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TÍTULO: Experiencia de la aplicación de tecnología de geoinformación para visualización cartográfica de resultados de observación de aves en el lago Kartma.

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RESUMEN: Se analizan los resultados de estudios de avifauna del lago Kartma, que forma parte del sistema lacustre del delta del río Syr Darya (región de Aral de la región de Kyzylorda de la República de Kazajstán). Los lagos del delta del río Syr Darya actualmente constan de 6 grupos principales, que incluyen 65 embalses, humedales protegidos por La Convención Internacional de Ramsar. Los autores del artículo realizaron estudios de aves en las aguas y en las cercanías del lago Kartma durante 5 años (2014 al 2018). La lista resultante incluye 67 especies de avifauna. Las rutas y sitios de observación de avifauna se presentan utilizando los datos de teledetección de la Tierra (RSD). La información es nueva para el área de estudio.

PALABRAS CLAVES: Mar del Norte del Aral, sistema de lagos del delta del río Syrdarya, humedales, avifauna del lago Kartma, tecnologías de geoinformación.

TITLE: Experience of the application of geoinformation technology for cartographic visualization of birdwatching results in Kartma Lake.

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ABSTRACT: The results of bird studies of Kartma Lake, which is part of the lacustrine system of the Syr Darya river delta (Aral region of the Kyzylorda region of the Republic of Kazakhstan), are analyzed. The lakes of the Syr Darya river delta currently consist of 6 major groups, including 65 dams, wetlands protected by the International Ramsar Convention. The authors of the article conducted studies of birds in the waters and in the vicinity of Kartma Lake for 5 years (2014 to 2018). The resulting list includes 67 avifauna species. Birdwatching routes and sites are presented using the Earth Remote Sensing (RSD) data. The information is new for the study area.

KEY WORDS: North Sea of the Aral, system of lakes of the delta of the Syrdarya river, wetlands, avifauna of Lake Kartma, geoinformation technologies.

INTRODUCTION.

The North Aral Sea and the Syrdarya river delta lakes system serve as a stopping point for avifauna, which is associated with a transit location on the route of the main air line of bird flights connecting nesting stations (Siberia and Northern Kazakhstan) with wintering areas (South and Western Asia and Africa) [Dimeeva L.A. et al. 2012].

In the year 2012, they were included in the list of wetlands of global importance, under the protection of the International Ramsar Convention [Guidelines of the Ramsar Convention on

Wetlands of Central Asia /2012], and in the International Database of Key Ornithological Territories [Khrokov, V.V. Skliarenko S.L. 2009; Biodiversity of wetlands of the delta front of the Syrdarya River, 2012; Sikhanova N.S., Rakhimov I.I. 2016].

DEVELOPMENT.

The Syrdarya river delta consists of three parts, subdivided from six main systems of natural lakes (see table 1).

Table 1. The Syrdarya river delta lakes system.

№	Delta structure	Item No.	Lake system	Number of water bodies	Cumulative
I	Upper delta	1	Kuandarinskaya	12	12
		2	Aksayskaya	13	25
II	Middle delta	3	Akshatauskaya	10	35
		4	Kamyslybasskaya	11	46
III	Lower delta	5	Primorskaya pravoberezhnaya	9	55
		6	Primorskaya levoberezhnaya	10	65

Each of the lake systems (Table 1) is a collection of individual lakes and wetlands connected by a complex network of natural channels and artificial canals [Sikhanova N.S., Rakhimov I.I. 2016; Sihanova N.S., Rahimov I.I. 2017].

Until recently, Kartma Lake was drained due to the shallowing of the Aral Sea. During the pre-regression period of the Aral Sea, the reservoir was a flood area, served as a fish receiving station with refrigeration units on the shore. Drainage of the reservoir began in the late 80s of the XX century, and lasted about 20 years with occasional inflows of water.

The rehabilitation process of some sections (of the coastal left bank, right bank) of the lakes of the Syrdarya delta, including the object of this study, begins in the year 2010, due to the construction of the Aklak dam on the Karaozek channel.

The positive effect of stabilization of the water regime of water bodies, has safely affected the biological diversity of the water area and the surrounding area. This circumstance requires active research and development in order to trace the main periods and phases of the occurring changes. The choice of bird fauna as a subject of study from a relatively extensive list of natural riches of the fauna and flora of the Aral Sea region can be explained by the pronounced conservatism of avifauna when choosing nesting and habitat sites [Sihanova N.S., Rahimov I.I. 2017; Sihanova N.S., Rahimov I.I. 2017].

