ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 4, Issue 10 , October 2017

Modern state of the wetland ecosystem of Ili river delta

DostayZh, Alimkulov S, MyrzakhmetovA

Doctor of Geographical Sciences, Professor**,** Chief Researcher, Department of Water resources, Institute of Geography, Satpayev University, Almaty, Kazakhstan
Candidate of geographical science**,** Deputy Director, Leading Researcher, Institute of Geography, Satpayev University, Almaty, Kazakhstan
PhD, Senior Researcher, Department of Water resources, Institute of Geography, Satpayev University, Almaty, Kazakhstan

ABSTRACT: The article deals with the changes in the underlying surface of the only preserved delta in Central Asia on the Ili River, depending on the inflow of water to the peak of the delta and the fluctuations in the water level of Lake Balkhash. To trace the dynamics of areas of the water surface, vegetation cover, wetlands and salt marches, the results of the study of the investigated territories by the method of deciphering aerial photographs from 1958 to 1984 by the specialists of the former USSR were used. Since 1985 to the present, the data of the space satellite Landsat have been used.
In addition, the article reveals the importance of the wetlands of the study area as a place of migration and nesting of migratory birds, as well as the reduction of unique delta biodiversity, depending on the water flow to the peak of the Ili River delta.

KEYWORDS: Estuary, River, Delta ecosystem, Runoff, Water level, Waterway, Lake, Water volume, Peak of delta, Flow losses, Water line.

I.INTRODUCTION

The Ili River at the confluence of Lake Balkhash forms an extensive natural delta with an area of more than 8 thousand km^2, which is the only preserved delta and is an important and unique ecosystem in Central Asia (Figure 1). The delta is hydraulically connected with the lake and plays the role of a natural regulator to maintain ecological balance in the Ili-Balkhash lake ecosystem, giving part of the water supplies to Lake Balkhash in dry years and accumulating it in the years of high water [1].

Being the habitat of the Balkhash tiger (the last specimen of the dead in the mid-1930s [2-4] and many other rare species, it is a system of lakes, waterways, branches, oxbows mixed with thickets of reeds and dry lands, which are the ecological environment of the lake, providing the habitat and reproduction of fish, muskrats, wild animals and a diverse biological complex.

The special value and uniqueness of the wetlands are for the desert zone. Formation of wetland ecosystems in the desert zone is an unstable and rare process, limited by water resources, which requires constant replenishment of large volumes of water.

Wetlands of the Ili delta are recognized as wetlands of international importance, included in the Ramsar List as a place of mass nesting of waterfowl and bywater birds, including globally endangered species [5]. It is inhabited by representatives of 427 species of rich desert flora and 345 species of marine fauna, as well as species of animals and birds included in the Red Book.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 4, Issue 10 , October 2017

