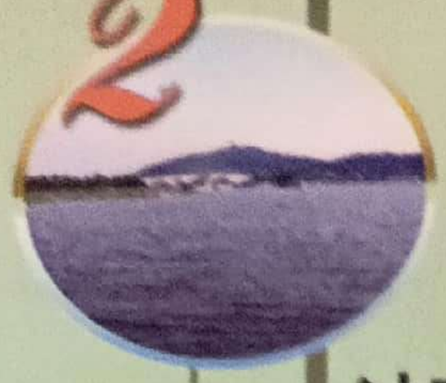


湖泊有毒藻类控制与生态修复国际学术研讨会

THE THIRD INTERNATIONAL SYMPOSIUM FOR STRATEGIES ON TOXIC ALGAE CONTROL IN LAKES AND RESERVOIRS FOR ESTABLISHMENT OF INTERNATIONAL NETWORK

2003年10月25日~28日　中国 无锡

Oct. 25~28, 2003　Wuxi CHINA

主办单位：
中国环境科学研究院
日本国立环境研究所
江苏省无锡市人民政府
日本文部科学省
中科院南京地理与湖泊研究所
国家973“湖泊富营养化过程与蓝藻水华暴发机理研究”项目组
日本水道咨询公司

Sponsors:
Chinese Research Academy of Environmental Science (CRAES)
Japanese National Institute for Environmental Studies (JNIES)
Wuxi Municipal Government, Jiangsu Province, China
Ministry of Education, Culture, Sports, Science and Technology, Japan
Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences (NIGLAS)
Study on Mechanism of Eutrophication and Blue Algal Bloom Burst in Lakes (2002CB412300)
Nihon Suido Consultants CO., LTD. (NSC)

Water quality of lakes and reservoirs of Uzbekistan

Mamatov S.A.[1], Shirokova Y.I.[2]

[1] Head of Water Resource Conservation Department of the Central Asian Research Institute of Irrigation (SANIIRI)

[2] Deputy director of the Central Asian Research Institute of Irrigation (SANIIRI)

Uzbekistan is situated in semi-dry climatic zone. However, there are a lot of lakes and lake systems here. Uzbekistan's lakes are subdivided into mountain and sub-mountain, and plain ones according to their altitude location (Figure 1).

