodies. Thus, in order to obtain reliable information on the pollution of water bodies, it is necessary to monitor pollutants in both surface waters and river sediments. River sediments are an integral part of aquatic ecosystems and play a key role in them. Undoubtedly, in relation to water, which is a mobile component of the aquatic environment, river sediments exhibit the property of retaining contaminants in river sediments. This causes the concentration of pollutants to increase with the concentration of those substances in the water.

River sediments accumulate in the water basin and are composed of various species and fractions. First of all, large pests fall to the ground. In lakes and reservoirs, the deposition of a thin layer of turbid and silt fractions usually occurs after a layer of coarse particles, rather than a single layer of material deposited in rivers.

Solid particles are considered when checking water quality: - Contaminant collectors: heavy metals and organic micro-pollutants are collected as follows: according to experts, mainly dealing with solid particles, the percentage of heavy metals collected in suspended particles varies from 20 to 99%, depending on the amount and type of solid particles:

- Contaminant storage can change contaminant storage when contaminated solid particles settle; - Biota can be contaminated when pollutants are released into the water (this is called secondary pollution);

- pollution indicator; since contaminants are usually concentrated in the solid phase, this material can be used to detect environmental pollution even in conditions where the concentration of contaminants in the water is low.

Thus, river sediments are a promising object of environmental analysis, which can reflect the long-term state of pollution (especially in low-velocity water bodies).[96]

Conclusion for Chapter 1

The Zarafshan River Basin is one of the most densely populated areas in Central Asia.The Zarafshan River, which belongs to the basin of the amudarya river, originates on the territory of Tajikistan with the pouring of the Matchohdarya River and the Fandaria River. The river crosses the border of Uzbekistan and supplies water to three consecutive regions-Samarkand, Navoi and Bukhara. Therefore, the quality of water in the Zarafshan River Basin has a high impact on human activities. With the growth of the population and the increase of anthropogen impact, water pollution requires special attention to provide a sustainable environment for future generations. Since 2010, as a result of the high population growth in the river basin to increase the exploitation of fossil resources in the high flow and use of water for domestic needs, industrial and crop production in the lower flow. The river has an ice-snow water supply. Currently, 85% of Zarafshan river water resources are used in irrigation farming, 11% in kidroenergetics and thermal energy, 3% in industry, 1% in utility services.Although the river is a relatively low water river on the Right Bank of the Amudarya, the demand for water is high and continuous increase is projected. On the territory of Uzbekistan, near the city of Samarkand, the river divides into two branches - Agdarya and Karadarya. In ancient times, the river reached the Amudarya, but now the river disappears in the Kyzylkum steppe; the dry delta of the river is located in the karakul region of the Bukhara region.

To examine the pollution with heavy metals in selected gidroposts in Zarafshan River and to make practical recommendations for metals that exceed the permissible norm .to compare the statistical data presented with the research work of previous years and to evaluate them.

II. Methods and data

We used methods as follows to study changes of concentration of heavy metals in water:

1) The Concentration of heavy metals was compared with the permissible levels of heavy metals.
2) Confidential intervals were determined and use to separate the different sources of heavy metals.

2.1 Water quality standards and their assessment

One of the existing sources of information on the quality of water bodies is the Hydrometeorological Service of the Republic of Uzbekistan (UZHYDROMET):

The UZHYDROMET system has established a stationary network of observation points for the natural composition and contamination of surface waters based on physical, chemical and hydrobiological indicators of water quality. The observations cover major watercourses and reservoirs in the region. Information about the quality of water (water pollution) in the lower reaches of the Amu Darya river includes 17 hydrochemical parameters. The criteria for assessing surface water pollution (table 1) set by O'zDSt 950:2011 included various limiting indicators of harm: fisheries, toxicological, sanitary-toxicological, organoleptic, and general sanitary.

Tab. 1: Water quality indicators of surface water supply sources, separated according to limiting indicators of harmfulness (LIH) and their MPC according to GOST 2874-82and SanPiN 4630-88.

№	The ingredients and indicators	Unit of measure ment	Maximum permissible concentratio n (MPC)	Limiting sign of harmfulness
1	Oxygen	mgO2/l	no <4	general requirements
2	Biochemical oxygen consumption	mgO2/l	3	general requirements
3	Chemical oxygen consumption	mgO/l	15	toxicological
4	Ammonium nitrogen	mg / l	2	toxicological
5	Nitrite nitrogen	mg / l	0,5	toxicological
6	Nitrate nitrogen	mg / l	10	toxicological
7	Iron (Fe)	mg / l	0,3	toxicological
8	Copper (Cu)	mg / l	1	toxicological
9	Zinc (Zn)	mg / l	1	toxicological
10	Phenols	mg / l	0,001	fisheries
11	Oil products	mg / l	0,3	fisheries
12	Synthetic surfactants	mg / l	0,5	toxicological
13	Suspended solids	mg / l	750	general requirements
14	Chromium VI (Cr)	mg / l	0,05	sanitary-toxicological
15	Fluorine	mg / l	0,7	sanitary-toxicological
16	Arsenic	mg / l	0,001	toxicological
17	Mineralization	mg / l	1000	general requirements

The quality of water for irrigation is evaluated by methods recommended by various researchers. Methods of the following authors are mainly used: I. L. Khosrovyants and E. I. Chembarisov; H. Stabler; US Department of agriculture (SAR); M. F. Budanov; a.m. Mozhayko and T. K. Collar; A. N. Kostyakov.

2.2 Determining the confidential intervals.

Confidential intervals of heavy metals were determined using the dependence between a concentration of heavy metal and a discharge of the river flow (monthly) for each post for each heavy metal. Then boundary line was created using the criteria that all points were located below the line. If this relation was close for different posts it was assumed that the source of the heavy metal is the same. If there was significant difference between confidential intervals it was assumed that the source of heavy metals is changed.

The confidential intervals show the part of the space where depending on river flow discharge a concentration of the heavy metal can be expected.

2.3. Water sampling and preparation for analysis

There are special sampling programs for water sampling. These programs will depend on the tasks assigned. According to the international system ISO-5667 / 1-82, there are 3 main types of programs: quality control, quality description, investigation of the causes of pollution.

Quality control programs include the description of the properties and composition of water and the concentration of substances in accordance with the permissible concentrations of pollutants or permissible emission standards. Such programs are primarily used in state control and monitoring services (Uzhydromet, State Committee for Nature Protection, State Sanitary and Epidemiological Surveillance, etc.).

Pollution research programs. These programs focus on the concentration of pollutants in pollution sources and their status in the water body. All types of programs should include a list of specific indicators, methods of their analysis and designation of sampling programs (location of sampling points, frequency of sampling, sampling types, sampling methods, sampling equipment, sampling processing methods).The objective of water quality monitoring is to obtain quantitative information on the physical, chemical, and biological characteristics of water via statistical sampling.[31]

The location of monitoring points is determined taking into account the existing use of the water basin or water flow for the needs of the national economy. To monitor the correlation with water regimes, it is necessary to place water chemical monitoring points close to (or directly within) hydrometric posts.
Sample delivery time should not exceed 24 hours for the first 2 types of indicators. Safety issues should be considered when selecting a sampling site, i.e. sampling should not be performed in life-threatening areas.

If the data collected are insufficient, the following studies will be conducted:

• weekly sampling throughout the year; • Daily sampling every 1 week for 13 consecutive weeks (4 sampling times for 1 year);

• Sampling every hour for 1 day with a period of 13 weeks.

The Importance of Water Quality Testing. Water quality testing is important because it identifies contaminants and prevents water-borne diseases. Essentially, water quality testing makes sure that water is safe and meets local and international water standards.

Using such a scheme adapted to local conditions, different statistical descriptions of the annual, quarterly, monthly, and weekly distribution are obtained, and the research options are applied to rivers that have undergone major changes.

Water analysis. A chemical analysis of the dissolved materials in water, including a determination of the amount of suspended solids and the pH value.

Water sampling, the process of taking a portion of water for analysis or other testing, e.g. drinking water to check that it complies with relevant water quality standards, or river water to check for pollutants, or bathing water to check that it is safe for bathing, or intrusive water in a building to identify its.[31]

2.4 Method of sampling of water and river sediments

Quality control programs

Quality control programs include the description of the properties and composition of water and the concentration of substances in accordance with the final permissible concentrations of pollutants or permissible discharge norms. Such programs primarily use state control and surveillance services. (Bashhydromet, State Committee for Nature Protection, State Sanitary Inspection, etc.).

Sediment can come from soil erosion or from the decomposition of plants and animals. Wind, water and ice help carry these particles to rivers, lakes and streams. The Environmental Protection Agency lists sediment as the most common pollutant in rivers, streams, lakes and reservoirs.

Erosion can move sediment through water, ice, or wind. Water can wash sediment, such as gravel or pebbles, down from a creek, into a river, and eventually to that river's delta. ... Sediment created and deposited by glaciers is called moraine.

Sediment pollution is the single most common source of pollution in U.S. waters. Approximately 30% is caused by natural erosion, and the remaining 70% is caused by human activity. Construction activity is the most common source of sediment pollution.[120]

Water quality description programs, they include determining the importance of a number of parameters over a given period of time. Programs can be episodic short-term (rarely but for systematic observations) and long-term (for systematic routine observations) designed for a particular study. Both short-term and long-term programs have a research character and are the main assessment of the condition of the object under study.

Water quality describes the condition of the water, including chemical, physical, and biological characteristics, usually with respect to its suitability for a particular purpose such as drinking or swimming.

Major water pollutants include microbes, nutrients, heavy metals, organic chemicals, oil and sediments; heat, which raises the temperature of the receiving water, can also be a pollutant. Pollutants are typically the cause of major water quality degradation around the world.[71]

The general requirements for the sampling location are as follows:

When choosing the location of sampling points (stations), it is necessary to conduct a preliminary study on the subject of determining the representative location of observation in the water body. At the same time it is necessary to take a cocktail to take a sample of the distance from the laboratory conducting the analysis and take into account its cost.

Further research should be accompanied by the collection of information on all factors affecting water quality: surface and groundwater water regimes, catchments and discharges, topography, climate, population availability (urban and rural areas), point and area pollutants .

A sampling plan is a term widely used in research studies that provide an outline on the basis of which research is conducted. It tells which category is to be surveyed, what should be the sample size and how the respondents should be chosen out of the population.

It is necessary to collect all the information about the previous research on this water body, based on the collected information, to assess the importance of factors affecting the quality of water intended for different types of use.

It is then necessary to conduct recognized field surveys of the water body to select sampling points. These studies include the identification of key parameters as well as a range of contaminants that may be present in high concentrations. Surveys should be conducted not only at the locations of the proposed observation points, but also throughout the entire water area of the water body.

The location of monitoring points is determined taking into account the existing use of the water basin or watercourse for the needs of the national economy. In order to communicate with water regimes, it is necessary to place water chemical monitoring points close to (or directly within) hydrometric posts.

Sampling is important because it is impossible to (observe, interview, survey, etc.) an entire population. When surveying, however, it is vital to ensure the people in your sample reflect the population or else you will get misleading results.

Sampling is critically relevant everywhere that analytical chemistry has a role to play. Ambient sampling of the atmosphere is used to provide analytical data on seasonal or other trends that can be correlated with natural or societal processes.[89]

Observation points

Observation points have to be established in water basins and watercourses of the following districts:

• location of wastewater discharged into water bodies and streams, cities and large settlements;

• Discharge of wastewater by separate large industrial enterprises (factories, mines, quarries, oil fields, power plants, etc.), regional production complexes;

• a place for breeding and wintering of valuable and especially valuable feeding organisms;

• tributaries of the river, which are important for fisheries;

• the place where rivers cross state borders;

• points at the end of large and medium rivers;

• Addition of large water bodies and streams to the polluted stream.

At the observation points we studied natural processes anddetermined the volume of water and the background status of runoff water in areas not affected by anthropogenic impact, including state reserves and natural national parks and watersheds and watercourses located within large natural associations.