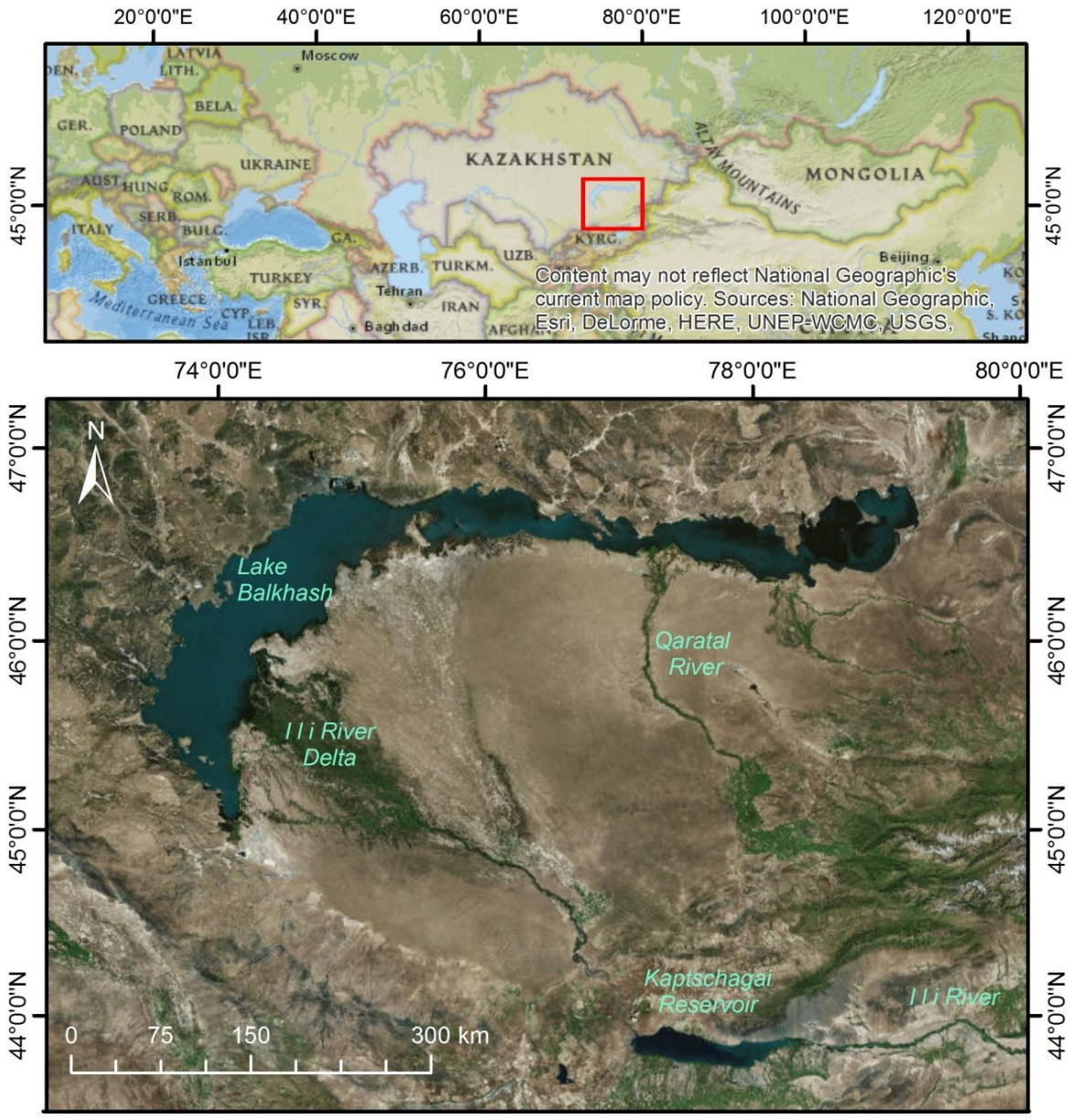

Fig 1. Geographic location of the study area

Lake Balkhash is one of the largest lakes in continental Asia and the fifth largest isolated reservoir in the world. The uniqueness of the lake is that it is divided by a narrow strait into two parts with different chemical characteristics of water - in the western part it is practically fresh, and in the eastern part - brackish. The area of Lake Balkhash is approximately 16.4 thousand km² (2010), lies at an altitude of about 340 m above sea level. The level of Lake Balkhash is one of the main indicators of the state of the whole ecosystem of the basin, known for its high water level variability from 341 to 343 m from the level of the World Ocean [6,7]. In addition, the lake has a large ecological and economic significance for the region as an object regulating the state of the natural environment of the adjacent territory, a unique biotic complex, a regulator of sanitary and hygienic living conditions of the population of the coastal zone and the whole basin, as well as a source of water supply for the facilities of the Lake Balkhash side.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 4, Issue 10 , October 2017

The main aquifer artery feeding the delta and Lake Balkhash is the Ili River, 80% of the runoff of all rivers flowing into the body of water [8].

The Ili River originates the Tien Shan Mountains in the territory of the People's Republic of China and flows into Lake Balkhash on the territory of the Republic of Kazakhstan. 60% of the catchment area is located on the territory of Kazakhstan and 40% is on the territory of the People's Republic of China [9,10].

Since 1970, as a result of the commissioning of the Kapshagai water reservoir (Figure 2), coinciding with the low-water phase of the hydrological regime of the Ili River, as well as the ever increasing taking surface water for irrigation, the natural phase of the rise in the lake level was interrupted and the combined effects of natural and human factors led to a sharp drop in the water level up to 340.65 m (1987). Thus, in its coastal part huge salt marshes were formed, the Ili River delta was practically being dried up. The progressive desertification of the whole coastal zone and deltoid parts of rivers began.

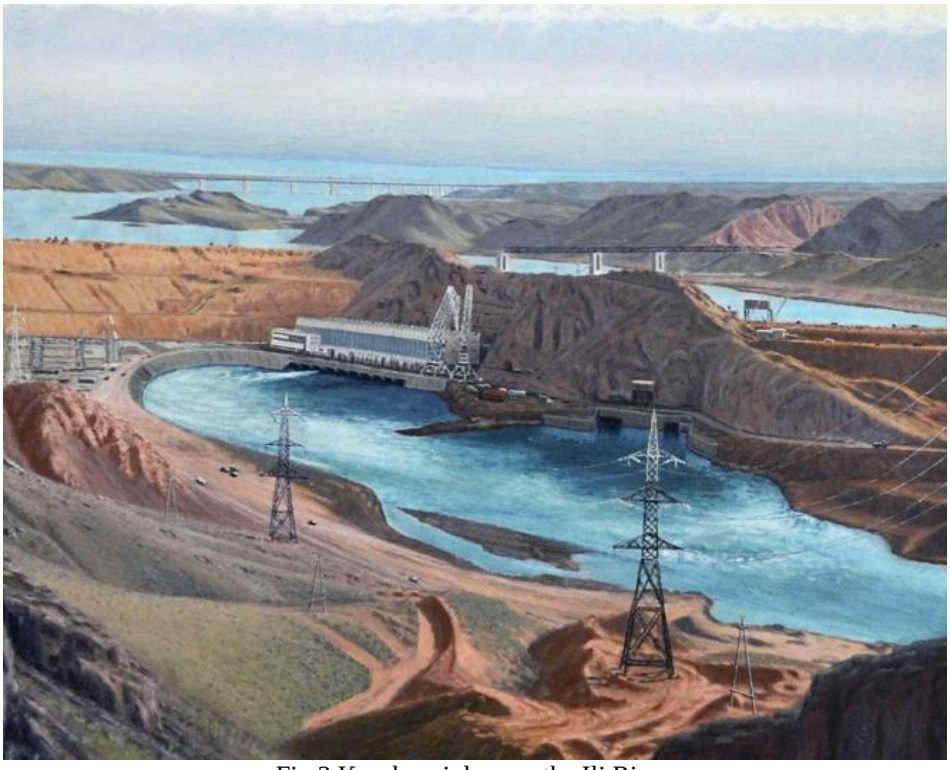

Fig 2.Kapshagai dam on the Ili River

With the beginning of filling Kapshagai water reservoir there was a dangerous ecological situation and an unpredictable course of events in the Lake Balkhash side, which had more dangerous tendencies, and caused great public anxiety and led to a great consolidation of the scientific forces of the former KazSSR, so, they were discussed at various levels in the republic and the USSR.

Thanks to the republic's efforts, an intermediate stage of comprehensive research was successfully completed in 1986 [11], which was approved at a number of republican meetings, and then approved at a special meeting of the Committee on the Environment of the Council of Ministers of the USSR and the corresponding orders of the Ministry of Water Resources of the Kazakh SSR. In this document, it was said to localize the area of irrigated land in the Ili-Balkhash basin through the use of surface waters; limit the filling of Kapshagai water reservoir up to the volume of 14 km^3, not getting it to the design mark of 28 km^3; to carry out the reconstruction of irrigation systems.