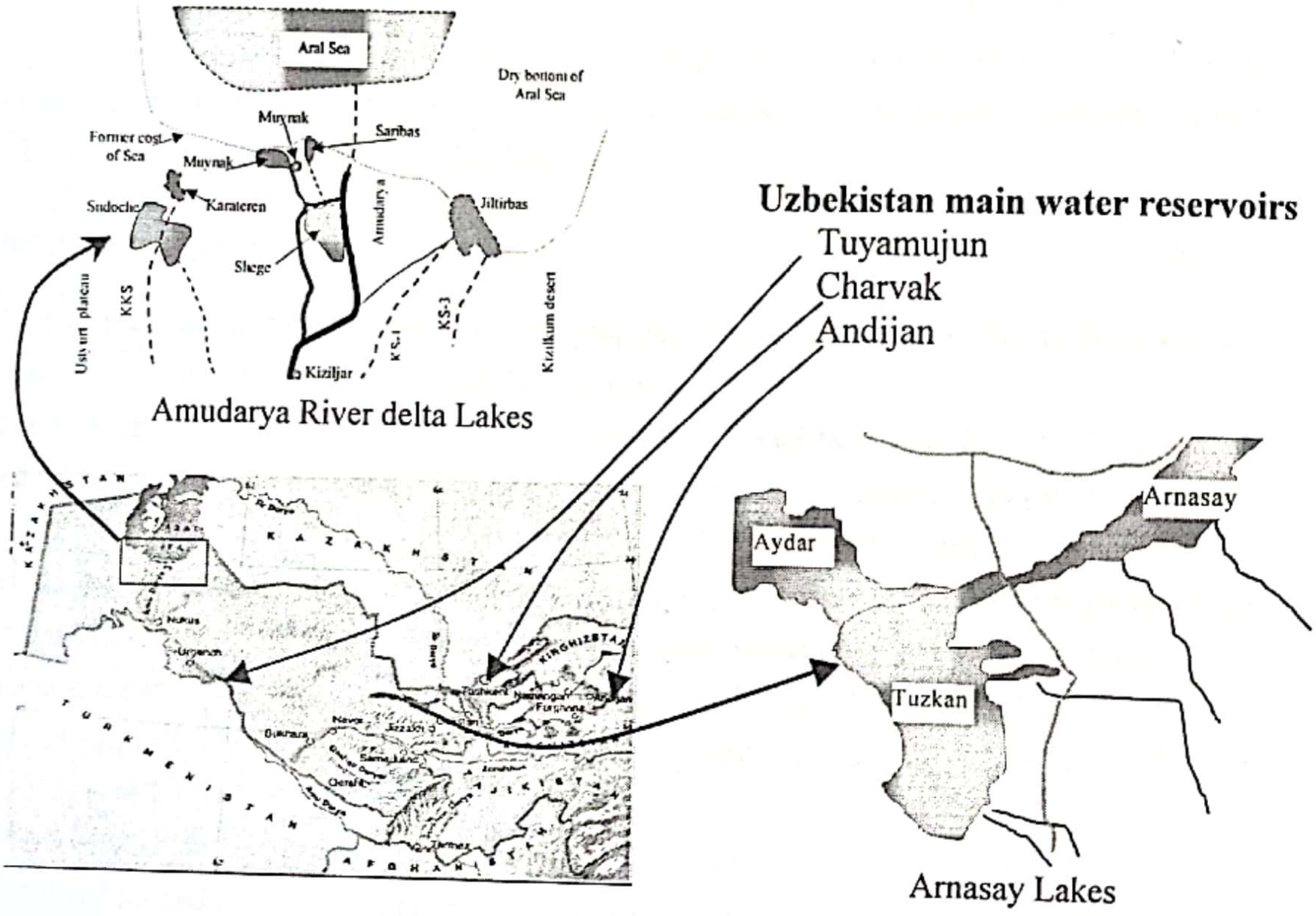


Figure 1. Location and scheme of Uzbekistan Lakes and main reservoirs

Mountain and sub-mountain lakes generally occupy small areas, and all of them are natural by their origin.

Under the conditions of Uzbekistan's mountain and sub-mountain zones reservoirs network is highly developed. Such big reservoirs (artificial lakes) as Andijan, Charvak, Ghissarak and Pachkamar ones are located in this zone. Generally water in these lakes is fresh and drinkable (table 1).

Plain lakes are very significant for conditions of Uzbekistan, which are for the most part located in river deltas and natural depressions. At this parts of Uzbekistan there are as well big reservoirs such as Tuyamujun, Talimarjan, Kattakurgan, Tashkent and other. Water quality in these reservoirs is somewhat worse than one in submountain reservoirs. (table 1)

Table 1. The Uzbekistan reservoirs water quality

Reservoir	Volume, km^3	TDS, g/m^3	SO_4, g/m^3	Cl, g/m^3	BOD, g/m^3	COD, g/m^3
Andijan	1.75	300-500	100-150	10-18	0.9-2.7	6-15
Charvak	2.0	200-300	15-30	4-10	0.3-1.2	2-5
Khisarak	0.17	200-300	50	7-10	0.6-2.7	3-5
Pachkamar	0.24	1200-1800	650-850	140-210	0.9-2.7	5-11
Tuyamujun	2.34	700-1400	300-600	175-280	1.8-3.0	10-18
Talimarjan	1.53	700-800	250-400	140-250	0.9-2.4	12-20
Kattakurgan	0.85	400-500	150-200	35-70	2.0-3.0	8-15
Tuyabuguz	0.21	200-400	50-200	10-35	1.0-2.7	6-12