When selecting the exact sampling location, the sample must be representative (belonging to the water body at the location), ie the water must be taken from the full flow at the point along the vertical and horizontal profiles. The sampling areas for all sampling in the water body should be studied for uniformity at the daily intersection at the sampling site. This is done by taking samples at intervals along the cross section at different depths.[58]

The water quality monitoring station should be installed in places where river flow measurements are carried out (hydrological posts or near them, at points where there are no significant changes in river flow) with data on water consumption and the ability to calculate the flow mass of various detectable substances.

Sometimes, taking into account the data of 2 or more water metering stations, the flow calculation is carried out indirectly or by conducting field surveys, the sampling site should be accessible in any weather conditions, especially in areas with harsh climatic conditions. 3 types of indicators for the storage of water samples:

1) conservative long-term storage (chlorides, sulfates, etc.);

2) non-conservative, limited-term storage (biogenic elements, metal ions);

3) Laboratories to be analyzed should not be too far from the sampling site due to the fact that they are composed of non-preservatives (BPK, oxygen, etc.).

Sample delivery time should not exceed 24 hours for the first 2 types of indicators. Safety issues should be considered when selecting a sampling site, i.e. sampling should not be performed in life-threatening areas.

Observation points. One point shall be established in places where wastewater is not organized in watercourses: one point shall be established at the point of discharge of contaminated streams, on the uncontaminated section of watercourse, on the headwaters of the river, at the point of crossing the border at the headwaters of the river.[31]

2 or more points shall be installed in places where wastewater is discharged into streams in an organized manner. One is placed above the source of contamination and the other is placed below the source of contamination (or below the source pit). The upper source is installed at a height of 1km from the source of contamination. To select the point below the source of contamination, it is necessary to take into account that the wastewater will be in a place where it will be completely mixed with the runoff water.In this case, it is necessary to take into account the full mixing point in advance, and then to determine its location during the study of the site by measuring the conservative chemical components specific to the site. Water quality in different water bodies is very less constant over time, it is subject to change. However, while some parameters have some correlation between the rate of change, others change independently.

The inconsistency of water quality allows quantitative changes in the concentration of substances entering the water body. These changes are due to natural causes or are the result of human activity, they can be periodic or random. Periodic annual changes can be determined by rainfall patterns, snowmelt or seasonal changes in temperature, seasonal growth and death of plants. In connection with the processes of photosynthesis and the inflow of meltwater from the snow to the water intake, naturally occurring daily cycles are also observed, which determine the pH of the water, the mineralization of the dissolved oxygen and the ionic composition of the water.[24]

Human industrial agriculture and domestic activities can cause periodic changes related to water intake and discharge cycles. If sampling points are used for quality control, then the vibration amplitude of the water quality parameters varies in water bodies and water flows. The higher it is in the water flow, the higher the sampling point is closer to the source where the changes occur. In this source, the mixing of water in terms of distance is eliminated, and as the distance between the source of change and the sampling point increases, not only the amplitude of vibration decreases, but also liquefaction occurs. However, the expression of some parameters is reduced due to self-cleaning processes.

If the change is of a periodic nature and sampling is also carried out periodically, then it is possible to estimate the change in water quality during the previous cycle. The sampling program provides for a random selection of sampling times but in this case one flat samples should be taken throughout the year. In the first stage, additional research is needed to establish the sampling frequency, including the collection of information on all factors affecting water quality, as well as information on the requirements for water quality at the site.

If the data collected are insufficient, the following studies will be conducted.

- Weekly sampling throughout the year;
- Daily sampling every 13 weeks for 1 consecutive week (4 sampling times for 1 year)
- Sampling every hour for 1 day with a periodic 13 weeks.

Using such a scheme adapted to local conditions, different statistical descriptions of annual, quarterly, monthly and weekly distribution are obtained. These types of surveys apply to rivers that have undergone major changes.

The sampling frequency can be reviewed based on an analysis of the information obtained from time to time.

If no additional studies are performed, the following sampling frequency for the first year of observation may be accepted; for rivers - every 2 weeks; every 2 months for lakes and reservoirs.

The frequency of sampling and types of applications in the State National Government of Surface Water Pollution Monitoring in the Central Asian Region are related to the categorization of the monitoring point, which shows itself well.[31]

Method of preparation of river sediment samples for analysis

Heavy metals are metals with an atomic mass of more than 40. At present, heavy metals other than mercury, lead and chromium in river sediments have not been developed, so it is proposed to compare the level of pollution with the natural background to assess the pollution of river sediments with heavy metals. The expression of the metal content in river sediments of districts far from the industrial center can be used as a background.

The sediment sample is placed in the top sieve then the sieves are shaken to sort the sediment into the various sieves. The mass of sediment in each sieve is measured using scales and the percentage of the total sample can be calculated.

The sediment can be collected directly into the sample container or placed into the container by the diver with a scoop and sealed and composited at the surface. The diver should be downstream of the sample site and should use caution not to disturb the fine grained sediment at the substrate surface.

The simplest way of taking a sample of suspended sediment is to dip a bucket or other container into the stream, preferably at a point where it will be well mixed, such as downstream from a weir or rock bar. The sediment contained in a measured volume of water is filtered, dried and weighed.

Selection of sampling site. Sampling of river sediment is carried out once a year during the summer to determine industrial pollution. As a rule, river sediments planted with cultivated crops are selected for control. When it is necessary to study the distribution of pollution in detail, information on the order and number of sampling can be obtained from management.

Sampling of river sediments. Special sampling equipment is used for sampling of river sediments. Samples are taken from the middle of the river whenever possible. The samples taken are placed in plastic containers for pre-contamination and sent to the laboratory for analysis.

The main requirements for sampling and preparation of river sediments are to protect them from contamination at all stages, ie from contamination during sampling, packaging, transportation, laboratory storage, air drying, crushing.

A sample of mixed river sediment weighing 0.5 kg is dried in the laboratory at room temperature until dry in air. An average sample weighing 0.2 kg is obtained from a laboratory-dried sample by dividing the sample into four. The plant roots and stones contained in the river sediment sample are removed. The average sample obtained is ground in a porcelain grinder and passed through a sieve 1 mm wide. A sample weighing 2.5 g is taken from the average sieved sample for analysis.

To prepare a 1M HNO3 solution, take 62 ml of concentrated (63%) HNO3 and add up to 1 l of bidistilled water. The sample taken for analysis is transferred to a flask, to which is added 30 ml of 1M HNO3 solution. The mixture is stirred in a blender for 1 hour and left for 1 day.

The mixture is filtered through a paper filter, and the finished solutions are submitted for analysis by atomic absorption spectroscopy (AAS). The samples are analyzed by atomic absorption spectroscopy to determine copper, zinc, lead and cadmium.[31]

Conclusion for Chapter II

Use the water that is to be analyzed for this purpose. Fill the bottle to a point just below the shoulder. Leave just a little air space. Immediately after filling the container, jot down all pertinent information regarding the water at the time the sample is taken.

The sediment can be collected directly into the sample container or placed into the container by the diver with a scoop and sealed and composited at the surface. The diver should be downstream of the sample site and should use caution not to disturb the fine grained sediment at the substrate surface.

Atomic Absorption Spectrometry (AAS) is a very common and reliable technique for detecting metals and metalloids in environmental samples. The total metal content of water and mud samples was performed by Flame Atomic Absorption Spectrometry or Graphite Furnace Atomic Absorption Spectrometry

Concentrations of many metals are determined by Inductively Coupled Plasma (ICP) by mass spectrometry (MS). The ICP is used to ionize the sample while the mass spectrometer is used to separate and quantify those ions. Calibrating the instrument with known standards allows for an unknown sample to be quantified.

The most common heavy metal pollutants are arsenic, cadmium, chromium, copper, nickel, lead and mercury.

Water sources (groundwater, lakes, streams and rivers) can be polluted by heavy metals leaching from industrial and consumer waste; acid rain can exacerbate this process by releasing heavy metals trapped in soils. Toxic heavy metals can bioaccumulate in organisms as they are hard to metabolize.

The most common metal pollution in freshwater comes from mining companies. They usually use an acid mine drainage system to release heavy metals from ores, because metals are very soluble in an acid solution.

A heavy metal blood test is a group of tests that measure the levels of potentially harmful metals in the blood. The most common metals tested for are lead, mercury, arsenic, and cadmium. Metals that are less commonly tested for include copper, zinc, aluminum, and thallium.

More specific definitions have been published, but none of these have been widely accepted. The definitions surveyed in this article encompass up to 96 out of the 118 known chemical elements; only mercury, lead and bismuth meet all of them.

The term heavy metal refers to any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentrations.

3. River flow variations basin. Sources of river pollution

3.1 Water issue in Zerafshan River basin

The ecological condition of water is formed under the influence of production, agriculture and natural factors. As a result of constant monitoring, the main pollutants and sources of pollution of the waters of the Zarafshan basin are identified. At 10 checkpoints on the border of Samarkand region - Zarafshan river at the entrance to Uzbekistan (Ravat Khoja), Shagal quarry, Jambay flour factory, “Boynazar” OSTI in Kattakurgan, Taligulan, Chiganak and Khauzaksay at the Siyob canal discharges The highest levels of ammonium ions from 1.7 to 9.4 MAC are regularly recorded in the discharge waters of the Siyab Canal, Taligulan, Chiganak and Khauzasay collectors. The highest levels of ammonium ion pollution in 2003 and 2005. Years

Jambay flour factory, Aviaotryad aeration station, Bulungur winery are the main sources of water pollution in the Zarafshan river due to insufficient treatment of industrial effluents, as well as ammonium ions of household and industrial effluents of Kattakurgan city.

In the territory of Navoi region, constant monitoring is carried out at the entrance to the Zarafshan River in the region, in the Central, Mirzo Mumin, Bishkek and Sanitary collectors, Navoi TPP and <Navoiyazot> ICHB discharges. Navoi TPP will be discharged into the Zarafshan River through the BKTI.[101]

Figure 7. Territory of Navoiazot territory https://kun.uz/news

“Navoiyazot” ICHB wastewater is the main source of contamination with nitrates, petroleum products and copper. MAC value, petroleum products changed at the level of 1.2-4.18 MAC value.[63]

The Zarafshan River being the sole source of potable water supply receives communal, household, industrial and agricultural sewage in the Leninabad province of Tadjikistan, the Samarkand and Navoi provinces of Uzbekistan. The quality of water in the examined part of the river Zarafshan is formed by dropping industrial and municipal sewage of the cities Samarkand, Kattakurgan, Navoi, Pendjikent and towns Bulungur, Dzhambai as well as by agricultural sewage from the rural area. All these significantly worsen the sanitary and hygienic situation in the region. The most contaminated water is in the area below Navoi-city, i.e., in the investigated area. Here the Sarafshan receives the sewage from the chemical plant "Navoiazot" (Navoi-nitrogen), where the main contaminating components are acids, ammonium, nitrates, cyanides, organic substances, and phenols.[30]

Scientists measure a variety of properties to determine water quality. These include temperature, acidity (pH), dissolved solids (specific conductance), particulate matter (turbidity), dissolved oxygen, hardness and suspended sediment.

River flow regime is one of the means that addresses the complexity of stream flow response through the process of systematically organizing streams, rivers or catchments into groups that are most similar with respect to their flow characteristics

River discharge is the volume of water flowing through a river channel. This is the total volume of water flowing through a channel at any given point and is measured in cubic metres per second (cumecs). The discharge from a drainage basin depends on precipitation, evapotranspiration and storage factors.

Many factors affect water quality

- Sedimentation.
- Runoff.
- Erosion.
- Dissolved oxygen.
- pH.
- Temperature.
- Decayed organic materials.
- Pesticides.

