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INFLUENCE OF CLIMATE CHANGE AND ENLARGEMENT OF IRRIGATED SOILS ON QUALITATIVE INDICATORS OF RIVER WATER

Annotation. *It was determined that beginning from 1990s increase happened in temperature and amount of the precipitations significantly reduced. These climate changes affected the quantitative indicators of the Kur water. The ion content of the river water considerably rose in 2018 in comparison with 1952 and 1990s. This rise was more intensive towards the river mouth. In 1952 the ion sum in the Girag Kasaman station was 419,0 mg|l, but in 1990 this figure was 608,3 mg|l, in 2018 it was 620,5 mg|l. But in Banka near the river mouth a quantity of ions was 865,0 mg|l in 1952, 874,7 mg|l in 1990, but it was 888,1 mg|l in 2018. The climate alteration affected mineralogical composition and amount of biogenic elements. A quantity of minerals legally rose while approaching the river mouth. Especially this increase has risen even further for 30 years.*

Change of the Kur water quality in this direction causes formation of some problems in irrigation use. Tons of harmful salts enter every hectare of land. The undrained and old unrepaired drained soil are salinized and create condition for degradation.

Key words: *the Kur river; climate changes; ion content; mineralization; biogenic elements; water quality*

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Introduction

At present there are some problems on the earth and the ecological problems are more urgent. The climate changes occupy a very important place among them. This has created and continues to create a fundamental problem on the Earth, including in the Azerbaijan Republic.

Increase of the temperature and reduction of the rainfalls directly affect the water supply and rivers including the Kur wateriness. It is known from the statistic information that the temperature rise and rainfall decrease show itself sharply in the areas where the Kur river crosses.

A main aim of the researches was to study dependence of the climate change of the qualitative indicators as its irrigative water and influence of expansion of the irrigated soils along with the change of the Kur mellowness.

Some different specialists performed researches in this direction and showed increase of the water mineralization indicators of the water in the Kur in different years [2, 4, 5, 7, 8, 9]. E.A. Gurbanov [3], Babayev and others [11], noted the height of great effect of these waters on soil degradation.

The climate change shows itself in quantity indicators of two main factors: temperature and an amount of rainfall. Difference of the zone climate along the Kur of the Azerbaijan Republic have been statistically defined on seasons of 1970–1994 and 1995–2015 (Table 1). An analysis of the temperature on the basis of the information of the metrological stations in the physical-geographical province of the Kur valley has been performed and it is clear from the investigations that an increase of temperature in winter was most 4,4˚C in Mingachevir, the least in Ganja – 0,8˚C. But in the spring months the temperature decreased – 0,1-1,2˚C in all other stations. In the summer months the temperature increased in all other stations except the Mingachevir station (Table 1).

Table 1. Difference of the temperatures on seasons of 1980–1994 and 1995–2015

№	Metrological station	Height (m)	Winter	Spring	Summer	Autumn	Annual
1	Mingachevir	93	+4,4	-0,5	-0,1	+1,1	+1,2
2	Zardab	-5	+1,1	-0,4	+1,7	+1,9	+1,1
3	Salyan	-22	+0,8	+0,2	+1,3	+1,8	+1,0
4	Shamkir	165	+0,9	-0,1	+0,9	-1,0	+0,2
5	Ganja	309	+0,8	-1,2	+1,2	+1,3	+0,6
6	Aghstafa	340	+0,9	-0,2	+1,1	+1,2	+1,0

Table 2. Difference of the precipitations on seasons of 1970–1994 and 1995–2015

№	Metrological station	Height (m)	Winter	Spring	Summer	Autumn	Annual
1	Mingachevir	93	-12,6	+25,6	-3,3	-65,8	-65,7
2	Zardab	-5	+5,8	+6,2	-23,5	-20,1	-31,7
3	Salyan	-22	+1,5	+25,7	-19,3	-24,6	-16,7
4	Shamkir	165	-12,1	+0,1	+7,6	-44,7	-49,1
5	Ganja	309	-1,6	+27,3	-1,9	-19,8	+4,0
6	Aghstafa	340	-13,4	21,2	-18,9	-23,5	-34,6

The temperature grew in all the station except Shamkir station in autumn. The performed analysis gives a chance to say that the most temperature rise was observed in the zones along the Kur in autumn. An average annual rise of the temperature was observed in all the stations along the Kur.