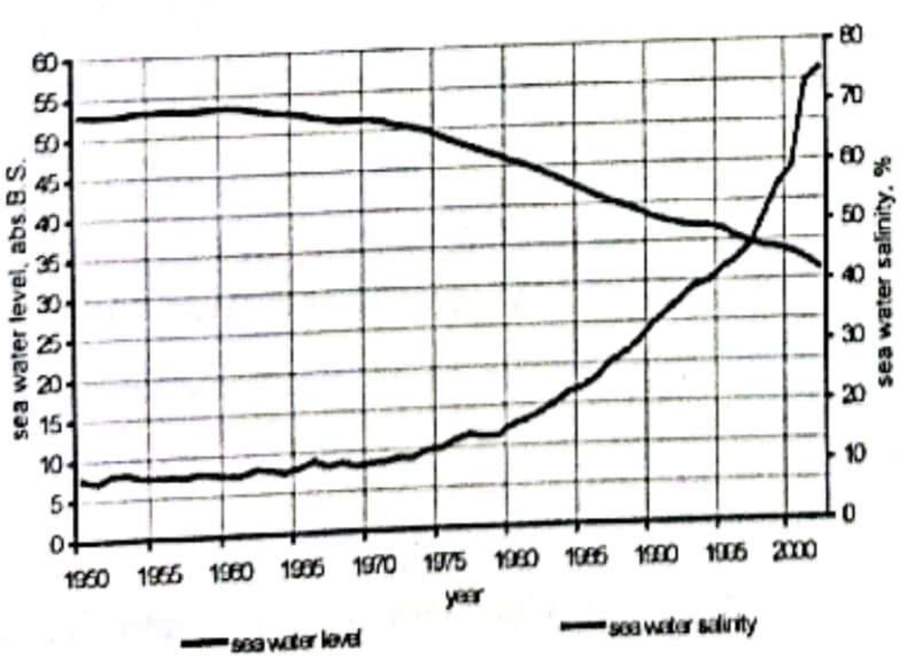
One of largest natural lakes of Uzbekistan is the Aral Sea. Smaller natural Uzbekistan's lakes are in main situated in the Amudarya river delta. Among them particularly rank Sudoche, Shege, Muynak, Saribas, Karateren, Dautkul lakes.

Intensive development of irrigation agriculture in the XX century's end required for irrevocable withdrawal of great amount of river water through artificial regulation of the river flow. As a result, the Aral Sea and natural lakes of the Amudarya river delta began to suffer due to lack of water resources (table 2).

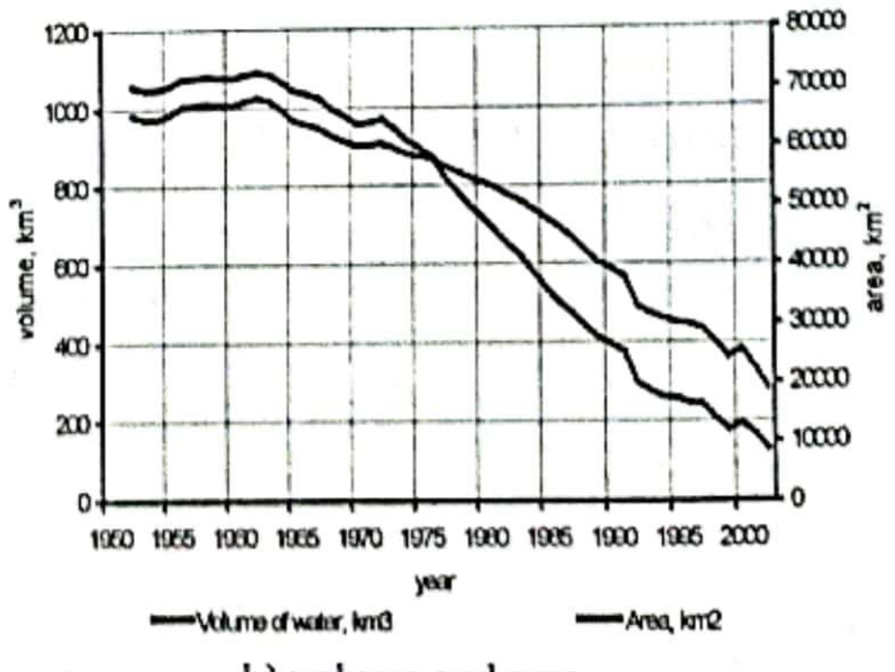
Table 2. Trends of river inflow to the Aral Sea, sea water level and salinity (1951-2002 years)