Physico-chemical indicators are the traditional 'water quality' indicators that most people are familiar with. They include dissolved oxygen, pH, temperature, salinity and nutrients (nitrogen and phosphorus). They also include measures of toxicants such as insecticides, herbicides and metals.[73]

3.2 Upstream impact

In the territory of Uzbekistan, about 85% of the water resources of the basin are used for irrigation, 11% for thermal power plant cooling purposes, 1% for communal services, 3% for industry and 1% for fishery. [Figure.8] [36]

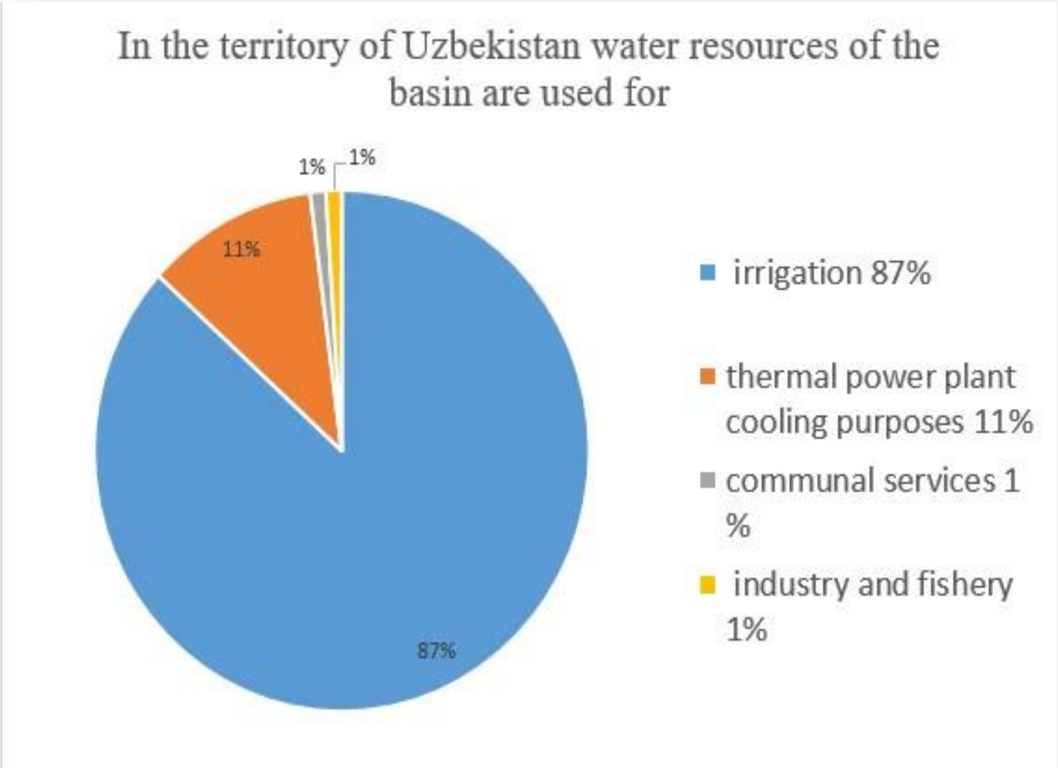


Figure.8 Zarafshan river water`s are used for

The amount of mineralization in the water of the Zarafshan River is higher than the permissible norm for heavy metals - copper (Cu), nitrogen compounds – nitrite ions (NO2), organic substances and phenols. In the lower reaches of the river, water quality deteriorated compared to its upper reaches.

Conducted analysis shows that in the range from the beginning of the river to the place of pouring, the mineralization of river water, especially in areas where large industrial enterprises are located, has increased, the level of pollution of water with industrial and household sewage is also higher. The hydrochemical regime of the Zarafshan river can be considered under the influence of a powerful anthropogen.

Upstream refers to the material inputs needed for production, while downstream is the opposite end, where products get produced and distributed.[1]

The Central Asian countries are particularly affected by the global climate change. The cultural and economic centers in this mostly arid region have to rely solely on the water resources provided by the rapidly melting glaciers in the Pamir, Tien-

Shan and Alay mountains. By 2030, the available water resources will be 30 % lower than today while the water demand will increase by 30 %. The unsustainable land and water use leads to a water deficit and a deterioration of the water quality. Documenting the status quo of the water resources needs to be the first steps towards an integrated water resource management. The research presented here provides a detailed overview of the transboundary Zarafshan River, the lifeline for more than six million people. The findings are based on field measurements, existing data from the national hydrometeorological services and an extensive literature analysis and cover the status quo of the meteorological and hydrological characteristics of the Zarafshan as well as the most important water quality parameters (pH, conductivity, nitrate, phosphate, arsenic, chromate, copper, zinc, fluoride, petroleum products, phenols and the aquatic invertebrate fauna). The discharge of the Zarafshan is characterized by a high natural discharge dynamic in the mountainous upper parts of the catchment and by sizeable anthropogenic water extractions in the lower parts of the catchment, where on average 60.6 % of the available water is diverted for irrigation purposes in the Samarkand and Navoi provinces. The water quality is heavily affected by the unsustainable land use and inadequate/missing water purification techniques. The reduced discharge and the return flow of untreated agricultural drainage water lead to a critical pollution of the river in the lower parts of the catchment. Additional sources of pollutants were identified in the Navoi special economic area and the mining industry in the Tajik part of the catchment. The impact of the global climate change and the socio-economic growth on the water availability and the water demand will aggravate the detected problems and might lead to severe local and transboundary upstream–downstream water conflicts within the next decades.[59]

The term upriver (or upstream) refers to the direction towards the source of the river, i.e. against the direction of flow. Likewise, the term downriver (or downstream) describes the direction towards the mouth of the river, in which the current flows.

3.3 Irrigated agriculture

The largest proportion of water however is used for irrigation. The Zarafshon river basin has 551’910 ha of irrigated land: 376’700 ha in the Samarkand province (68%), 95’980 ha in the Navoi province (17%), 49’240 ha in the Dzhizak province (9%) and 29’990 ha in the Kashkadarya province (6%). In order to distribute the river water on to the fields, the Zarafshon system includes six diversion points and nine reservoirs with a total storage capacity of 1.2 km3.[Figure 9][72]

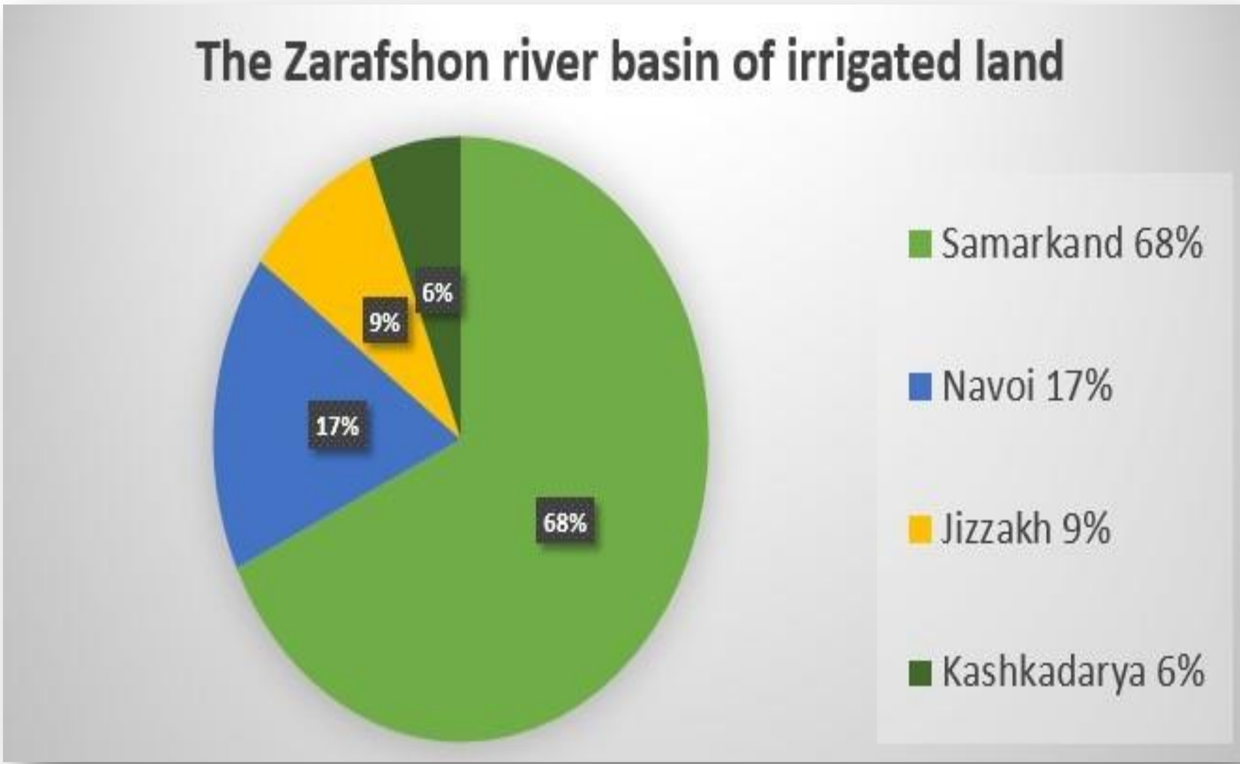


Figure 9.The Zarafshan river of irrigated regions in the territory of Uzbekistan.

Irrigation is the application of controlled amounts of water to plants at needed intervals. Irrigation helps to grow agricultural crops, maintain landscapes, and revegetate disturbed soils in dry areas and during periods of less than average rainfall.

The Zarafshan river basin is one of the most densely populated areas in Central Asia. The current social and economic situation in the region requires a significant increase of water supply to communal and household needs, developing industry, irrigated agriculture and other fields of national economy

The major cause of degradation of water resources in Uzbekistan is usage of much water for irrigation and fields wash mg. In the rural area, open water reservoirs and underground water are contaminated by collector-drainage water washed from fields and sewage water from farms. This is an important risk factor leading to water deterioration. Since the range and fonns of antropogenic impact on water quality in different provinces of the Republic are becoming more diverse, the problems of ecological risk for population health caused by the water factor are of the greatest importance.[62]

The problems of rational utilization of water resources and their protection against different hnds of pollution are of top priority in Uzbelustan. Outstripping rate of national economy development compared to environment-protection activity is known to have a negative effect on formation of water quality in reservoirs for industrial and recreational goals and drmlung.

The concentrations of general mineralization, nitrites, phenol, mineral oil and copper have been investigated from 2002 to 2010. The discharge of collector-drainage water and treated waste water along the river watercourse and its influence to the river water quality were evaluated in a third step. The results show that the main sources of pollution in the Uzbek territory of the Zarafshon river water are the agricultural collector-drainage waters from the irrigation farming zones in the Samarkand and Navoi provinces as well as the waste water from the ore processing facilities in Tajikistan.[37]

The largest proportion of water however is used for irrigation. The Zarafshon river basin has 551’910 ha of irrigated land: 376’700 ha in the Samarkand province (68%), 95’980 ha in the Navoi province (17%), 49’240 ha in the Dzhizak province (9%) and 29’990 ha in the Kashkadarya province (6%). In order to distribute the river water on to the fields, the Zarafshon system includes six diversion points and nine reservoirs with a total storage capacity of 1.2 km3. Agricultural crops, mainly cotton, occupy 30% of the irrigated areas of the basin. Other irrigation agriculture includes cereals (mostly wheat, covering 20% of the area), gardens and vineyards (10%) and household plots (10%). The rest of the irrigated area (30%) is used for vegetables, cucurbitaceous and forage crops (UNDP 2007). Approximately 100’000 ha of the river basin are characterized by a ground water level of 23 m. In this area an extensive drainage and collector network is installed, that recovers 730% of the annual flow. To the greatest extent the drainage water is used for irrigation purposes in dry years when the run-off from the Zarafshon river decreases.

The deficit and the pollution of the Amudarya and Syrdarya river systems is one of the most important issues for the Aral Sea basin countries. The overuse of and the strong dependence on the water resources, the high degree of pollution, the disparate distribution and usage of the water resource between the two countries and the already noticeable impact of the climate change make especially the Zarafshon a most challenging river. However, while the big streams Amudarya and Syrdarya are thoroughly analyzed, only a few scientific studies deal with the pollution and protection of the Zarafshon river water. Based on the assessment of the anthropogenic pollution the reports indicate increases of intestinal infections and morbidity rates up to water-borne epidemic situations for typhoid fever and bacterial dysentery in the Samarkand, Navoi and Bukhara regions[29].