An analysis of the literary sources of the fauna of the birds of the Aral Sea region showed the absence of any studies of the avifauna of Kartma Lake up to the year 2014, and the research initiated by the authors of this work [Dimeeva L.A. et al. 2012; Guidelines of the Ramsar Convention on Wetlands of Central Asia /2012; Khrokov, V.V. Skliarenko S.L. 2009; Biodiversity of wetlands of the delta front of the Syrdarya River, 2012; Sikhanova N.S., Rakhimov I.I. 2016; Sikhanova N.S., Rakhimov I.I. 2016; Sihanova N.S., Rahimov I.I. 2017; Sihanova N.S., Rahimov I.I. 2017; Sihanova N.S., Rahimov I.I. 2017] began from that year on Lake Kartma.

Methods.

The object of research is Kartma Lake located on the territory of the Aral region of the Kyzylorda region of the Republic of Kazakhstan; an integral part of the left-bank seaside section of the lake system in the Syrdarya river delta. Water flow of the lake is provided by the Syrdarya river through Karateren-1, Karateren-2 canals [Sihanova N.S., Rahimov I.I. 2017].

In the northern part of the reservoir, the settlement of Kolzhag is located, in the western side - the settlement of Kone Karateren of the rural district of Karateren (Fig. 1).

Fig. 1. Schematic map of lake Cartma.

Collection of field materials in the waters and the vicinity of Kartma Lake was carried out by the authors from winter 2014 to summer 2018. In total, 18 expeditions were carried out. The counting of birds in the study area was carried out on the basis of areal and route methods [Bogoliubov A.S. 1999; Ravkin Iu.S. 1967].

Registration of birds, according to the first method, is carried out 2 times a day: in the morning and in the evening, at pre-selected fixed control points - sites at small elevations, convenient for detailed and repeated viewing and photographing of the water area with adjacent shallow waters. Route registration of avifauna is carried out once a day, with a duration of no more than 3 hours per transect. Also, water routes on the lake's water area were boated [Sihanova N.S., Rahimov I.I. 2017; Sihanova N.S., Rahimov I.I. 2017].

The species were determined using the determinants and reference editions by V.K. Riabitsev et al. [A field detector of birds of Kazakhstan / 2014.], Birds of Kazakhstan [Dolgushin I.A. 1960; Birds of Kazakhstan, 1960].

The mapping of the object of study, routes and bird counting sites, the resulting layer of the quantitative composition of avifauna was performed on the basis of remote sensing data (RSD). High resolution space images were selected and edited in the SAS Planet GIS product. This GIS tool has several advantages; for example, it is possible to select the source of a satellite image obtained from the following map services: Google Satellite, Yandex maps, Nokia Satellite, Bing Maps satellite, etc., which will allow varying images of different terrain. In the design of cartographic materials, standard toolboxes were used: "Tags", "Compass", "Route", etc.

Results and Discussion.

The taxonomic composition of the avifauna of Kartma Lake is systematized for representatives of 10 orders: Ciconiformes (4 species), Anseriformes (8 species), Falconiformes (5 species), Galliformes (1 species), Gruiformes (2 species), Charadriiformes (27 species), Columbiformes (1 species), Coraciiformes (1 species), Upupiformes (1 species), and Passeriformes (17 species) [A field detector of birds of Kazakhstan / 2014, Aye R. Schwiezer M., Roth T. 2012.; Message S., Taylor D. 2005; Gavrilov E., Gavrilov A. T., 2005; Klaus Malling Olsen, Hans Larsson, 2004].

The greatest species diversity is recorded among the birds of the order Charadriiformes, the subdominant position is characteristic of the species of the order Passeriformes [Wassink, A & GJ Oreel. 2008; Svensson L. 2010]. This circumstance can be explained by the following arguments: a separately and compactly placed, reported network of reservoirs located in the arid, sharply continental conditions of south-western Kazakhstan, right on the main highway of the birds' flyway (especially Anseriformes and Charadriiformes) from wintering to breeding stations. The variety of passerines is explained by the fact that they count for a little less than half of the population (46%) of the avifauna of Kazakhstan, which will undoubtedly be reflected in the registration of bird fauna [A field detector of birds of Kazakhstan, 2014].

The distribution of the quantitative composition of taxa and avifauna individuals of Kartma Lake from 2014 to 2018 is presented in Table 2.

Table 2. Indicators of the structural organization of avifauna of Kartma Lake (2014-2018).