In 1987, on the recommendation of the Institute of Geography, dredging operations were carried out on the delta territory to water the dried up areas, with the subsequent reduction of the environmental costs of the runoff in the delta, and also to increase the water level of Lake Balkhash. As a result of the work, the throughput of the Zhideli River

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 4, Issue 10 , October 2017

distributary increased, and it began to transport up to 50% of the flow, and the Lake Balkhash level began to increase. However, these actions negatively affected the delta. With the direct hit of water into the lake, the water and marsh potential of the delta decreased.

II. THE ROLE OF THE REGION AS THE PLACE OF MIGRATION OF BIRDS

The main and most important role of wetlands is to provide habitat for a large number of plants and animals, including rare, endemic, unique species. The value and uniqueness of the flora of the investigated territory is confirmed by the presence of rare species in its structure: from the Red Book - 7; relic - 7; endemic for Kazakhstan - 18; other rare, needing regional protection - 6. The resource value of the flora is also very high - more than 80% of the species have different useful properties, 31 species of wild relatives of cultivated plants have been identified. Phytocenotic diversity of the territory is distinguished by a special set of plant communities, including the following types of vegetation: aquatic, marsh, meadow, tugai, desert [12]. The study area is on one of the largest passageways of migratory water birds. In the delta, more than 150 species of birds nest, including 23 sedentary birds. The category of migrants includes 125, the voyages - 6 species. Of these, 12 are listed in the Red Book: pink and curly pelicans, spoonbill, karavayka, swan-swan, white heron, and also rare birds of prey - snake-eagle, white-tailed eagle, long-tailed eagle and osprey. The population of the white-eyed blacks in the delta of the Ili is considered to be the largest one in Central Asia, and the brown dove is considered to be the largest one in Kazakhstan. The most noticeable group of birds is the waterfowl, most of which form colonies on numerous lakes. The colonial nests of pink and curly pelicans, spoonbills and other birds are unique, as well as a turangue ornithological complex (43 species). Colonies of pelicans in the delta of the Ili River are among the last ones in our country.

The region is a place of reproduction, feeding and growth of valuable fish species. The ichthyofauna includes more than 19 species of fish. The most valuable of them are pikeperch, carp, catfish, asp, bream, white cupid, silverfish, perch, bersh, sturgeons, etc.[8].

III. STUDY OF THE ILI RIVER DELTA AND THE DATA SET

A) Data of aerial photography of the Ili river delta

In 1957-1958, aerial photography was carried out on a spectrozonal aerial photographic film at a scale of 1: 25,000. Most of the territory was taken in July 1958
In May, 1974, the right-bank and left-bank parts of the delta at a scale of 1: 50,000 and 1: 80,000 were taken separately by aerial photography.
In May, 1978, the delta was once again photographed at a scale of 1: 100,000.
Two aerial photographs of the Ili River delta were carried out in the scale of 1:50 000 and 1:65 000 according to the orders of GGI in 1981-1984.

The 1984 photographings were performed in parallel in the visible and infrared spectral ranges. The Mingeo Aerial Design Laboratory carried out fragmentary radar (1975) and thermal imaging (1981) aerial photographs of the delta. In order to study the information content of other types of surveys, thermal imaging was carried out in 1981 along several routes in the center of the delta (day and night variants).

In parallel with the materials of conventional AFS, the conditions for deciphering water objects and vegetation according to thermal imaging and radar survey data were considered.

B) The data set from the landsat satellite

The main source of data for this study is the Landsat data archive from the USGS. The Landsat program provides the longest and most continuous set of satellite land cover data. Data have been available free of charge since the 1970s, including the MSS, TM and ETM + sensors. Two main issues had to be considered for data collection. First, the resulting images within a single time step should cover the entire study area with the smallest time interval [13]. Secondly, the images should be cloudless and high-quality. In connection with these requirements, a complete data set

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 4, Issue 10 , October 2017

was searched in the Landsat archive. Table 1 provides an overview of the selected data sets and additional sensor information.

Table 1. Specification of the use of Landsat images (from USGS 2013c)

Sensor	*Acquisition Date*	*Spectral Resolution*	*Spatial Resolution*
Landsat 2 / MSS	22. Aug 1977 23. Aug 1977 (2 images) 9. Sep 1977	4 spectral	60-m (channel 1-4)
Landsat 5 / TM	7. Jul 2011 (2 images) 30. Jul 2011 (2 images)	7 spectral	30-m (channel 1-5, 7) 120-m (channel 6)
Landsat 7 /ETM+	24. Aug 2000 2. Sep 2000 (2 images) 9. Sep 2000	7 spectral 1 panchromatic	30-m (channel 1-5, 7) 60-m (channel 6) 15-m (channel 8)

C) Hydrological data

Hydrological regime of watercourses and reservoirs of the Ili River Delta is poorly studied. Systematic observations of the runoff of the main rivers and watercourses of the study area were started in the 1930s by the Administration of the USSR Hydrometeorological Service.
In different years, hydrological observations in the delta of the Ili River were conducted by a network of 16 gauging stations of Kazhydromet and the Institute of Geography (Figure 3).