It helps to cultivate superior crops with the water supply as per need of the crops. Ultimately it helps in economic development. Irrigation water improves water conditions in the soil, increases the water content of plant fibers, dissolves nutrients & makes them available to plants.

Furrow irrigation is best used for irrigating row crops such as maize, vegetables and trees. Border irrigation is particularly suitable for close growing crops such as alfalfa, but border irrigation can also be used for row crops and trees.

What are the problems of irrigation in agriculture?

Problems

Unwanted vegetative growth.

Losses of valuable water to the watertable.

Irrigation water travelling over soil can cause erosion.

Irrigation can cause pesticides, pathogens and weeds to spread during irrigation.

Cause runoff.

Increased operational costs (labour, pumping, cost of water)

Leaching of nutrients

Irrigation helps to grow agricultural crops, maintain landscapes, and revegetate disturbed soils in dry areas and during periods of less than average rainfall. Irrigation also has other uses in crop production, including frost protection, suppressing weed growth in grain fields and preventing soil consolidation.

Improperly managed agricultural activities may impact surface water by contributing nutrients, pesticides, sediment, and bacteria, or by altering stream flow. Fertilizer and pesticide use, tillage, irrigation, and tile drainage can affect water quality and hydrology[33]

3.3 Industry and domestic water use

The rapid development of the economy, that is observed in recent years along the Zarafshon increases the pressure on the water resources. Especially the heavy and chemical industry has developed fast. The various enterprises in the region produce spare parts for agricultural machinery, household refrigerators, conditioners, and different kind of lifts. Further important branches of the industrial sector include the light industry (with more than 50 enterprises) and the foodprocessing industry (canned food, wine, vegetable oil, tobacco, meat and confectionery products made of local raw materials) [UNDP 2007]

The continued growths of the industrial and agricultural sector are the centerpieces of the strategy for the improvement of the living conditions in Uzbekistan that was declared in 2007. This strategy assumes a steady growth of the agriculture at an annual rate of 4,5-5,0 % up to 2015 while the share of the industrial sector is supposed to increase from 23,1 % in 2007 up to 28,2 % in 2015 [WWW.UZ.STATISTICS.UZ, 2010].

This planned economic development will greatly increase the demand for usable water in the Zarafshon catchment within the next decade.

Accidents in the mining industry can be on a huge scale and leave a lasting impact on the environment. As a rule, these impacts are caused by flood events (Kraft et al., 2006). In such cases, large amounts of processing sludge and tailings are moved from mining sites and reach rivers nearby.a tailing pond dam could therefore lead to a devastating ecological disaster in the Zerafshan basin (e.g. river contamination, floodplain contamination in the Tugai forest, and sedimentation of contaminants in the Ravathodja Reservoir), as shown by Kraft et al. (2006) for a processing plant at a gold mine in Romania in 2000. The environmental conditions are quite different in the lower Zerafshan basin in Uzbekistan. Relevant factors here include: (1) a high population of 6.5 million people, (2) intensive cultivation with use of fertilizers and pesticides (though these chemicals presently are not used in large amounts), (3) high salinity of drainage water from the large cultivation areas, and (4) processing of mining products in the Navoi chemical plant, and the resulting air and water emissions. In summary, the environment is under much more pressure downstream than it is upstream. There is some additional industry in the Samarkand–Navoi–Bukhara region that, as a result of circumstances around the collapse of the Soviet Union, does not produce at all or only at very low levels. This has essentially reduced the contamination of soils and the pollution of air and water over the previous two decades.

Domestic water use is water used for indoor and outdoor household purposes—all the things you do at home: drinking, preparing food, bathing, washing clothes and dishes, brushing your teeth, watering the garden, and even washing the dog.

Within the energy industry, the most water-hungry process is the thermoelectric-power industry, which uses copious amounts of water to cool electricity-generating equipment.

Industrial withdrawals provide water for such purposes as fabricating, processing, washing, diluting, cooling, or transporting a product; incorporating water into a product; or for sanitation needs within the manufacturing facility. Water for industrial use.[64]

Conclusion for Chapter III

From the case-study data, it is evident that the biggest future challenges in the Zerafshan basin are the alteration of the flow regime, the expected further water quality deterioration downstream, and the pollution risks upstream. Both water quantity and water quality issues will increase the competition between upstream Tajikistan and downstream Uzbekistan. However, to achieve more rational planning of future mitigation and management practices, water utilization and water pollution upstream and downstream should be considered equally in the basin framework. Hence, close cooperation is what will bring mutual benefits to upstream Tajikistan and downstream Uzbekistan.

It is difficult to compare the different types of pollution from the two riparian states, but thepresenteddata indicate that thecurrent water pollutionwithin Uzbekistan could beeven higher than the transboundary water pollution from Tajikistan. With reference to equitable rights and obligations, the UN convention clearly highlights that each watercourse state is responsible for the pollution it causes. The fact that pollution of a river course travels downstreamratherthanupstreammakesitmorelikelythatupstreamwaterpollutioncause s downstream harm rather than vice versa. In relation to downstream development which might have had an effect on the ecosystem and consequently might have had an impact on the upstream state, it was noted that these kinds of impacts (determination of natural flow) might be difficult to assess because of the influence of existing impacts.

Furrow irrigation is best used for irrigating row crops such as maize, vegetables and trees. Border irrigation is particularly suitable for close growing crops such as alfalfa, but border irrigation can also be used for row crops and trees.

Industrial Use means use for or in a manufacturing, mining, or chemical process or use in the operation of factories, processing plants, and similar sites.

Domestic water use is water used for indoor and outdoor household purposes—all the things you do at home: drinking, preparing food, bathing, washing clothes.

4.Water quality change over 2010-2018 in the Zeravshan river basin

4.1 Distribution of heavy metals in Zarafshan river in last decade

Water pollution is a challenge for sustainable development in many river basins. This study analyzed pollution by heavy metals of Zarafshan River, which originates on the territory of Tajikistan and supplies water for population, industry and irrigation in Uzbekistan.

The analysis of water quality of the Zarafshan River for 2010-2018 did show minor changes of concentrations of heavy metals, except copper which is at levels above the permissible due to pollution originating in the river upstream. The study found that the copper concentration along the river bed is above the maximum permissible concentration for all stations on the territory of Uzbekistan, which primary sourced by the industry in the upstream of the river. Special attention is required also for copper concentration below the Navoi city, below the discharges of waste water from the Navoiazot factory. The results of the study indicate needs for establishing an interstate agreement: on permissible levels of heavy metals in the Zarafshan River at the point where the river enters to the downstream state; on environmental flow discharge to be released along the river to maintain suitable water quality. Further studies are required to estimate environmental flow regime and its quality.

For this study, water quality change was analyzed for eight hydrological stations located in the lower reaches of the river as follows:

P1- Ravathodja (on the Tajik-Uzbek border);

P2- The city of Samarkand, 1.5 km above of the Akdarya water division;

P3- The city of Samarkand, 0.5 km above the Siab collector;

P4- The city of Samarkand, 3.7 km below the mouth collector of Taligulyan;

P5- The city of Samarkand, 0.8 km downstream of Kattakurgan city;

P6- The settlement of Hatirchi (at the beginning of the Karadarya river);

P7- The city of Navoi, 1 km above the wastewater discharge point at the Navoiazot factory;

P8- The city of Navoi, 0.8 km below the wastewater discharge point at the Navoiazot factory.

These water monitoring sites P1,.., P8 are in the Uzbekistan part of the Zarafshan river (**Figure 3).**

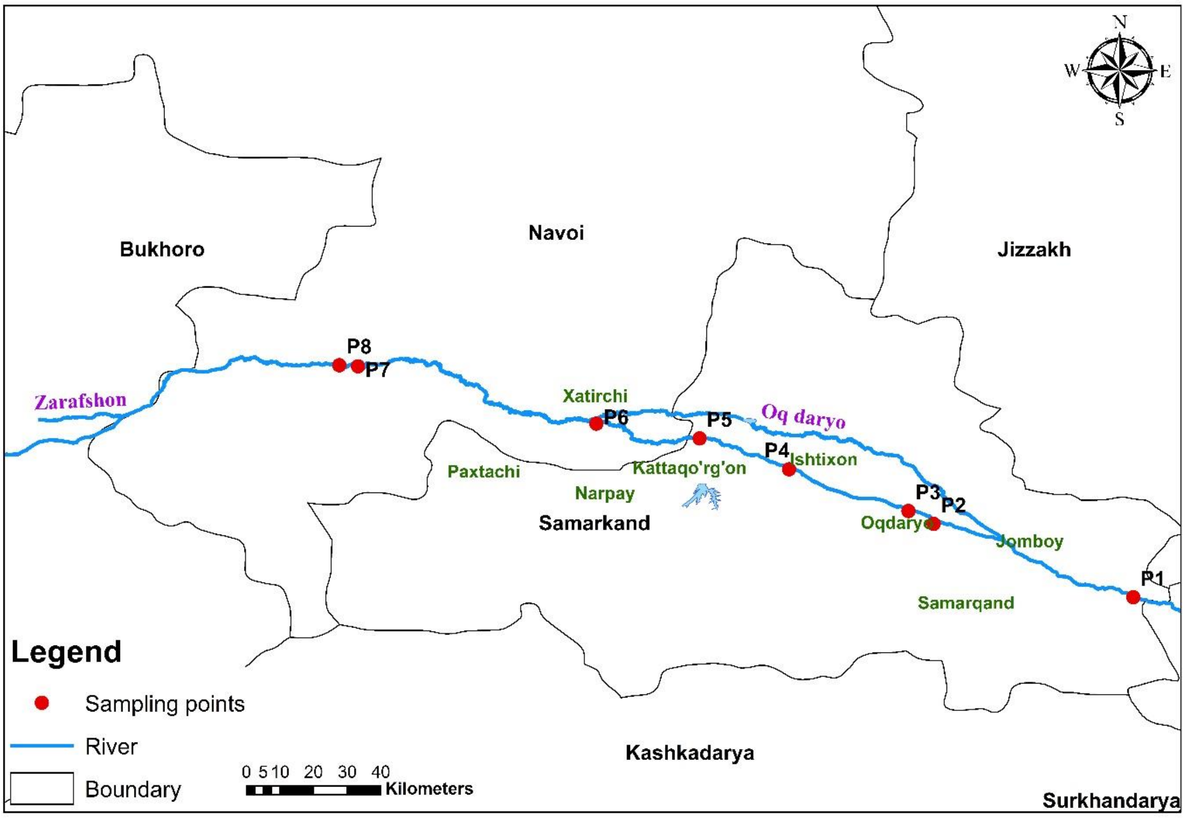


Figure.8. Water sampling sites (P1 – P8) along the Zarafshan river

Water quality data was from the Hydrometeorological Research Institute (NIGMI) of the Uzhydromet [5]. Water samples were analyzed in the laboratory of the NIGMI by using atom-absorbing spectrometry and plasma mass spectrophotometry methods [5]. Annual changes in the concentrations of iron, copper, zinc, chromium III, cadmium were analyzed, respectively. Concentrations of pollutants were compared with the maximum permissible concentrations of the pollutants in surface water [5].

The concentration of heavy metals is given for eight sampling points on the Zarafshan River.

4.2 Main pollutants and their concentration change

4.2.1 Iron. Figure 4 shows the average annual concentrations of iron in water. In Uzbekistan, the maximum permissible concentration for iron is 0.5 mg /l, while during 2012-2018 its concentration was from 0.01 to 0.07 with the long term average at 0.02 mg /l. Overall there is a trend of reducing the concentration of iron during 2010-2018. Our results are almost the same with findings of Kulmatov (2010). In Kulmatov's research, iron concentrations range from 0.01 to 0.15 mg/l. Kulmatov (2010) indicated that the concentration of iron had the highest level near the Navoi city in 2005, 0.8 km below the discharges of waste water from chemical factory of the Navoiazot; the indicated level was still below the permissible standard.