The most index was in Mingachevir – 1,2˚C, the least index was in Shamkir – 0,2˚C. It is possible to conclude from the investigations that the temperature which is a main element of the climate has risen significantly in the last 20 years (in the zones around the Kur (Table 1)).

It is seen from Table 2 that reduction happened in an average annual quantity of precipitations in other stations except Ganja station. The precipitation decrease was mainly observed in summer and autumn. But in spring months increase of the rainfalls is felt.

Object and method of the research

An object of the research is a great river of Kur in General Caucasus, its total length is 1515 km. The Kur belongs to three countries – Turkey, Georgia and Azerbaijan. Its length is slightly more in Azerbaijan [4]. An average yearly water consumption is 229–288 m^3/sec, in Mingachevir, 440–480 m^3/sec, in Surra hydro-station after joining the Araz, but 395–436 m^3/sec in Banka hydrostation some distance from the Araz. Its water consumption was 392–434 m^3/sec, in the mouth of the river was 392–434 m^3/sec, in 1980–1985. But it is important to note that the water consumption rises till 2000 m^3/sec, in some years. Construction of the water storages over the Kur and the climate changes in last 30 years affected decrease of its water consumption. The riverbed is formed in the zones with semi-desert and arid steppe climate with mild winter [7, 8].

The mathematic-statistic method along with the modern and traditional methods was also used. Some information related to water Management Project Institute off Azerbaijan [1].

The chemical analysis of water was performed by generally accepted methods [6, 10]. The water for analysis was taken in containers of 100 gm^3 from upper, middle and bottom part in vertical direction. The water samples were obtained in irrigation period of the agricultural plants – in May and August months.

Conclusion and analysis

The information obtained from the researches shows that it is possible to divide the reasons of change of the substance amount in water content of the Kur into two groups: natural and anthropogenic. A basis of the natural reason is climate alterations and phenomena. A nutrition source of the Kur is 36% snow, 30% subsoil water, 20% rain, and 14% glacial water. 80% of the Kur water directly related to climate. Therefore, the climate change affects its wateriness and water content intensively. We got the information due to 1952 and 1990 from the reference and archive materials to define this change [7, 8]. The information of 1952 was taken because after that time construction of the water storage over the Kur river shattered its natural flow regime, and this didn't go unnoticed by the water amount and quality. After 1990s the changes occurring in climate directly affected the Kur flow and water qualitative content.

The alteration of ion content in waters of the separate hydrostations was determined in the Kur river of Azerbaijan on years (Table 3). The consequences of the analyses of the there – year information for comparison have been given. A main character of 1952 is that the flow of the Kur wasn't regulated until this year. That is the dam and water storage weren't constructed. That's why, it is necessary to compare the results of the information of the next years with this year.

According to the information of 1952 the ion content changes as it reaches the mouth. A sum of ions was 522,6 mg|l, while it was 419,0 mg|l in the Giragkasaman massive, but its amount grows and becomes 865,2 mg|l as it reaches the mouth. An amount of anions SO_4, HCO_3 and Cl^- quickly increased as it reaches the mouth, but Ca^{+2} cation amount sharply decreased. A quantity of cation comparatively grew in the Surra hydrostation after joining the Araz. An amount of Mg^{2+} cation decreased in the Surra hydrostation and grew towards the mouth again.