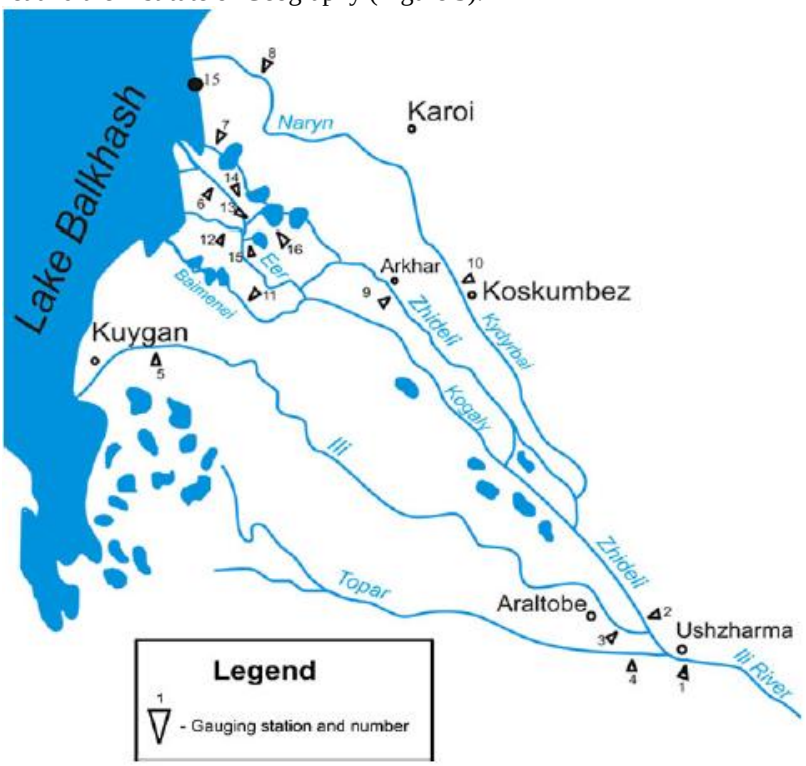

Fig 3. Arrangement of gauging stations

At the present time, systematic observations of the flow regime of the main streams are carried out in the upper part of the delta at the 3hydrologycal posts and at the bottom at the 2 hydrological posts of the RSE Kazgidromet. These posts mainly mark the flow regime at the inlet and outlet of the delta. And also in the 1980s, large-scale studies were carried out to study the dynamics of the Ili River delta. The Institute of Geography of Kazakhstan established the "Arkhar"

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 4, Issue 10 , October 2017

monitoring reference point (Figure 4) and the Hydrometric observations at 8 points, of which 7 were on the watercourses and one level post was on the lake Asaubai (Table 2) [14].

Table 2. Current state of geographic monitoring at the delta of the Ili River

№	River - Point	Period of action		Years of runoff monitoring
		opened	closed	
Posts of RSE "Kazhydromet"				
1	Ili River-s.Ushzharma	1937	active	1940-1943,1949-1996
2	Zhideli branch- 16 km below the source	01.01.1958 (01.09.2002)	active	1968-1995,2005,2007-2012
3	Ili branch-1 km below Zhideli branch off	29.08.1956 (01.09.2002)	active	1968-1982,1987-1997,2004-2012
4	w.Suminka-6 km below the source	1970	1995	1970-1984,1986-1994,2013-2014
5	Ili Branch-s.Zhideli	16.06.1957 (01.09.2002)	active	1968-1995,2004-2012
6	Zhideli branch,w.Iir-2.5 km from estuary	09.06.1957 (01.09.2002)	active	1968-1969,1971-1982,1984-1995,2005,2010-2012
7	Zhideli branch,w.Shubarkunan-1.5 km from estuary	1968	1995	1968-1970,1977-1978,1980-1981,1987-1995
8	w.Naryn-s.Nauryzbai	1968	1995	1968-1977
Posts of Institute of Geography				
9	Zhideli branch-s.Arkhar	1987	activ	1987-1991,2011-2014
10	w.Kadyrbai-s.Koskumbez	1987	activ	2012-2014
11	w.Baimenei-s.Baimenei	1987	1991	1987-1991
12	w.Balakashkan	1987	1991	1987-1991
13	w.Asubai	1987	1991	1987-1991
14	w.Sologubka-estuary	1987	1991	-
15	w.Kustastoe-source	1987	1991	1987-1991
16	Lake Asubai-Bugor	1987	1991	-

Reference Point of Monitoring "Arkhar" is the central link in the system of hydrometeorological observations and monitoring of the natural environment in the delta of the Ili River, is an integrated measuring and information system that provides information about the current and predicted state of Lake Balkhash.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 4, Issue 10 , October 2017

Fig 4. Reference point of monitoring "Archar" of the Institute of Geography of Kazakhstan

Currently, the Arkhar monitoring reference point conducts year-round meteorological observations, as well as measurements of water consumption at the Zhideli branch-s.Arkhar, which are carried out by modern hydrological instruments and equipment used in the system of the Hydrometeorological Service of the Republic of Kazakhstan. In addition, at 4 points, monitoring of the level regime is carried out simultaneously with measurements of water consumption, of which 2 stations are equipped with digital water level recorders during the ice-free period.

IV. RESULTS AND DISCUSSION

A) Runoff at the top and ecological needs of the delta

To determine the runoff at the top of the Ili River delta the data of observations of the river runoff in the Kapshagai natural boundary and in the settlement Ushzharma are considered, as well as the total runoff of all the arms formed at the top of the modern delta (Ili, Zhideli and Suminka).

Analysis of the data on the runoff of the Ili River – Kapshagai natural boundary showed that the data on this line can not be taken into account because of the water intake, which is used for irrigation, below the specified range to the top of the delta.

According to the results of the research [14] the data on the runoff at the reference monitoring post Ili River - s. Ushzharma due to their inadequate reliability (multi-arm in the track, absence of long-term observation of the level due to special conditions of the operation mode of the Kapshagai HPP, the river in this place flows through three channels, and the post is on one of these channels and is subject to constant erosion), and also for a number of other reasons were not used to assess the flow of river water to the top of the delta. In this regard, when determining the runoff at the top of the delta in 1970-2013, the total runoff in the sources of the three (Old Ili, Zhideli and Suminka) of these branches was used [15,16].

The Ili River run off entering the delta spreads through numerous watercourses, lakes and streams. As a result, the part does not reach Lake Balkhash, losing because of evaporation from the surface of water bodies and transpiration from wetlands. Some of the water is spent to fill inter-channel depressions and replenish groundwater reserves.