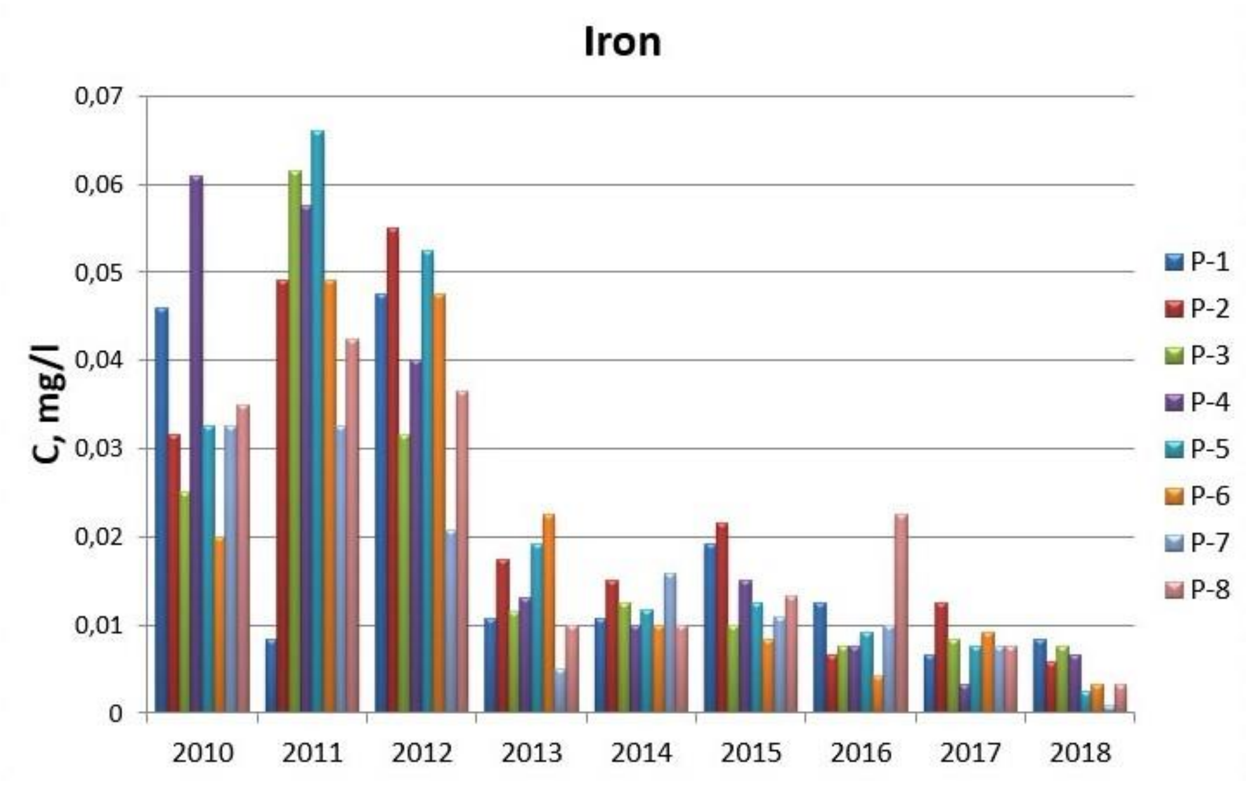


Fig.9. Temporal and spatial, along the river, changes of Iron concentration in Zarafshan river.

4.2.2Cooper. The maximum permissible concentration for copper for surface water in Uzbekistan is 0.001 mg/l. Studies show that only in one year (in 2010) of nine the copper level (0.0004 mg/l) at point R8 was below the permissible level. In the remaining years, it was noted that this heavy metal concentrations exceeded the permissible limit. High concentrations of copper have transboundary origin; in addition it may be produced by Navoiazot Production Association in the lower reaches of the river . The initial cause of high copper content in the river is Tajik industry companies located in the upstream of the Zarafshan river.

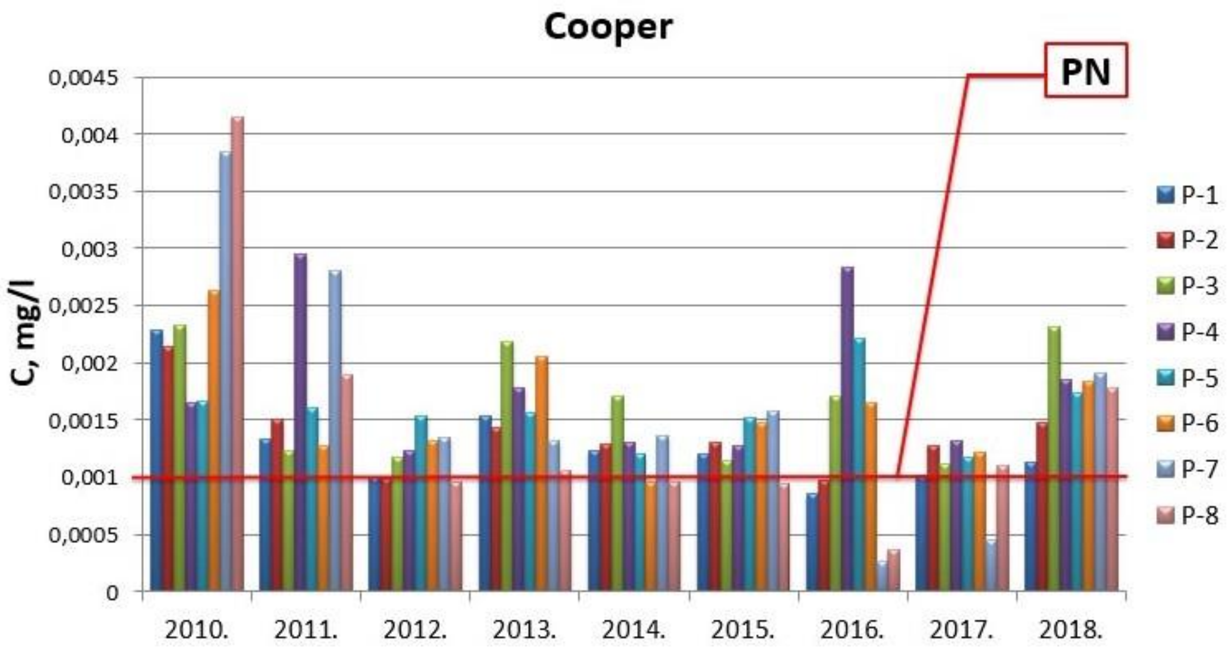


Fig. 10. Temporal and spatial, along the river, changes of Copper concentration in Zarafshan river

4.2.3 Zinc. In Uzbekistan, the maximum permissible concentration for zinc is 0.01 mg/l. The actual content of zinc is below the permissible level for all indicated hydrological stations; however the graph shows gradual temporal and spatial, along the river, increase of the metal concentration. While the zinc concentration did not exceed the permissible limit during 2010-2018, data for Post 7 shows that in 2018 it was about the permissible limit (0.0099 mg/l), which indicates the needs for special attention to this pollutant.

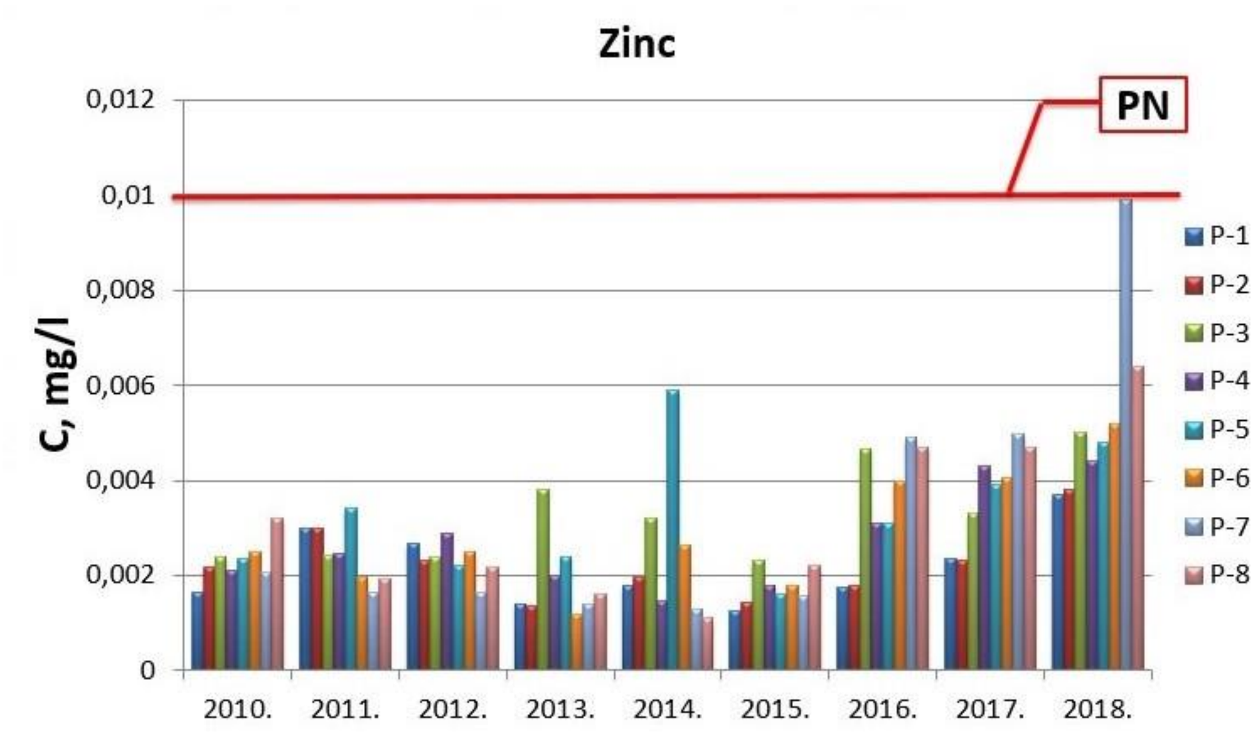


Fig. 11. Temporal and spatial, along the river, changes of Zinc concentration in Zarafshan river

4.2.4 Chromium III. In Uzbekistan, the permissible standard for Chromium III is -0.5 mg/l. Chromium concentration is below the permissible level for all stations and its variations can be explained by reducing river flow to the downstream.