Table 3. Alteration of ion content of the waters in the Kur in separate stations on years

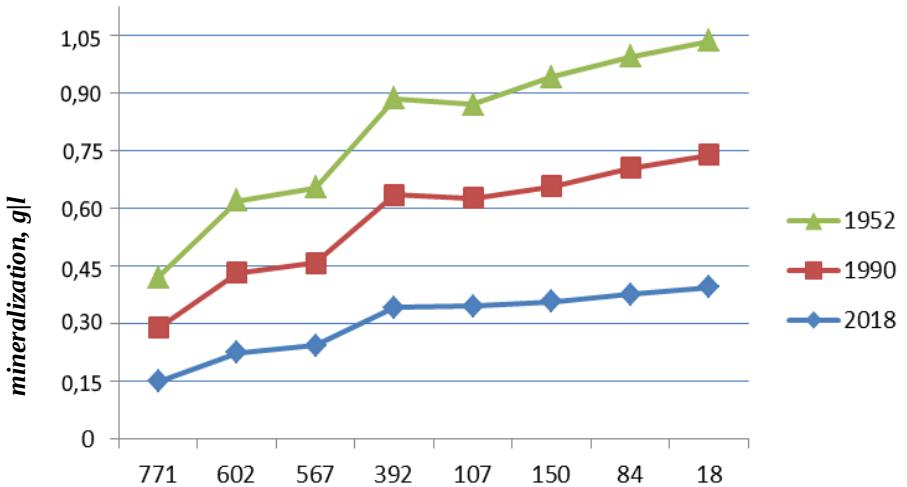
Hydrostation	Distance from the station, km	Ion content of water, ml/l						Total mg/l	Water consum-ption m^3/san
		Ca	Mg	Na+K	SO_4	HCO_3	Cl		
1952									
Giragkasaman	771	70,2	21,3	71,5	206,2	172,8	39,8	419,0	381
Mingachevir	602	55,8	27,6	87,5	193,5	178,6	89,6	522,6	390
Yevlakh	567	52,4	33,7	93,5	198,3	192,4	92,7	663,0	371
Zardab	392	52,8	34,3	88,8	193,5	182,5	97,6	649,5	366
Surra	207	52,6	24,4	94,4	210,6	195,4	100,3	677,7	558
Şhirvan	150	64,5	35,3	132,6	255,7	190,3	111,5	789,0	548
Salyan	87	67,4	50,3	141,6	260,3	211,2	113,7	844,5	525
Banka	18	67,6	47,2	136,4	281,4	219,0	113,5	865,2	524
1990									
Giragkasaman	771	69,6	28,5	87,7	201,0	176,3	45,2	608,3	308
Mingachevir	602	51,2	30,1	82,9	206,2	184,1	93,5	648,0	279
Yevlakh	567	52,5	34,3	91,6	204,9	186,8	101,9	671,9	263
Zardab	392	53,6	38,0	92,5	211,0	188,1	98,5	681,7	271
Surra	207	56,2	39,1	96,7	212,6	191,3	103,8	804,7	509
Şhirvan	150	62,6	43,2	128,6	250,0	199,5	112,6	806,5	491
Salyan	84	68,8	51,3	148,7	268,9	212,8	116,2	866,7	479
Banka	18	69,1	63,7	142,5	276,7	210,3	112,9	874,7	402
2018									
Giragkasaman	771	67,3	22,5	78,1	211,7	179,2	51,7	620,5	299
Mingachevir	602	55,9	24,5	85,6	238,2	196,4	69,5	670,1	273
Yevlakh	567	57,5	36,1	90,3	211,4	193,7	106,7	695,7	269
Zardab	392	54,8	29,8	93,9	223,5	199,8	101,2	703,0	251
Surra	207	67,7	28,8	136,5	259,1	202,0	103,5	797,0	508
Şhirvan	150	68,9	34,1	139,2	268,2	201,8	101,6	813,8	489
Salyan	84	69,5	57,2	147,0	269,7	216,5	119,3	879,2	425
Banka	18	69,8	59,6	149,7	271,4	219,0	118,6	88,1	382

According to the information of 1990 a quantity of ion was more (Table 3). A main reason of these changes is anthropogenic factors, but the climate alterations must be felt. The information of 2018 shows that an increase of ions amount is related to the climate changes.

The ions change in the river waters occurs in two directions. The fist is an increase of ions amount in the water towards the mouth. The second is the increase of ions from previous years to the present. The main reasons of this are increase of temperature and intensification of evaporation. The reduction of the rainfalls stimulates this increase.