The study of the ecological costs of runoff reaching the apex of the delta was carried out by estimating the river runoff losses within the delta, representing the difference in the inflow of surface waters to the top of the delta and outflow from the delta to Lake Balkhash. Channel losses are the source of delta supply, i.e. the more water in the year, the greater the flooding of the delta and the greater environmental runoff costs.

The course of a long-term change in the environmental costs of the Ili River delta for the period from 1953 to 2013 is shown in Figure 5, and their average values at different periods are presented in Table 3.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 4, Issue 10 , October 2017

Table 3. Environmental costs of runoff in the Ili River Delta

Periods	Inflow to the top of the delta		The outflow from the delta		Environmental costs	
	m^3 per second	km^3 per year	m^3 per second	km^3 per year	m^3 per second	km^3 per year
1953-1969	475	15,05	376	11,9	101	3,25
1970-1987	372	11,8	284	8,99	88,1	2,80
1988-2010	502	15,9	366	11,6	136	4,30
1970-2013	444	14,0	330	10,4	114	3.63

1) The period before 1970, which was a conditionally-natural period before the Kapshagai Reservoir was filled with a small anthropogenic influence, during which the influence of economic activity in Lake Balkhash basin was affected on the ecological state of the Ili River delta was insignificant, and was in a natural state.
2) The period, from 1970 to 1987, which was disturbed by the hydrological regime with reduced water content, associated with water management in the Kazakhstani part of the basin of the Ili River.
3) The period from 1988 to 2013, which was a period of regulated runoff with increased water availability, associated with water management activities in the territory of the Republic of Kazakhstan and an intensive reduction in the Ili River inflow from the territory of China.

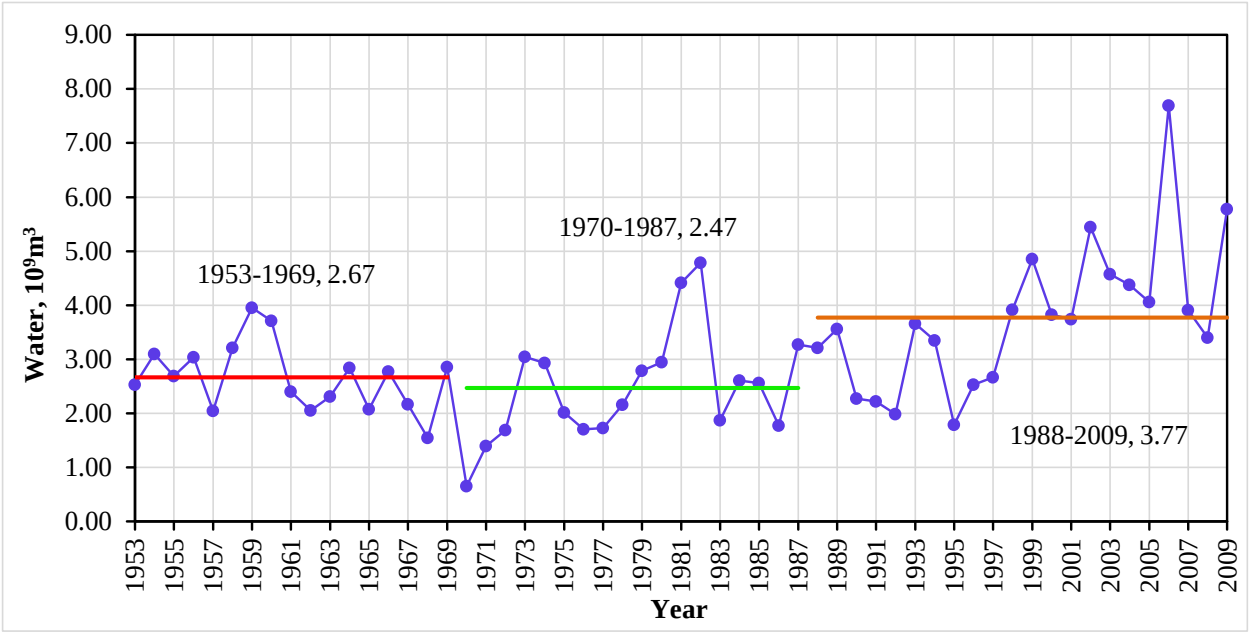

Fig 5. Dynamics of changes in environmental costs of the runoff of Ili River Delta

B) Changes in the elements of the underlying surface of the Ili river delta

Dynamics of changes in the underlying surface of the Ili River delta consisted in changes in the areas of the water surface (lakes, branches and waterways), vegetation cover, wetlands and saline areas.

Figure 6 shows the dynamics of the change in the areas of the elements of the underlying surface of the Ili River delta. Until 1984, the results of aerial photographs taken in different years by research organizations of the former USSR are shown. Since 1990, the data were obtained as a result of decoding of space images. Considering these results, we can carry out a comparative analysis of the dynamics of changes in the landscape elements of the Ili River delta.

Considering the results of aerospace data, it is possible to analyze the causes of the changes in the elements of the underlying surface of the Ili River delta. According to the presented data (Figure 6), it can be seen that the dynamics of

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 4, Issue 10 , October 2017

the delta surface is very complex. The analysis shows a close interconnection and interchangeability of landscape elements within the delta contour.