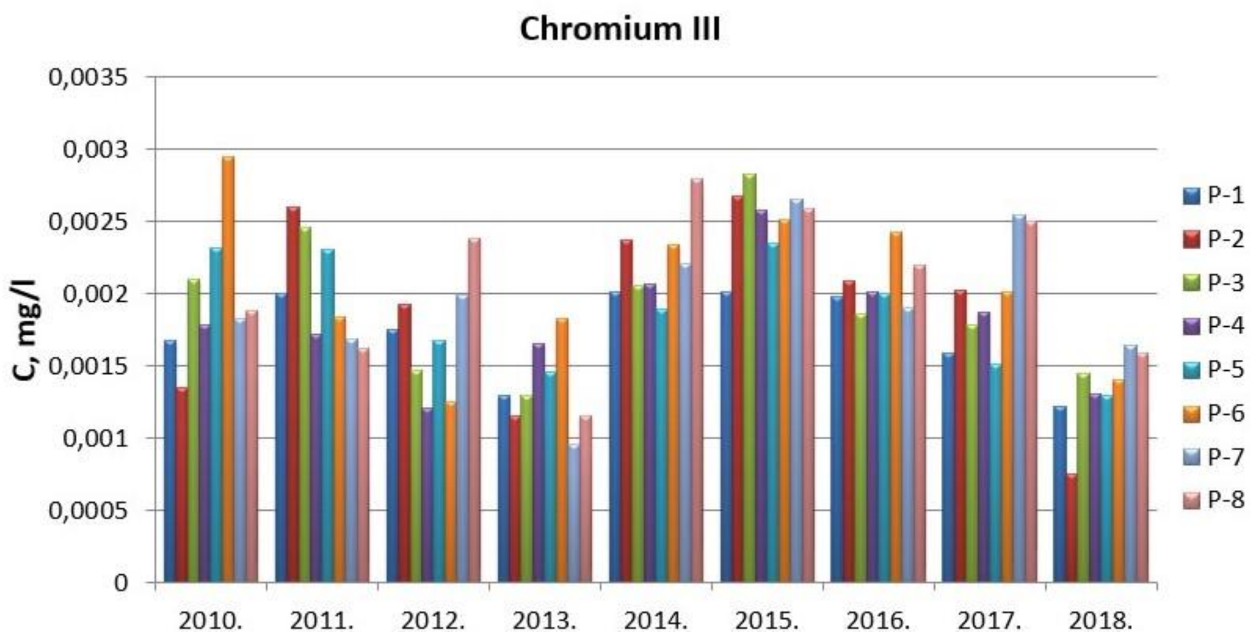


Fig. 12. Temporal and spatial, along the river, changes of Chromium III concentration in Zarafshan river

4.2.5 Cadmium. The maximum permissible concentration for cadmium is 0.005 mg/l. According to Uzhydromet, cadmium concentrations did not exceed the permissible levels for 2010-2018. The was not data for cadmium in 2011.Changes in the concentration of cadmium can be explained by diversion of the river flow for irrigation and the discharge of drainage and sewage water into the river channel.

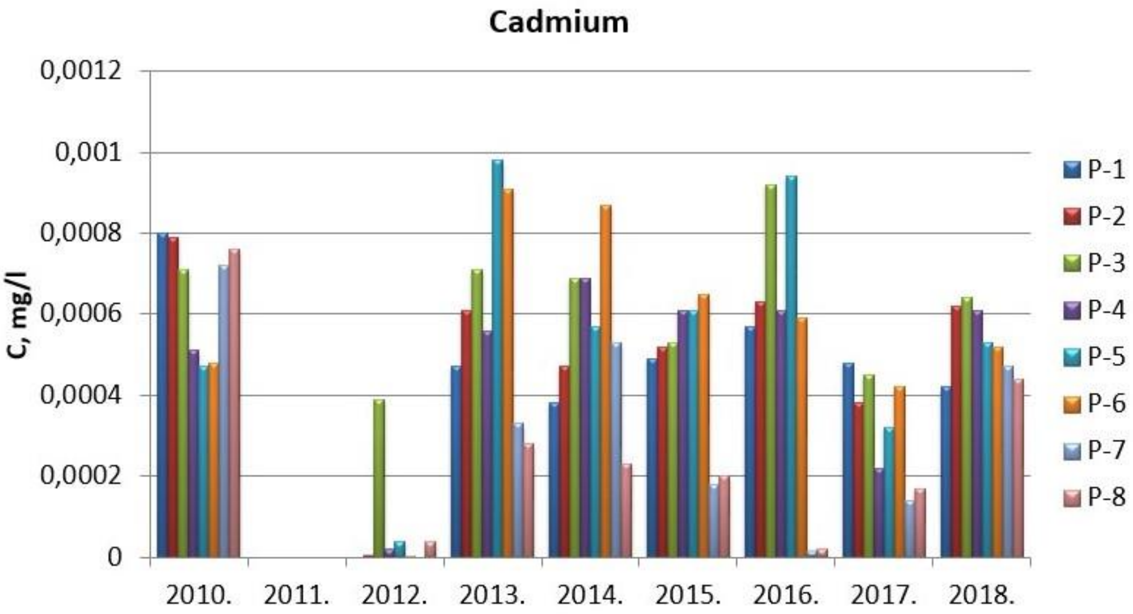
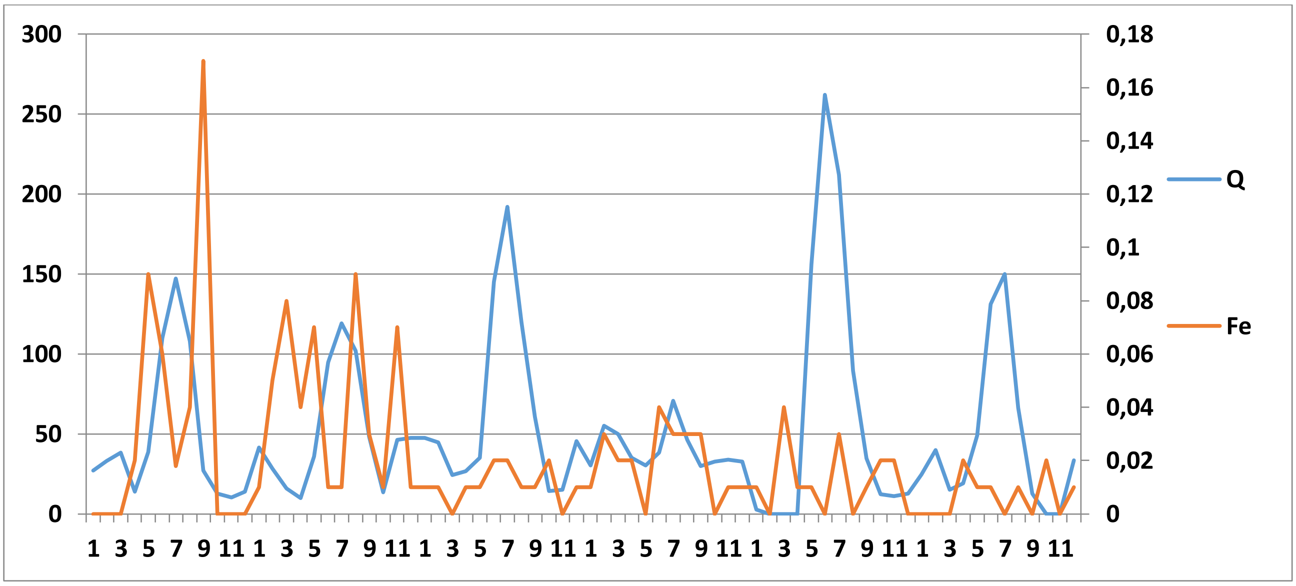


Fig. 13. Temporal and spatial, along the river, changes of Cadmium concentration in Zarafshan river

Correlation between water flow and heavy metals

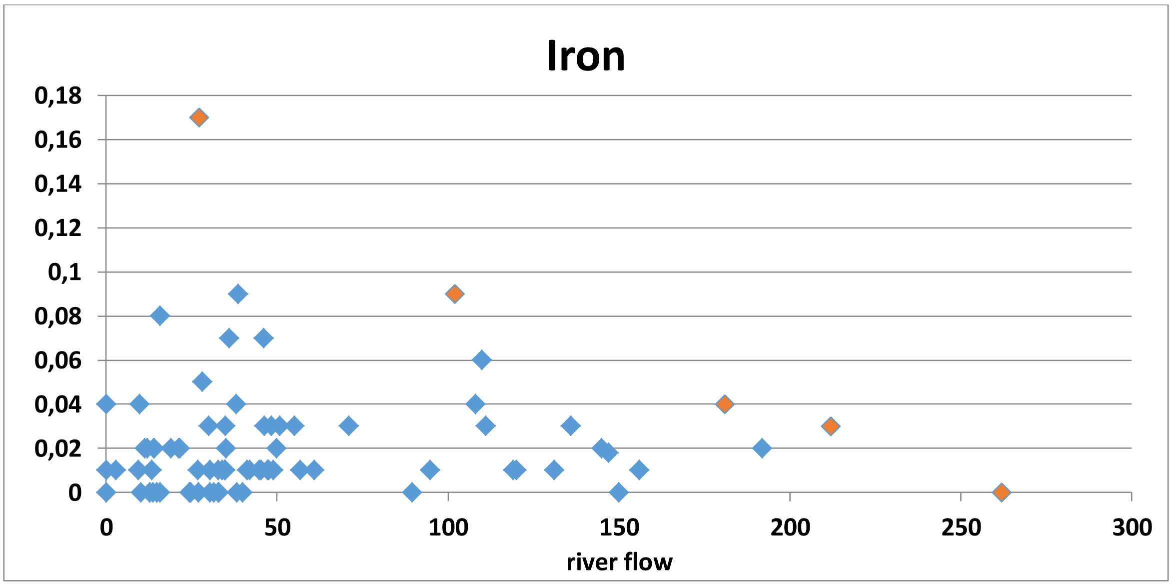
The analysis in this study shows a decrease in the flow of water in the river, which corresponds to the processes of Hydrogeology as well as the change in iron. Studies show that the concentration of pollutants increases with decreasing water flow towards.

Using a statistical method through correlation analysis was determined whether there is a relationship between two variables-water consumption and heavy metals, and it was determined how strong this relationship can be.[fig.14]



Average annual river flow vs Iron of Tajik and Uzbek border hydropost for

Q- river flow Fe-Iron



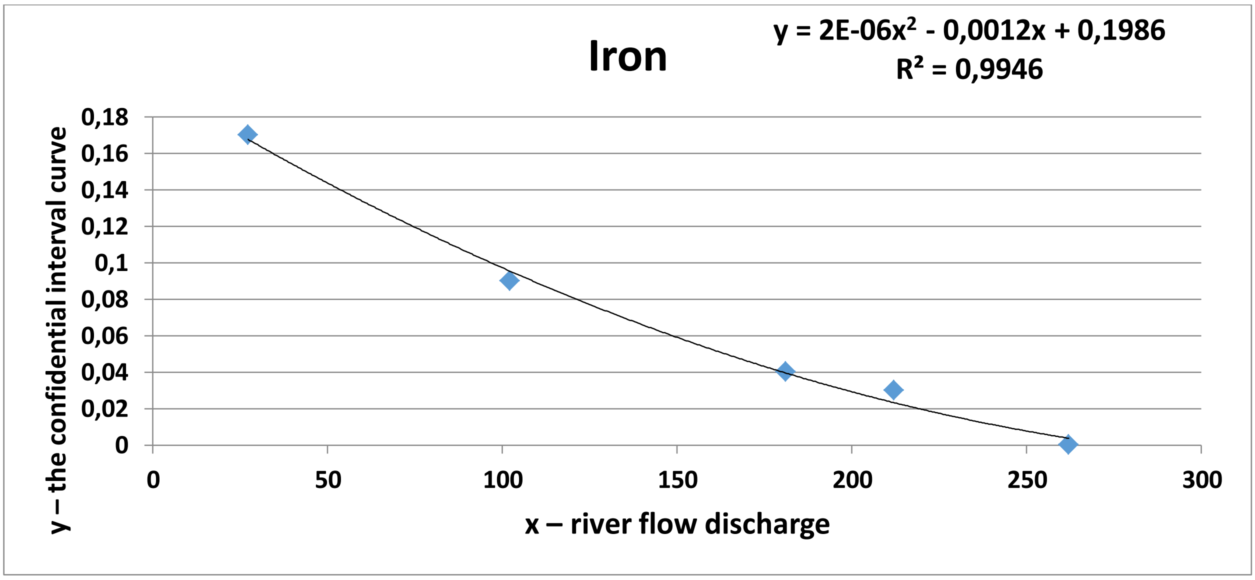
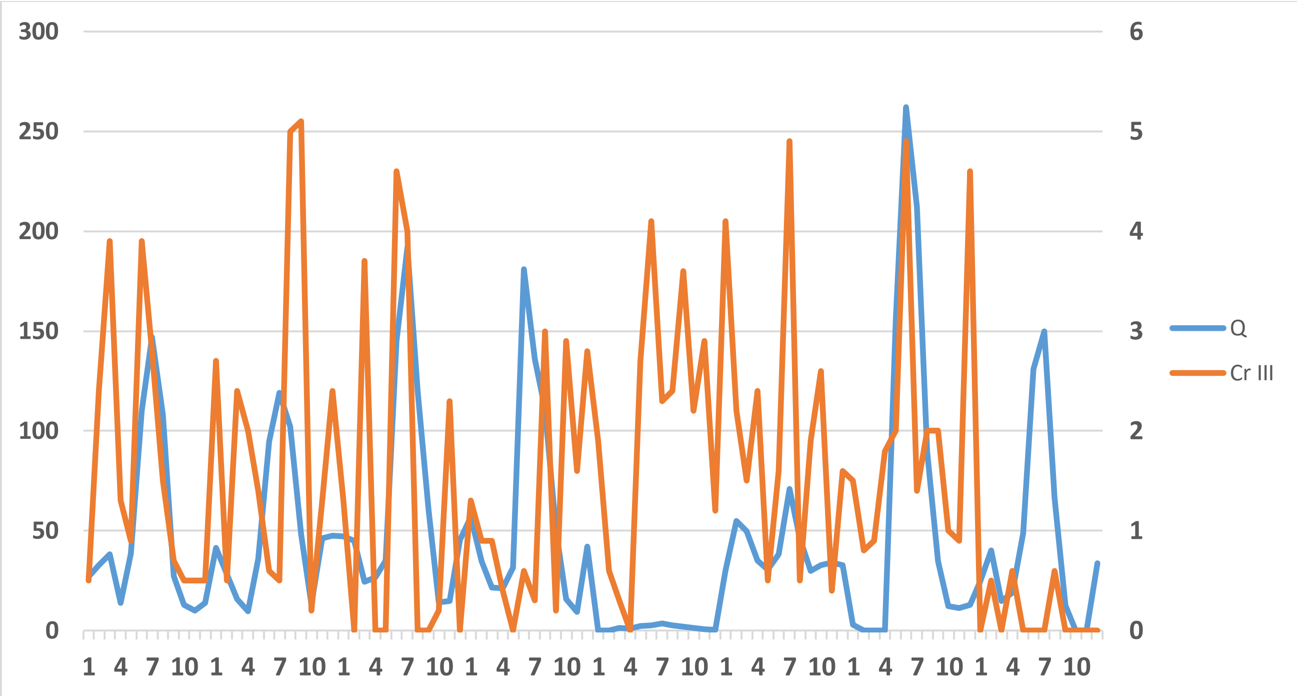