Indicators	2014	2015	2016	2017	2018
Total species	57	62	61	60	57
Total individuals	2572	5049	5161	4902	3081

The species composition of the bird fauna of Kartma Lake in the period of research from winter 2014 surveys to summer 2018 amounted to 67 differences. The maximum possible species richness was registered in the year 2015 for four reference seasons 62 species were observed. This circumstance is a consequence of favorable conditions (weather and climate, comfortable water level, etc.) established in the reference period.

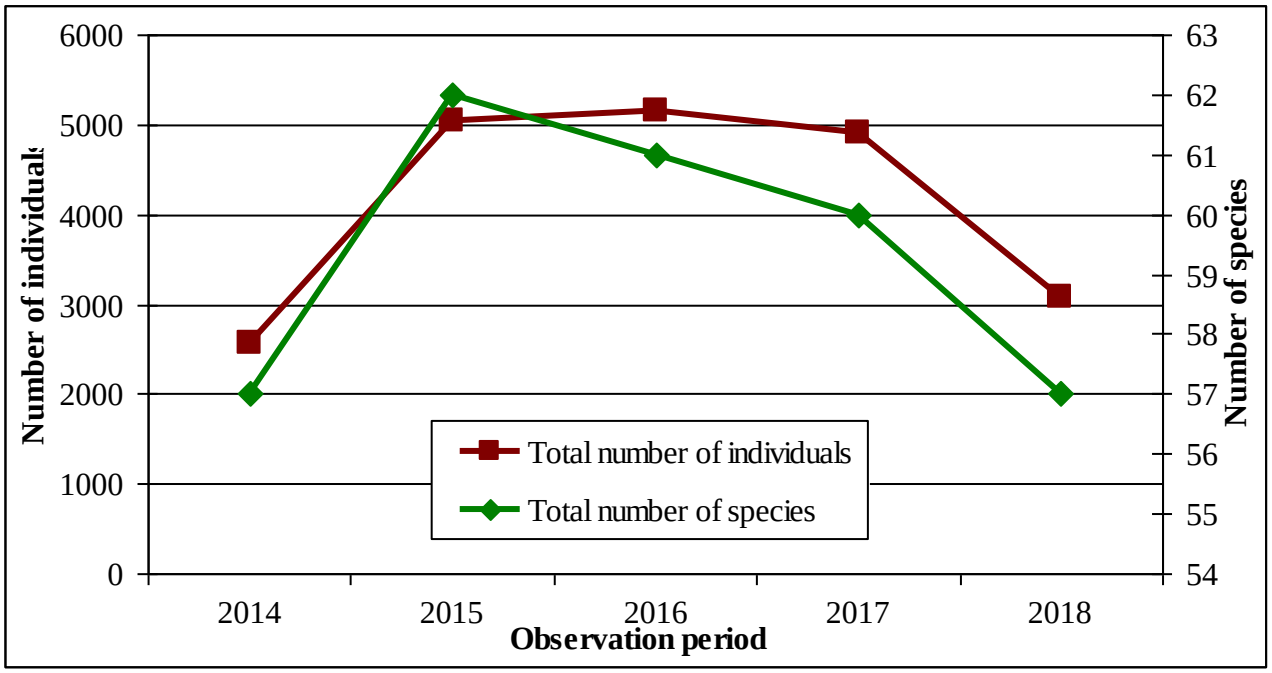
The minimum number of species was recorded in the year 2014 and 2018. Here, one of the leading factors of a smaller number of species is the comparatively cool weather observed in the reporting years; in addition, the resulting number of taxa and avifauna of the year 2018 is given for 3 seasons (winter, spring, summer) without the results of autumn counts.

Let us consider the number of individuals in the period of avifauna surveys. The maximum number of birds (5161 individuals) was recorded in the year 2016, despite the fact that 61 differences of avifauna were taken into account, that is, 1 species less than in the year 2015 (5049 individuals).

As it is known, the summer season bird counts are the base, the quintessence of year-round monitoring of avifauna. In summer 2016, 60 species of birds were recorded (2271 individuals), whereas in other years, no more than 47 species were observed (summer 2015). In previous publications, we have repeatedly noted the fact of an abnormally warm winter (first half) 2016, when 7 species of avifauna were recorded in bird surveys (December, 2016). All this contributed to obtaining good results when registering the number of birds.

In general, over the five-year period of avifauna surveys, we observe a close to normal distribution of the number of avifauna species compared to the number of individuals recorded during the same period (Fig. 3).

Figure 3. The occurrence of taxa and avifauna of Kartma Lake.