The analysis shows that an influence of the changes occurring in climate is felt in all ions amount of the water (Table 3). The general mineralization in waters increases under an influence of the climate changes (Graphics 1). It is clear from the graphics analysis that mineralization increases to Mingachevir, but this increase is very little noticeable. Though mineralization rises up two times in hydrostation after Yevlakh i.e. in Zardab, this increase weakly shows that the rise.

The researches show that the rise on years and stations is observed in an amount of the biogenic elements of the water (Table 4). A quantity of total nitrogen in Giragkasaman hydrostation grew 1,01 mg|l in 1952, but it was 1,98 mg|l in 1990, it became 2,25 mg|l in connection with the climate change in 2018. Such change is observed in a quantity of total phosphorus. The directions of the alterations occurring in mineralization repeat in biogenic elements. According to the information of 2018 an amount of total nitrogen is 2,25 mg|l in Giragkasaman and it gradually reduces towards the place at the joining of the Araz river, then. This index intensively rises. Undoubtedly, this is influenced by the composition of the waters of the Araz river. But this state isn't observed in total phosphorus. Change of mineralization in hydrostations as they move away from the mount of the Kur river on years (pic. 1).



Picture 1. Change of salt quantity over years

Table 4. Alternation of biogenic elements in the separate hydrostations of the Kur river on years

Hydrostation	Distance from the mouth, km	Sum of total hidrogen, mq/l			Sum of total phosphorus, mg/l		
		1952	1990	2018	1952	1990	2018
Girag Kasaman	771	1,01	1,98	2,25	0,017	0,031	0,048
Mingachevir	602	1,03	1,31	1,32	0,019	0,036	0,051
Yevlakh	567	1,11	1,35	1,42	0,026	0,049	0,054
Zardab	392	1,19	1,30	1,28	0,029	0,051	0,063
Surra	207	1,43	1,57	1,52	0,022	0,048	0,057
Şhirvan	150	1,50	1,62	1,79	0,027	0,052	0,059
Salyan	84	1,52	1,78	1,86	0,030	0,056	0,064
Banka	18	1,55	1,81	1,84	0,033	0,059	0,068

It is seen from the information of 2018 that total phosphorus gradually rises towards the mouth. It is clear from the information that a quantity of biogenic elements in water occurs in increase direction beginning from 1990s. It is possible

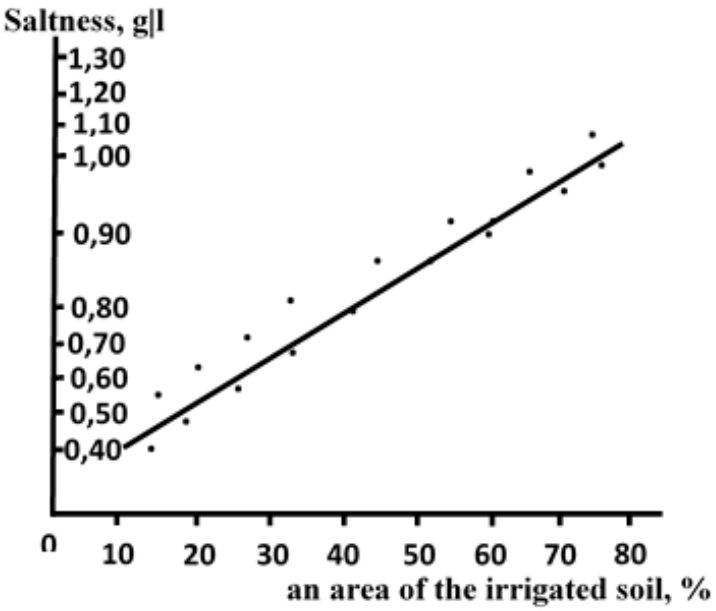
to relate it to the changes occurring in climate. Though these alterations are observed by floods for two times, the noticeable reductions are available in an amount of water consumption.

The researches indicate that the water mineralization increased in the rivers including in the Kur basin for recent decades. There are other factors in the climate along with the temperature increase and precipitation decrease.