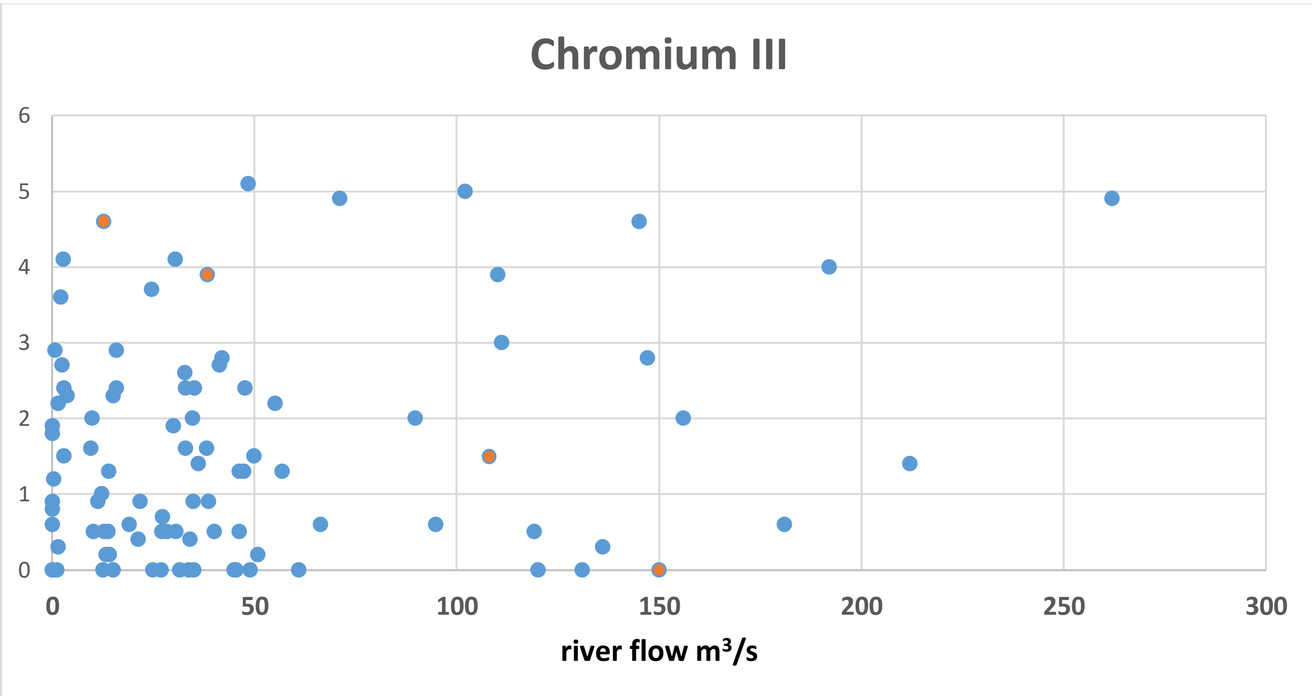
Fig.14. Correlation and confidential interval of Iron at post 1

The result of the correlation analysis for the first hydropost in Figure 15 showed that, with a decrease in water consumption, it also confirms the increase in Chromium III but the graph of confidence interval for Chromium shows that there are potentiallt several factors sourcing the metal.



Average annual river flow vs Chromium III of Tajik and Uzbek border hydropost

Q- river flow Cr-Chromium III



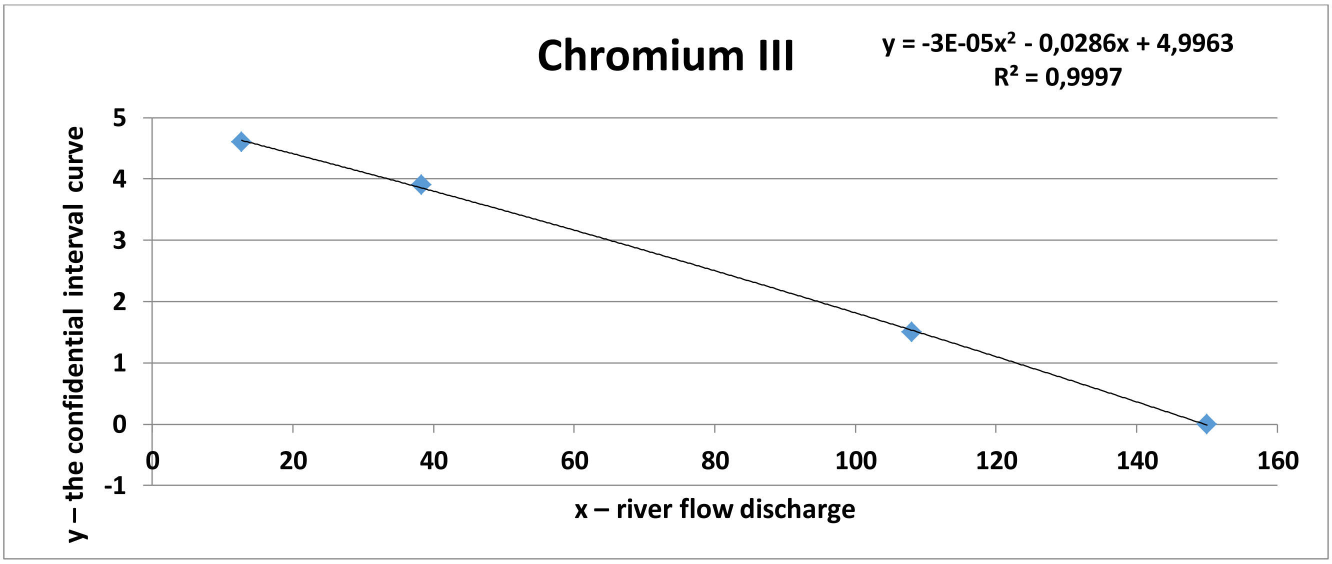
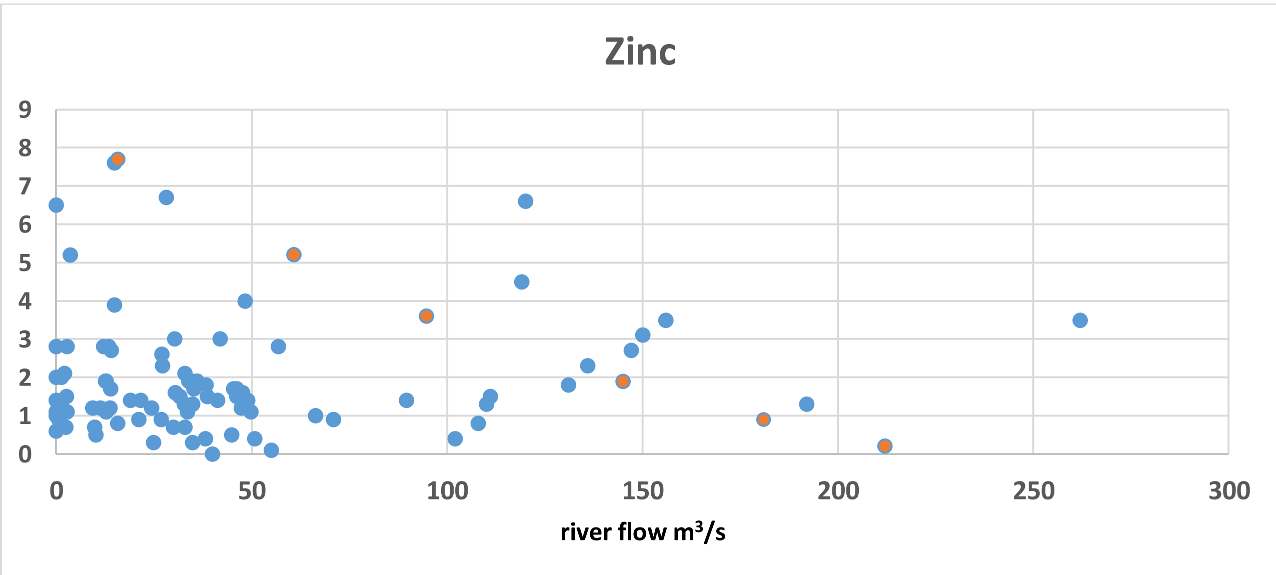


Fig.15. Correlation and confidential interval of Chromium III at post 1

These graphs for Zinc show It can be divided at the top of the up to 5% it is called the confidence interval of 95%.As the river flow increases, the concentration of Zinc decreases,which suggests that with increasing glacier melting. There will be no increase in river runoff pollution.