At the beginning of the schedule - from the year 2014 to 2015 - there is a sharp rise in the number of species and individuals, which is then replaced by a decrease in the first to the end of the

counting of birds (Fig. 3). Meanwhile, the number of marked individuals continues to grow until the year 2016, after which a decrease is observed. The reasons may be related to the decrease in the open water area of the reservoir from year to year, due to the rapid growth of reed beds (Phragmites australis), which negatively affects birds with a bioresource value (Anseriformes), since, for them, wide open thickets of reeds. Let us consider the main observation points of the avifauna of Kartma Lake. The location of points and routes of observation on Kartma Lake is shown in Fig. 2.

Fig. 2. Location of observation points and routes at the object of study – lake Cartma. The designation of sites: SE – site East; SS – site of the South; SSW – site South-West; SW – site West; SNW – site North-West; SN – site North; SNE – site North-East.

According to this map (Fig. 2), control points are located on the study area - 7 sites for bird counts, marked in the following order: SE – site East; SS – site of the South; SSW – site South-West; SW – site West; SNW – site North-West; SN – site North; SNE – site North-East.

The absence of control points and route counts on the southeastern coast of the reservoir is due to the flooding of this area and the inaccessibility for conducting full-fledged counts of birds. In essence, this site is a water-dam dividing Kartma Lake with the Karakamys bog.

On the basis of water routes, the authors noted a gradual increase in the range of dense reed beds, advancing from the southeast to the middle of the lake. The number and location of control points for the site registration of birds was specially chosen to study the influence of various factors (proximity of a settlement and other water bodies, soil and vegetation cover, etc.) on the quantitative composition of the birds' fauna. The resulting data on the number of species and individuals of birds reflect the validity of the location of the selected points for observation. It is noted that the distribution of bird fauna is directly related to the environment, even on the scale of a relatively small Kartma Lake; for example, representatives of Anseriformes, Charadriiformes, and Passerines prevailed at the control points of the SN, SNE during the period of counts. If the representatives of Anseriformes choose this part of the reservoir due to the extensive open reach, the second type (Charadriformes) - the intertidal zone rich in insect fauna, and finally, the Passeriformes build their nests in the buildings and cemeteries of the nearby village of Kolzhaga.

Another situation is observed on the southern side of the reservoir, which are connected with the Kyzylkum desert. Sites SS, SSW - located on the former bottom of the sea, the soil is loam, clay. It is dominated by desert avifauna species from the representatives of Falconiformes and Passeriformes. The SNW is also the post-bed land of the Aral Sea, but here the soil is sandy and sandy loam. Moreover, there are real dunes here, which unlike the sands of real deserts, do not

erode, due to the coarse-grained structure, intertwining with the roots of the vegetation cover and the close distribution of the groundwater.

Dendrophiles of the deserts from the representatives of Passeriformes dominate at this site. The SE is where the Karateren Canal flows into Kartma Lake. During the period of surveys, the expansion of tugai species from the Syrdarya River was observed several times, among which was a pheasant (Phasianus colchicus).

In summary,

1. From 2014 to 2018, the avifauna of Kartma Lake of the left-bank seaside section of the lake system of the Syrdarya river delta was counted.
2. During the preparation of this study, the means of geographic information mapping, in particular SAS Planet (version 160707), were actively involved.
3. The quantitative composition of the avifauna of the study area (from 2014 to 2018) was 67 differences, with the dominance of representatives of the Charadriifomes order, passerine (Passeriformes) were subdominant in bird counts.
4. During the study period, an increase in recorded species and individuals was observed in the middle stage of bird counts (2016), whereas the initial and final stages are characterized by low numbers of birds in the fauna.

CONCLUSIONS.

Registration of birds of Kartma Lake was carried out in the period from the years 2014 to 2018 and the quantitative composition of the avifauna is 67 species.

In this paper, the authors used geo-information resources (software product SAS Planet, version 160707). This tool provides essential assistance in the field when planning, conducting surveys (route and areal), in analyzing the results in cameral conditions, as well as in the design and preparation of scientific papers.

As a recommended measure to reduce the load on the sustainable existence of the avifauna of the water area and the adjacent territory of Kartma Lake, the local executive body (akimat of the rural district) needs to conduct a total cleaning of the coastal zone (littoral) of the south-eastern side of the lake annually in late September and early October, in December-January, cutting down last year's thickets of reeds in the central part of the reservoir.

Those activities can lead to an increase in the open water area, which will provide a beneficial effect on the quantitative composition of avifauna with bioresource potential (Anseriformes).

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