Period	River runoff			Sea water level, meter			Sea water salinity, g/dm^3		
	Total, km^3/decade	Average annual, km^3/year	Average annual change, km^3/year	By the end of period	Average annual change, meter/year	Difference from the original level (53,0)	By the end of period	Average annual change, g/dm^3	Difference from the original salinity (10,0)
1951-1960	609,61	60,96	0	53,5	-0,05	0,5	9,93	-0,02	-0,07
1961-1970	394,41	39,44	-21,52	51,44	0,21	-1,56	11,2	0,13	1,2
1971-1980	164,13	16,41	-23,03	45,75	0,57	-7,25	16,8	0,56	6,8
1981-1990	56,42	5,64	-10,77	38,24	0,75	-14,7	33,1	1,63	23,1
1991-2000	104,00	10,40	4,76	33,50	0,34	-19,5	58,6	2,55	48,6
2001-2002	0,22	0,11		31,43	1,04	-21,57	75	8,20	65,0

The Aral Sea level during 42 years (from 1962 to 2002) has dropped by 21.6 m, its area reduced by 3.6 times (from 68,000 down to 19,000 km^2), and its volume decreased about 8.3 times (from 1086 down to 131 km^2), water salinity increased nearly 8 times (from 9.93 to 75 %) (figure 2).



a) level and salinity



b) volume and area

Figure.2. Historical trends of Aral Sea water level, water salinity, water volume and area

Decrease of river flow resulted in not only lowering the Aral Sea level and as well as reduction of lake areas at the Amudarya river delta.

In 1963-1965 the total area of the Amudarya river delta's lakes was 2460 km^2. In that period hydrologic and hydrochemical regimes of these lakes had good state. Then water salinity in such delta lakes as Kuksu, Shege, Zakirkul, Khodjakul, Dautkul ranged within 334 to 1200 g/m^3 during.

By the present the total area the Amudarya river delta's lakes has considerably reduced. Now most part of the lakes exists owing to drainage water (0.6 to 2.4 km^3/year depending on year's water capacity) from irrigated lands of the South Aral Sea area, and only little part of the delta lakes (Shege, Muynak and Saribas) exists thanks to river water.

Change of the delta lakes' water chemical contents depends completely on the one of feeding source. The delta lakes (Sudoche, Karateren-zapad, Karateren-vostok) and the former sea bays (Jiltirbas and Adjibay) exist thanks to drainage water only, which is fed by groundwater of the South Aral Sea area's irrigated lands. Generally, this water is mineralized. Therefore, these lakes are characterized by high salinity of their water, water mineralization in Sudoche lake ranges within 4528 to 18302 g/m^3.

State of the lakes (Shege, Muynak and Saribas) situated at the present Amudarya river delta depends entirely on water quality and quantity, coming from the river. These lakes were artificially made in the 90s of the XX century and were intended to supply population of the Muynak district with clean tap water. So, their relatively good state is ensured by delivery of clean water of the Amudarya, and other lakes of the South Aral Sea area are subjected to high variation.(table 3).

Table 3. South Aral Sea area's lakes water quality (1998-2002 y.)