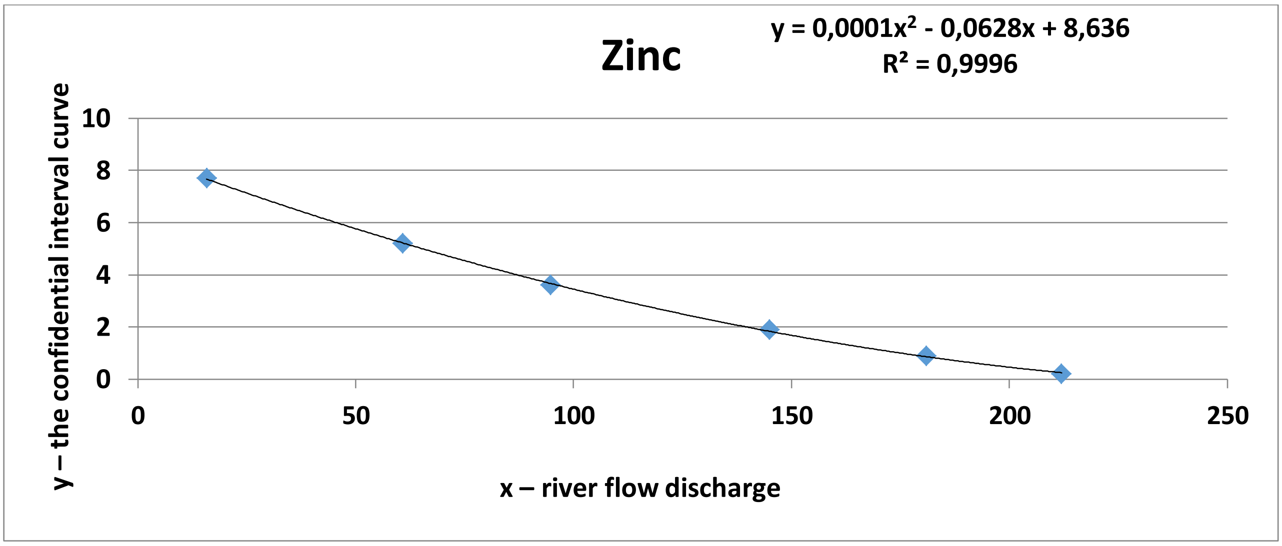
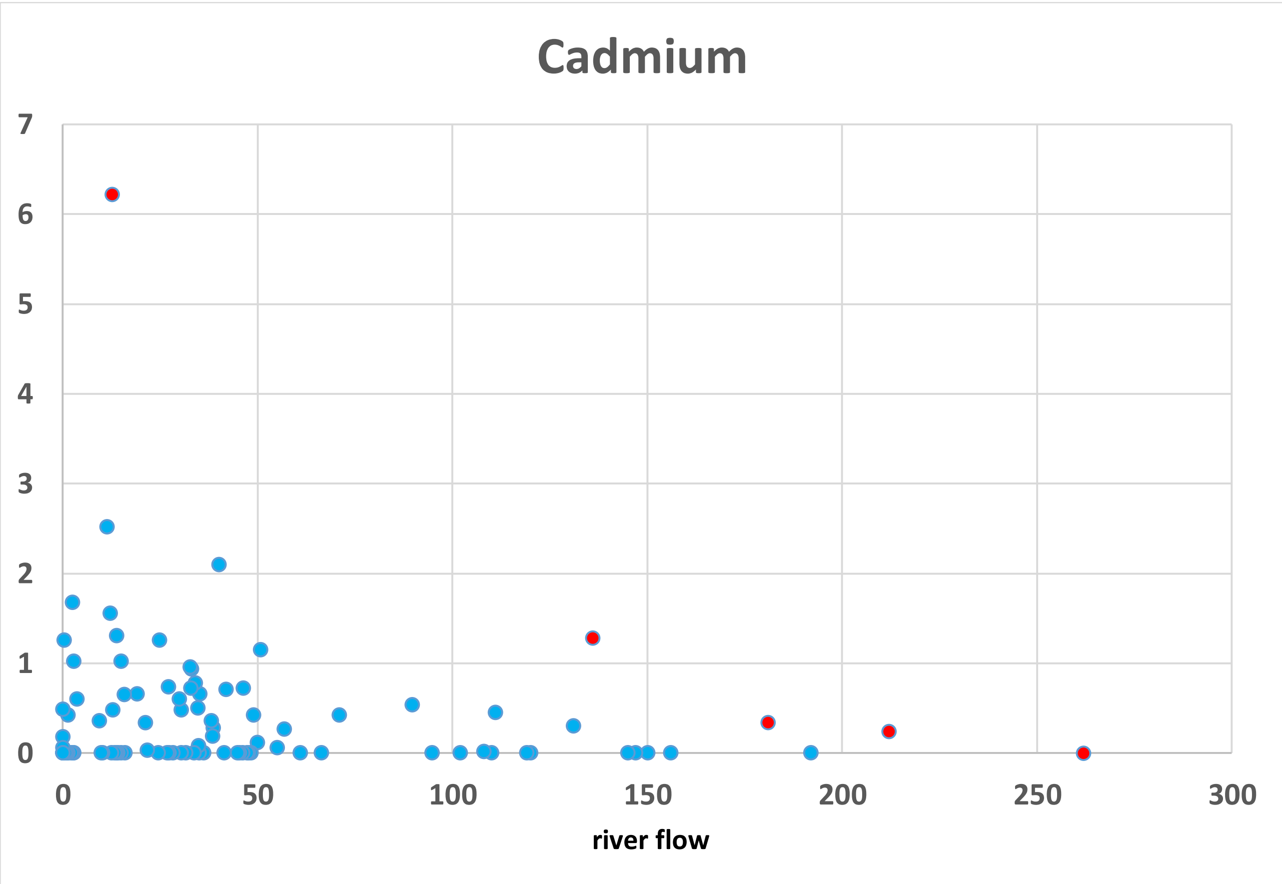


Fig.16 Correlation and confidential interval of zinc at post 1

In the first post, the flow of water and the cadmium relationship (figure. 17) R2= 0,9989 is equal to. With the increase in river flow, the cadmium concentration decreased



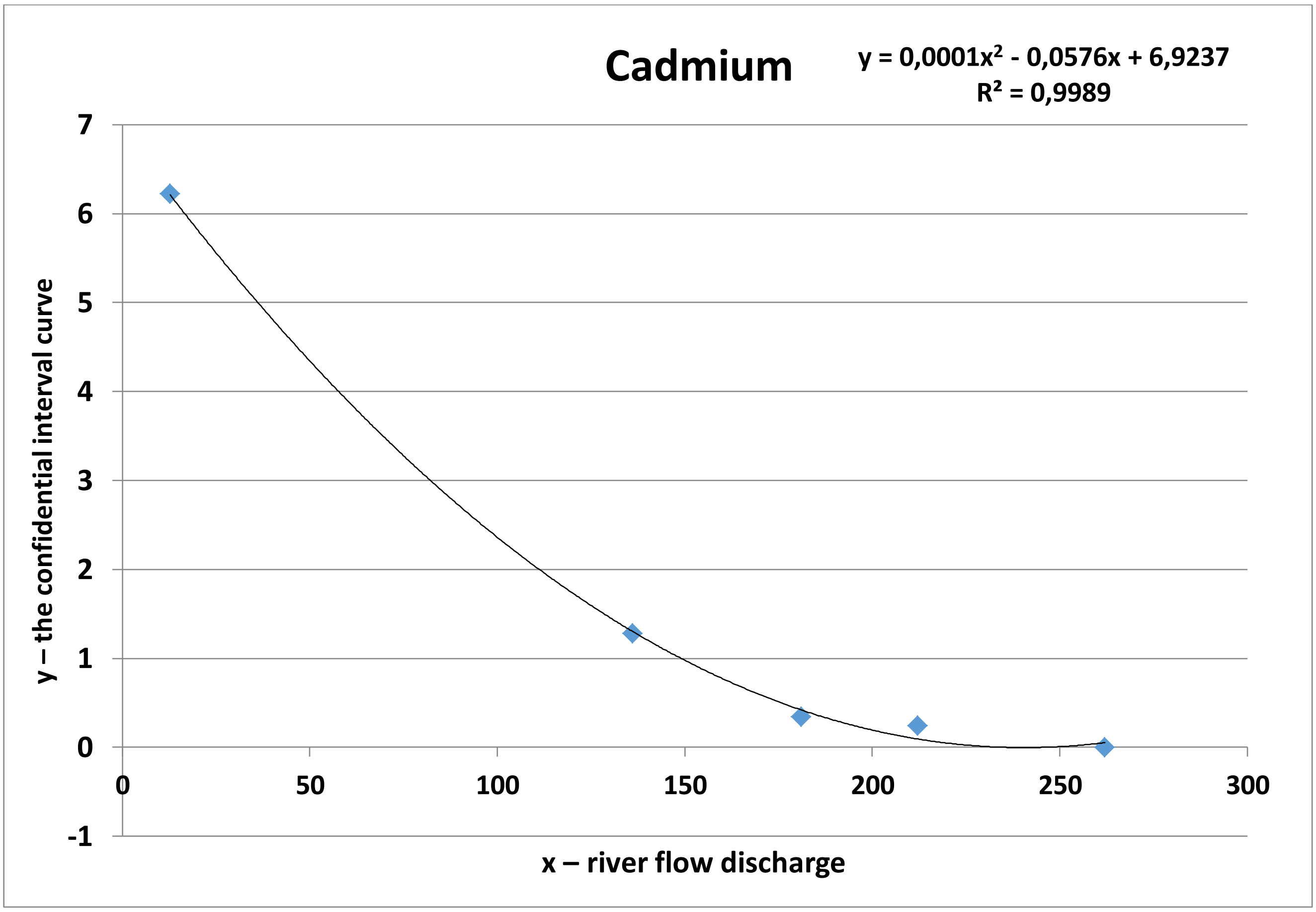


Fig.17. Correlation and confidential interval of Cadmium at post 1

All points are below the confidential interval curve which formula as folows

$y = 0.0001x^2 - 0.0576x + 6.9237$ $R^2 = 0.9989$

y – the confidential interval curve and x – river flow discharge, m3/s

Conclusion for chapter IV

Water pollution in river basins has been a problem for sustainable development. The study analyzed the contamination of the Zarafshan River with heavy metals, which originate in Tajikistan and supply water to the population, industry and irrigation of Uzbekistan. The study predicted changes in heavy metal concentrations between 2010 and 2018. In this study, we found that in many cases the levels of heavy metals exceeded the permissible levels. However, the concentration of reserves is higher than the permissible level, which was caused by Tajik enterprises located in the upper reaches of the Zarafshan River, as well as industrial enterprises located in the lower reaches of Uzbekistan. Additional research is needed to analyze the distribution of heavy metals in the river basin.

The results of the study indicate needs for establishing an interstate agreement: (1) on permissible levels of heavy metals in the Zarafshan River at the point where the river enters to the downstream state; (2) on environmental flow discharge to be released along the river to maintain suitable water quality. Further studies are required to estimate environmental flow regime and its quality.

The study found that the copper concentration along the river bed is above the maximum permissible concentration for all stations on the territory of Uzbekistan, which primary sourced by the industry in the upstream of the river. Special attention is required also for copper concentration below the Navoi city, below the discharges of waste water from the Navoiazot factory. The analysis of water quality of the Zarafshan River for 2010-2018 did show minor changes of concentrations of heavy metals, except copper which is at levels above the permissible due to pollution originating in the river upstream.

Conclusions and Proposal

Water quality is of vital importance given the many diverse uses for water in different industries. For example, in terms of drinking water, quality is very important because the water has to be clear of harmful contaminants in order to ensure that it's safe for human consumption.

The discharge of the Zarafshan is characterized by a high natural discharge dynamic in the mountainous upper parts of the catchment and by sizeable anthropogenic water extractions in the lower parts of the catchment, where on average 60.6 % of the available water is diverted for irrigation purposes in the Samarkand and Navoi provinces. The water quality is heavily affected by the unsustainable land use and inadequate/missing water purification techniques. The reduced discharge and the return flow of untreated agricultural drainage water lead to a critical pollution of the river in the lower parts of the catchment. Additional sources of pollutants were identified in the Navoi special economic area and the mining industry in the Tajik part of the catchment. The impact of the global climate change and the socio-economic growth on the water availability and the water demand will aggravate the detected problems and might lead to severe local and transboundary upstream–downstream water conflicts within the next decades.

Studies have shown that the higher the river flow, the lower the concentration of heavy metals we have proved that through confidential interval the can be found at the top of the up to 5%, which is called the 95% confidential interval or if the line has increased by 5 %, then here is another factor affecting.

The study is in the first post among the heavy metals obtained confidential interval 0.99%

In my proposal for this research We found that the amount of copper is higher than the permissible norm.

The main sources of pollution of copper of Zarafshan River are the industrial effluents of the enterprises of the Republic of Tajikistan and Navoiazot Production Association.

Environmental flow is to be estimated for the river which is a subject of our future research

An agreement with Tajikistan on the quality of water is to be signed , so that copper concentration does not exceed the permissible standards.

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