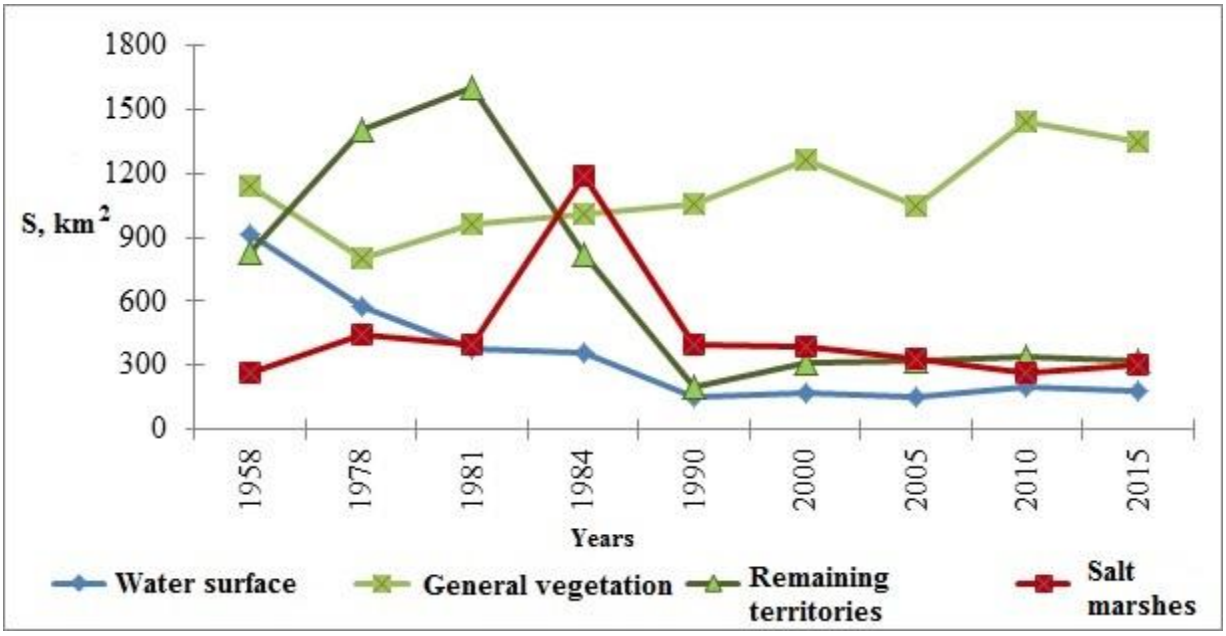

Fig 6. Dynamics of changes in the area of the delta landscape over the period of 1958-2015.

All the areas of the water surface, vegetation, wetlands and salt marshes, the remaining territories included in the territory of the Ili River delta were analyzed.

The aero-photo and space images were carefully considered, compared with the volume of water inflow to the top of the Ili River delta and the amount of outflow from it (Figure 7). In this case, a comparative analysis of the dynamics of the water surface of the delta with the inflow of water to the top and the outflow of water from the delta are carried out.

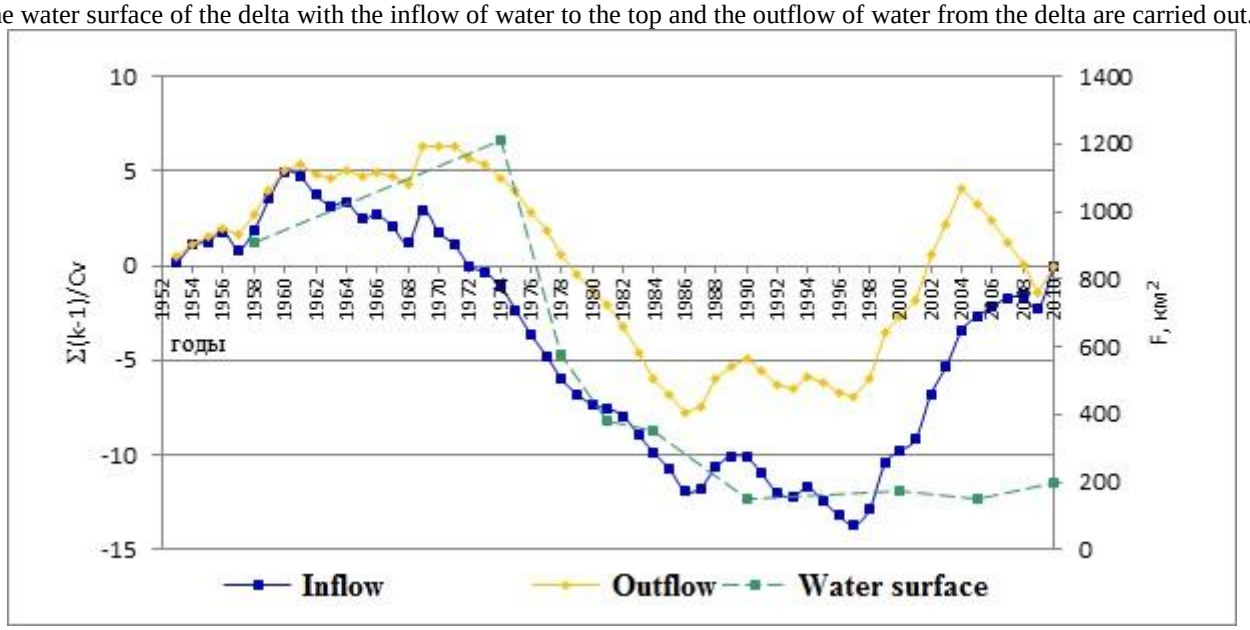

Fig 7. Difference integral curve of inflow and outflow of water, as well as changes in the water surface of the Ili River delta

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 4, Issue 10 , October 2017

After regulating the runoff of the Ili River by Kapshagai reservoir the delta's flow regime and the nature of watering have changed dramatically.
Runoff to the top of the delta for 1970-1987 on average decreased up to 8.99 km^3 per year, with its natural values f 14.2 km^3 per year. The intraannual distribution of the runoff changed: instead of the maximum flood consumption reaching 1,800 m^3 per second, releases from the reservoir did not exceed 800 m^3 per second, winter and autumn consumption increased 1.5 times, and the share of average monthly summer consumption decreased significantly.
The areas of the water surface are characterized by the largest (1209 km^2) indicators in 1974, due to the commissioning of the Kapshagai HPP, the inflow of water to the delta decreased sharply (by about 110 m^3 per second), which in turn was accompanied by the reduction in the water surface of the delta .