Lake	Ca^{2+}, g/m^3	Mg^{2+}, g/m^3	$Na^{+}+K^{+}$, g/m^3	HCO_3^-, g/m^3	Cl^-, g/m^3	SO_4^{2-}, g/m^3	TDS, g/m^3
Shege	80-300	36-240	182-598	90-320	85-888	317-1488	1019-3578
Muynak	110-750	43-870	183-2960	93-293	205-6160	400-3800	1127-14660
Saribas	60-600	31-450	216-1770	110-320	377-2050	279-3980	1240-9040
Sudoche	120-260	180-4548	148-8420	215-549	511-12070	624-18000	1878-43573
Karateren	100-740	50-276	606-1913	234-390	693-3152	912-1680	3116-6997

Along with development of new irrigated lands in the XX century's latter half, on other parts of Uzbekistan (on deserts' natural lowlands) began to appear new sort of lakes – irrigation-discharged lakes which accumulated drainage water discharged from irrigated fields. In Uzbekistan desert parts have been formed such lakes as Tuzkan, Aydarkul (Aydar), Denghizkul. Shurkul and others. In the initial period of their appearance these lakes served mostly as natural evaporation ponds of mineralized drainage water. As their volumes and areas increased, necessities for use them for various purposes of economy, and lake fish-breeding began to develop.

The Arnasay lakes system including Aydar, Tuzkan and Arnasay Lakes was formed in 1969 owing to water discharge of 21.8 km^3 from the Chardara reservoir to the blind Arnasay depression which presents tectonic hollow reaching from west towards east for 180 km, 2 to 4 km wide. Area of the lakes increased from 120 km^2 up to 2300 km^2, and had capacity of about 20 km^3.

Nowadays, Arnasay Lakes feed by river water from the Chardara reservoir and drainage water (1.7-2.6 km^3/year) of irrigated lands of the Golodnaya and Djizak steppes. Transition of the Toctogul hydro-system (in

the Kirgistan) from irrigation to energetic regime (beginning from 1993-1994) caused high discharge of great amount of flood water from the Chardara reservoir to the Arnasay lakes system, thanks to that the lake water level began high rising, and happened flooding up of vast adjacent territories. By the 2000 year, it took place the level rise compared to January of 1993 for 7.6 m, total water surface area increased up to 3258 km^2, and water capacity in the lakes system increased to 35.5 km^3 (figure 3).