As we mentioned above, expansion of irrigated soil, the water returning in the opposite direction in irrigation raise mineralization. Expansion of irrigation intensifies this process.

The irrigative water causes increase of groundwater in the higher areas. The irrigative water which is salinized in the Kur river mixes with the groundwater and returns to the Kur again. This process occurs several times, firstly returning of excess water from surface irrigation, and the second is due to the construction of the collector drainage, and the water is collected and mixed with the river water, the third is water storage constructed on the Kur, Araz and other rivers. The water which collects in these storages intensively evaporates in a hot period and therefore mineralization rises. For.ex: the water storages built in the rivers of Mingachevir, Shamkir, Tazakand, Varvara on the Kur, and Araz, Mil-Mughan and other rivers on the Araz increased mineralization of the Kur River.

The observations indicate that water mineralization in the river rises even higher in the dry years. We have prepared a graph of water salinization due to enlargement of the irrigated soil area on the basis of the above results (pic. 2).



Picture 2. Impact of increase of the irrigated area on salinization

It is known from the graph that an enlargement of the irrigated area in the low flow of the Kur river is a reason for saltness increase. Growth of the irrigated part of the general area is attributed to water salinity. For.ex: if 10% of the general area is irrigated, the saltness doesn't change. But if 5% of the soil is irrigated, the saltness rises for 2 times. The irrigated soil area rises 2,5 times at 80%.

Conclusion

The research and statistics analyses show that the changes in climate of the Kur river – the temperature rise and rainfalls decrease are occurring. This doesn't pass unnoticed to the ecosystem and human economic activities, it seriously affects the qualitative and quantitative indicators of the water supply.

The information in the hydrostations over the Kur river on different years indicates that an amount of ions in water content rose and this increase grew until two times after 1990s. A quantity of minerals in water content rose more than 50% towards the mouth. The biogenic elements in water content – total nitrogen and total phosphorus also increased, this rise is observed in the stations which are far from the stations. As a result of enlargement off the irrigated soil area, the saltness indicator rose in the water of the Kur river.

Increase of the ion content and mineral of the irrigative water created salinization risk of souls and this causes the entry of harmful salts (on average 10 tons per hectare). As a result of enlargement of the irrigated soil area, the saltness indicator rose in the water of the Kur river.

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ВПЛИВ КЛІМАТИЧНИХ ЗМІН ТА РОЗШИРЕННЯ ЗРОШУВАННЯ ҐРУНТІВ НА ЯКІСНІ ПОКАЗНИКИ РІЧКОВОЇ ВОДИ

Анотація. Встановлено, що починаючи з 1990-х років відбулося підвищення загальної температури повітря і кількість опадів значно зменшилася. Ці зміни клімату вплинули на кількісні показники якості води річки Кура. Вміст іонів у річковій воді

у 2018 р. значно зріс у порівнянні з 1952 та 1990 рр. Інтенсивніше зростання спостерігалося поблизу гирла річки. Якщо в 1952 р. вміст іонів на гідрологічній станції Гіраг Касаман становив 419,0 мг|л, то в 1990 р. цей показник складав 608,3 мг|л, а в 2018 р. – 620,5 мг|л. А на гідрологічній станції Банка біля гирла річки кількість іонів становила 865,0 мг|л у 1952 р., 874,7 мг|л у 1990 р. та 888,1 мг|л – у 2018 р. Зміна клімату вплинула на мінералогічний склад і кількість біогенних елементів річкової води. З наближенням до гирла річки рівень мінералізації закономірно зростав. Особливо показовим є це зростання за останні 30 років.

Зміна якості води р. Кура викликає значні проблеми при застосуванні зрошувальних заходів. На кожен гектар землі потрапляють тонни шкідливих солей. Неосушені та старі невідновлені осушені ґрунти засолюються, і, таким чином, створюються умови для подальшої деградації ґрунтів.

Ключові слова: р. Кура; зміни клімату; вміст іонів; мінералізація; біогенні елементи; якість води

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