Based on the materials of the four aerial photographs, the gradual reduction in filling up of the delta from 1970 to 1984 was established. At that time, the inflow of water to the delta acquired a regulated character, its insignificant fluctuations over the years were observed, and a decrease in the total area of lakes and the channel (1209 to 354 km^2) was consistent with a continuous decrease in the Balkhash Lake level. At the same time, the lake systems in the interfluve of Topar-Ili completely degrade. The same occurs in the region of the Iir-river channel, the most watered area, which is the core of the delta [17].

The analysis of interpretation of the early and modern space images of the Ili River delta allowed assessing the interrelation of vegetation cover, wetlands and dry water inflow to the top, as well as the level of Balkhash Lake.
Some of the lakes dried up due to artificial drainage of water from them through canals. In most cases, shallow lakes were overgrown with reeds and gradually passed into the gradation of wetlands. Some of the drained lakes have become dry valleys and salt marshes (Figure 8).

The rapid reaction of the plant world of the delta to changes in the hydrological regime contributes to the violation of the environmental conditions of the investigated area in the worst possible way.
Change in the main landscape forming factor - the hydrological regime in connection with the regulation of the Ili River flow, naturally, causes significant changes in other components of meadow ecosystems that depend on it.
Due to the complexity of physical and geographical processes in the deltas of desert rivers and the impact of human economic activity, we only note the leading factor that causes this or that change in vegetation.

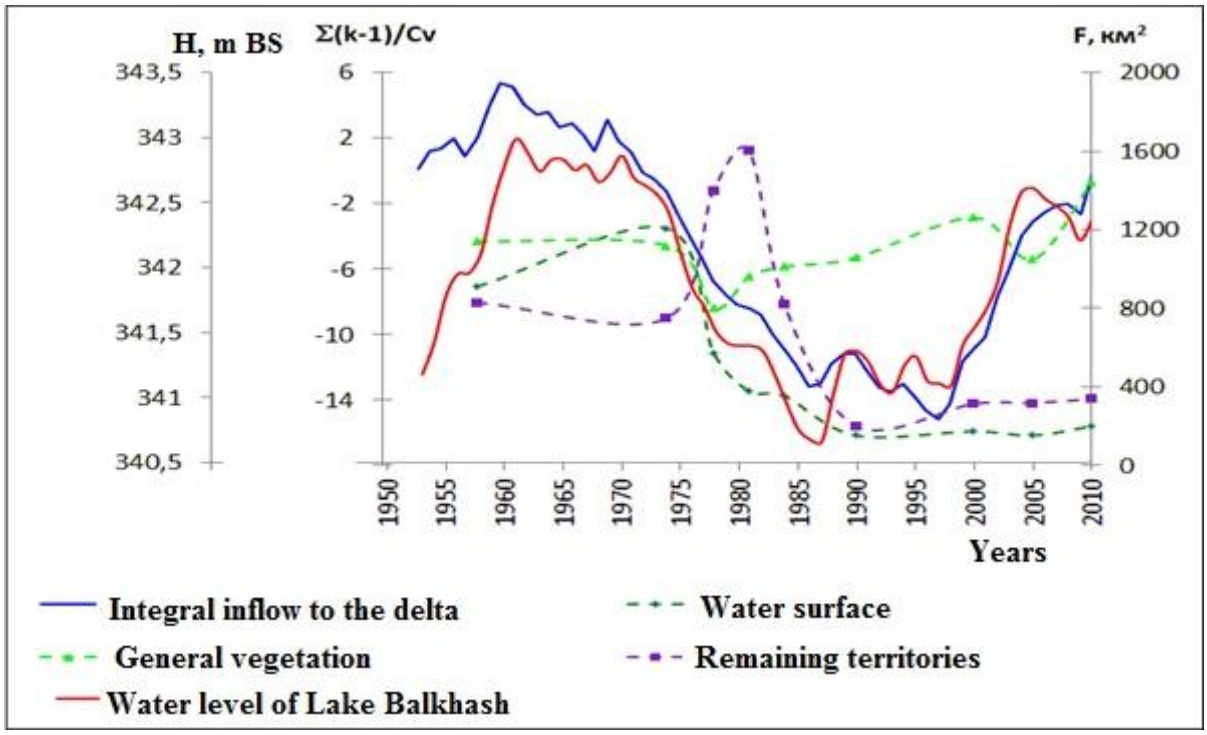

Fig 8. Time course of the landscape generating factors with elements of the underlying surface

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 4, Issue 10 , October 2017

In the modern delta, even in natural conditions, an area of more than 500 thousand hectares is off the influence of floods. This area is the interfluve of Ili-Topar, the south-west coast of Balkhash Lake and part of the right bank of the Ili channel in its middle course. After regulating the runoff of the Ili River, new delta areas stopped being under the influence of surface flooding, where as a result of the complete cessation of water flooding the vegetation cover was lost, after which they turned into dry lands and wastelands [18].

V. CONCLUSION

The analysis of changes in the ecological space of the Ili River delta is carried out using aerial and space research methods. The following conclusions are obtained: from 1970 to the 1990s, the dynamics of landscapes changed dramatically; the process of drying up of the territories is taking place.

Drying of the delta of the Ili River are accompanied by deep ecological disturbances in the natural complex, which was recently considered unique in terms of the richness of hunting grounds, fish spawning grounds, pastures, etc. The main reasons for all these processes were cyclical climate fluctuations and economic activity in the basin; in recent years (after the 1990s) influence of anthropogenic impact on the territories of the People's Republic of China is increasing.