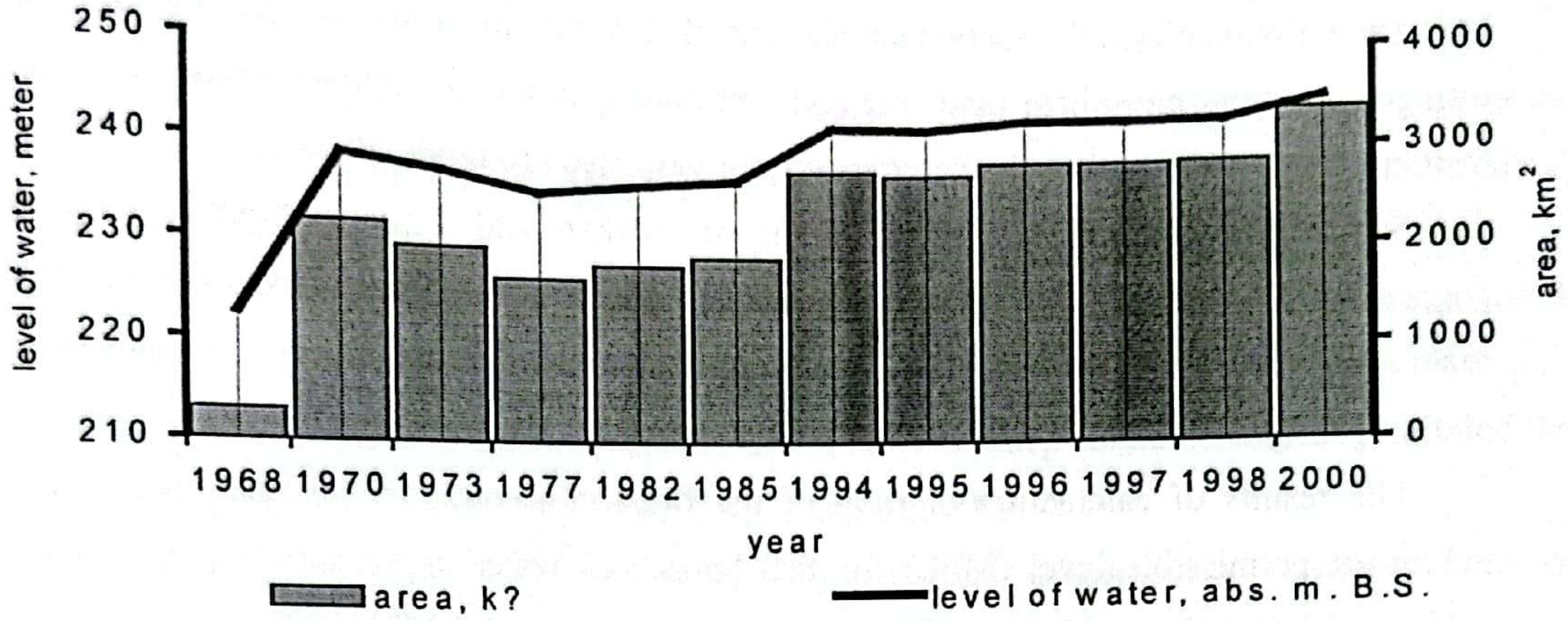


Figure 3. Historical trends of Arnasay lakes water level and area

the conditions of hot climate, relative shallow water and feeding waters (river or drainage) quality.

Evaporation from the lakes is fluctuates from 1300 to 1500 mm/year. Losses for evaporation in different years are from 3,4 to 2,5 km^3. Evaporation leads to increase of salt structure of lake water for 10-15%. However, dominant factor influencing on hydrochemical regime is antropogenic – chop of drainage water.

In spring periods of year in water of Eastern Arnasay relatively low salinity is shown, that could be explained by arrival of big volumes of fresh water from Chardara reservoir. And largest indicator of water salinity is in the beginning of autumn, when losses for evaporation is compensated only from drainage water.

In the Aydar and Tuzkan lakes this correlationship is noticeably lower because of inflow of mixed waters of Eastern Arnasay (table 4).

Table 4. Arnasay lakes water quality (2002-2003 y.)

Lake	Ca^{2+}, g/m^3	Mg^{2+}, g/m^3	$Na^{+}+K^{+}$, g/m^3	SO_4^{2-}, g/m^3	Cl^{-}, g/m^3	TDS, g/m^3	T-N, g/m^3	T-P, g/m^3	BOD, g/m^3	COD, g/m^3
Arnasay	200-280	210-260	390-590	1340-1480	670-680	3120-3330	2,3-20	0-0,4	1,2-1,3	12-25
Tuzkan	440-480	410-450	1150-1790	2490-4320	1410-1710	6390-8720	0,1-46	0-0,4	1,7-3,2	14-40
Aydar	440-500	420-470	1550-1810	2780-4290	1530-1960	7420-8690	0,1-55	0-0,5	1,6-2,0	13-40

In general lakes are characterized as saltiest, thermal and with good gaz regime all year.

Highest water flora in Arnasay lakes is shown by 8 types, and most diffusive are reed (Scirpeta), reed mace (Typheta), pondweed (Potamogeteta), without vividly identified flora zone. Average size of raw flora mass 2.5 ton/ha under 15% of lake overgrown. Average biomass of fitoplankton on vegetation period – 7.8 g/m^3.

Dominant forms of zooplankton have 7 types. Quantitative development of zooplankton in the lakes is uneven. Its number is fluctuates from 10 to 70 thousandspeciment/m^3. Maximum number of biomass of zooplankton is disclosed in summer period. Average biomass of zooplankton is 1.5 g/m^3.

Dominant group of zooplankton in lakes is larva of hironomid. Its average biomass is 1.7 g/m^2. In general quantitative development of zoobentos is depend on range of factors, in detail, saline of grounds, thus in Aydar and Tuzkan its low, and in Eastern Arnasay it is high.

In general, reserves of fitobentos and fitoplankton of the Arnasay lakes can be considered as high feeding, reserves of zooplankton and zoobentos average feeding.

Sanitation-ecological assessment showed that water in Aydarkul can be seen by three parameters: nitrogen nitrate, phosphate and organic substance water is characterized as contaminated and very contaminated, and on other characteristics from very clean to moderate dirty.

Sanitation-ecological quality of water of Tuzkan and Eastern Arnasay in year is changes from contaminated to clean. From all water quality parameters in Arnasay Lakes overreach standards almost all main ions –Ca^{2+}, Mg^{2+}, Na^{+}, SO_4^{2-}, Cl^{-}, and highest overreach of maximum permissible level (MPL) is sulfates about 41 times.

The results of calculation of ratio of the fined concentration of water quality indicators in lakes to maximum permissible level (MPL) for fish household water usage showed, that in water of Aydar Lake sulfates (27-43 MPL), chlorides (5 MPL), ions of calcium (2.5 MPL), of magnesium (10-12 MPL), sodium (10-15 MPL), and COD (1-2.7 MPL) overreach permissible norms.

In water of Tuzkan Lake sulfates (25-42 MPL), chlorides (5-5.5 MPL), ions of calcium (2.5 MPL), of magnesium (10-12 MPL), sodium (10-14 MPL), and COD (1-2.7 MPL) overreach permissible norms for fish household water usage.

And in water of Eastern Arnasay Lake permissible norms for fish household water usage overreach sulfates (13-15 MPL), chlorides (2-2.5 MPL), ions of calcium (1.5 MPL), magnesium (5.5 MPL), sodium (3-5 MPL) and COD (0.8-1.7 MPL).

Irrigation water quality assessment shows that waters of all lakes doesn't watch the demands of statutory norms of mineralization and main ions (sulfate, chloride, magnesium) because overreach the permissible norms – 3-8 times.

Summary:

- Water quality of Uzbekistan reservoirs is differs depending on its altitude location. Submountain reservoirs are characterized by good water quality, and high water salinity and its inaptitude for drinking characterize champaign reservoirs.
- Lakes of Uzbekistan mostly located on champaign-desert part of country and have irrigation-down throw (drainage) origin.
- At present salinity of water in largest lake of Uzbekistan – Aral Sea is 75 g/dm^3 and it is inaptitude for inhabitance of living organisms.
- In Amudarya River delta lakes, which exist by means of highly mineralized drainage water level and quality of water undergo acute changes, and in lakes, which give drinking water, sanitation-ecological status is relatively good because of river water supply.
- Reclamation and irrigation of new lands at the end of XX century lead to formation of new (irrigation-down throw (drainage)) type lakes in prairie parts of Uzbekistan, for example Arnasay Lakes (Aydar, Tuzkan, Eastern Arnasay).

- Arnasay Lakes water is highly mineralized, moderate contaminated, and content of almost all main ions (sulfates, chlorides, magnesium and sodium) doesn't watch standards of water quality for fish household water usage and also doesn't watch standards of irrigation water quality.

References:

[1] Nikolayenko V.A., Mamatov S.A. Features and methodology of hydroecological assessment of impact of water household on hydroecosystem condition of Aral Sea basin. Water resources of Central Asia. Almaty, 2002, pp.358-364.

[2] Nikolayenko V.A. Water quality of reservoirs of Amudarya and Sirdarya and its usage for drinking purposes problems. Articles of "Reclamation and water economy ". SANIIRI. Tashkent., 1996, pp. 42-48.

[3] Mamatov S.A. To estimate requirements for water quality to keep stable ecological profile of the South Aral Sea area. SANIIRI report (from its archive), Tashkent, 2002.

[4] Mamatov S.A., Nikolaenko V.A., Ruziev I.B. Hydroecological assessment of current state of some Amudarya river delta's reservoirs. Articles of "Present problems of reclamation and water economy and ways of their solution". Part 2. SANIIRI. T., 2001, pp. 32-42.