It is determined that the change in the main landscape forming factor - the hydrological regime in connection with the regulation of the Ili River runoff, causes significant changes in other components of the natural environment of the Ili River delta and Balkhash Lake, which depend on it. In the modern delta, even in natural conditions, an area of more than 500 thousand hectares has emerged from the influence of floods. This area is the interfluve Ili-Topar, the south-west coast of. Balkhash Lake and part of the right bank of the Ili channel in its middle course. . After regulating the runoff of the Ili River, new delta areas stopped being under the influence of surface flooding, where as a result of the complete cessation of water flooding the vegetation cover was lost, after which they turned into dry lands and wastelands.

Thus, the main factor determining the unfavorable state of the ecology of the Ili River delta is the insufficient supply of water. In addition, the deterioration of the state of the delta ecosystem is connected with insufficiently justified, unjustified, and often erroneous economic measures, conducted in the river basin and in the delta itself.

Acknowledgements

The study was carried out in the framework of Project 0851/GF4 "Hydrological basis for conservancy of wetland ecosystem and resources potential rise of Ile River estuary", financed by the Ministry of Education and Science of the Republic of Kazakhstan. We are grateful to RSE "Kazhydromet" for supporting us with hydro meteorological data. In addition, we would like to thank anonymous reviewers for valuable comments on the manuscript.

REFERENCES

[1] Dostay Zh, Alimkulov S, Tursunova A, Myrzakhmetov A. "Modern hydrological status of Ili River". Arabian Journal of Geosciences, Volume 6, Issue 8, pg no: 3041-3047.
[2] Nikkolaev V.A. "The Ili River delta and Bakanasy". Proceedings of the Science Academy of KazSSR.Volume 4.pg no: 35-54 (In Russian).
[3] Filonetz P.P. "The Ili River delta". Problems of Geography of Kazakhstan, Issue 10, pg no: 25-39 (In Russian).
[4] Jungius H. "Feasibility Study on the Possible Restoration of the Caspian Tiger in Central Asia". Russia. 1963.
[5] Petr T, Mitrofanov V.P. "The impact on fish stocks of river regulation in Central Asia and Kazakhstan". Lakes and Reservoirs: Research and Management, Volume 3, pg no: 143-164.
[6] Davydova A.I. "The Balkhash Lake". In: Alekin O.A. (eds.) Natural resources of large lakes of the USSR and their prospective changes, Nauka, Leningrad, 1984, pg no: 205-244 (In Russian).
[7] Petr T. "Lake Balkhash". *International Journal Salt Lake Research. Volume* 1, pg no: 21-46.
[8] Dostay Zh.D. "Management of the hydro-ecosystem of the basin of Lake Balkash". Almaty, 360 pages (In Russian).
[9] Propastin P. "Multi-sensor monitoring system for assessment of locust risk in the Lake Balkhash drainage basin". Environmental Management. Volume 50, Issue 5, pg no: 1234-1246.
[10] Propastin P. "Problems of water resource management in the drainage basin of Lake Balkhash with respect to political development". In: Leal Filho W (eds.) Climate change and the Sustainable Management of Water Resources, Springer Verlag, Berlin,pg no: 449 – 462.
[11] Tursunov A.A. "Results of the scientific research on the Ili-Balkhash problem and the way out of the ecosystem of the basin from the crisis". Geographical problems of the Ili-Balkhash basin, pg no: 3-19 (In Russian).
[12] Sultanova B.M., Rachkovskaya E.I., Ivashchenko A.A., Berezovikov N.N., EvstifeevYu.G., Grunberg V.V., Malakhov D.V., Kurteshev T.S., Belgubaeva A.E. "Biological diversity of the projected Ile-Balkhash natural reserve". Bulletin of the Kaznu Series Environmental http://bulletin-ecology.kaznu.kz/index.php/1-eco/article/view/391.Accessed 29 September 2012(In Russian).
[13] Propastin P.A. "Simple model for monitoring Balkhash Lake water levels and Ili River discharges: Application of remote sensing". Lakes and Reservoirs: Research and Management, Volume 13, pg no: 77-81.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 4, Issue 10 , October 2017

[14] Scientific report. “Hydrological aspects of monitoring the delta of the Ili River”.Almaty.1990 (In Russian).
[15] Sokolov A.A. “Hydrological and water management aspects of the Ili-Balkhash problem”. Hydrometeoizdat, Leningrad, 1989 (In Russian).
[16] Abdrasilov S.A., DyusenovaR.Kh. “Determination of flow losses in the delta of the Ili River, taking into account the phase of its development”. Hydroecological problems in the use of water resources in Kazakhstan, pg no: 114-127 (In Russian).
[17] Sumarkova V.V., Tsytsenko K.V., Podolny O.V. “Aerospace research and water balance of the Ili river delta”. Hydrometeoizdat, St. Petersburg, 1992 (In Russian).
[18] Janalieva G.M., Bogachev V.P. “Landscapes of the present delta of the Ili River”. Alma-Ata, 1992 (In Russian).

AUTHOR’S BIOGRAPHY

	**DostayZhakypbay-** Doctor of Geographical Sciences,Professor, Chief Researcher of Department of Water Resources at Institute of Geography, Satpayev University. He has published over 150 scientific papers in the field of hydrology, hydroecology, geoecology and conversation of natural resources, geography, water resources and toponomy, including 9 scientific monographs.
	**AlimkulovSayat** - Candidate of Geographical Sciences, Leading Researcher,Deputy Director of the Institute of Geography, Satpayev University.His research interests lie in the field of hydrology andwater resources.AlimkulovSayat published over 50 articles in various national and international conferences and journals.
	**MyrzakhmetovAkhan** – PhD,Senior Researcher and acting Head of DepartmentWater Resources at Institute of Geography, Satpayev University.He is the author of about 30 scientific manuscripts in the field of hydrology, hydrochemistry, water resources and geography