https://doi.org/10.55764/2957-9856/2025-1-22-30.3

IRSTI 89.57.25
UDC 502.35

D. V. Malakhov[*1], O. V. Dolbnya[2], R. A. Kurbanova[3]

[1 *]Head of GIS and RS Department (Institute of Zoology, Almaty, Kazakhstan; ***dmitry.malakhov@zool.kz***)
[2] Researcher (GIS and RS Department, Institute of Zoology, Almaty, Kazakhstan; *olga.dolbnya@zool.kz*)
[3] Junior Researcher (GIS and RS Department, Institute of Zoology, Almaty, Kazakhstan; *rekhangul.kurbanova@zool.kz*)

FLOODING OF 2024 IN TURGAY-IRGYZ INTERFLOW: THE IMPACT ON THE BIODIVERSITY ASSESSED BY SATELLITE DATA

Abstract. The impact of extreme flooding in 2024 on the environment and biodiversity was assessed by remote sensing data for the region of Aktobe Oblast. The climatic conditions were compared for dry, wet and moderately wet years along with those during the flooding year 2024. It was demonstrated for remote and sparsely populated areas that using satellite data and cloud calculations represents a reliable method of flood impact assessment. Different possible impacts of flooding events on several components of biodiversity (vegetation, terrestrial vertebrates) are discussed using case studies from other countries.

Keywords: flooding, environmental damage, biodiversity, remote sensing, assessment.

Introduction. Flooding is one of the global natural disasters that usually causes significant damage to ecosystems and the environment. Their magnitude mainly determines the content and extent of the consequences of floods. Depending on the scale, floods are categorised into low, high, outstanding and catastrophic floods [1]:

– Low (small) floods are mainly observed on flat rivers and have a recurrence rate of about once every 5-10 years. These floods cause insignificant material damage and almost no disruption to the rhythm of life of the population.

– High (large) floods, accompanied by significant inundation, cover relatively large river valleys and sometimes significantly disrupt the population's daily life. In densely populated areas, high floods often lead to the need for partial evacuation of people and cause tangible material and moral damage. They occur once every 20-25 years.

– Outstanding floods cover entire river basins. They paralyse the population's economic activity and sharply disrupt people's everyday lives, causing great material and moral damage. In this case, there is a need for mass evacuation of the population and material values from the flood zone and protection of the most critical economic facilities. Such floods occur once every 50-100 years.

– Catastrophic floods cause inundation of territories within one or more river systems. Production and economic activity can be completely paralysed in the flood zone. Such floods cause huge losses and loss of life. They do not occur more often than once every 100-200 years.

In Kazakhstan, the damage from floods in 2024 amounted to almost 400 billion tenge [2,3]. However, this assessment concerns the socio-economic sphere, while the flood impact on the environment and biodiversity has never been attempted. This paper outlines a reliable method to assess the impact of floods on the environment using remote sensing data.

Study area. The study area comprises the territories of Turgay State Reserve and adjacent Irgiz-Turgay Nature Reserve, where fieldwork was conducted in August 2025 (figure 1).

The Turgay State Reserve of republican significance was established in 1967 on the territory of Irgiz district. Currently, the Reserve area is 296,000 ha. The flora is represented by 430 species from 64 families and 216 genera. There are plant species listed in the Red Book of Kazakhstan: Fisher's bird's-foot (*Ornithogalum fischerianum*); two-flowered tulip (*Tulipa biflora*); drooping tulip (*Tulipa patens*); Shrenka's tulip (*Tulipa schrenkii*); pinnate wattle *(Stipa pennata*). The animal world of the Reserve is represented by 29 species of mammals, 14 species of reptiles, 4 species of amphibians and 11 species of

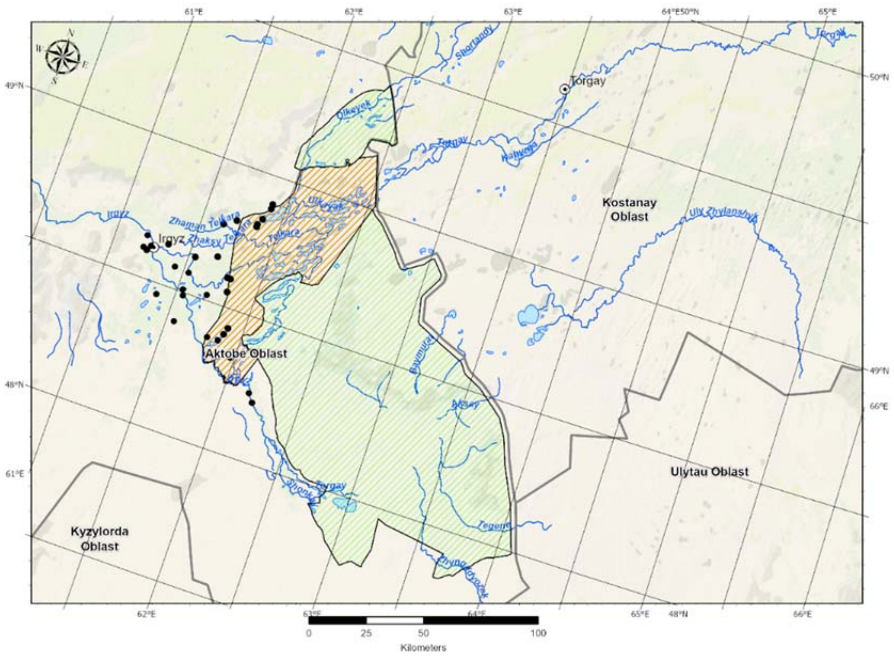

Figure 1 – Study area. Black dots – fieldwork locations, red hatching – Turgay State Nature Sanctuary area; green hatching – Irgiz-Turgay State Nature Reserve area

fish, 170 species of birds, of which 34 are listed in the Red Book of the Republic of Kazakhstan [4]: pink pelican (*Pelecanus onocrotalus*); curlew pelican (*Pelecanus crispus*); spoonbill (*Platalea leucorodia*); grackle (*Plegadis falcinallus*); little white heron (*Egretta garzetta*); flamingo (*Phoenicopterus roseus*); lesser swan (*Cygnus bewickii*); Whooper Swan (*Cugnus cygnus*); Red-breasted Goose (*Branta ruficollis*); Merlin (*Oxyura leucocephala*); Siberian Crane *(Grus leucogeranus*); Grey Crane (*Grus grus*); Whooper Crane (*Anthropoides virgo*); Bustard (*Otis tarda*); Streptet (*Tetrax tetrax*); Jack (*Chlamydotis macqueenii*); Gyrfalcon (*Chettusia gregaria*); Thin-billed Curlew (*Numenius tenuirostris*); Black-billed Crested Grouse (*Larus ichtyaetus*); Black-bellied Grouse (*Pterocles orientalis*); White-bellied Grouse (*Pterocles alchata*); Sedge (*Syrrhaptes paradoxus*); Saker Falcon (*Falco cherrug*); peregrine falcon (*Falco peregrinus*); long-tailed eagle (*Haliaeetus leucoryphus*); white-tailed eagle (*Haliaeetus albicilla*); Imperial Eagle (*Aquila heliaca*); golden eagle (*Aquila chrysaetos*); steppe eagle (*Aquila nipaleisis*); osprey (*Pandion haliaetus*); kite (*Circaetus gallicus*); owl (*Bubo bubo*). Due to the extensive reed beds, high numbers of wild boar (*Sus scrofa*) are preserved in the Reserve.

The Irgiz-Turgay Nature Reserve was established to preserve and restore natural complexes to protect habitats (wintering grounds, summering grounds, calving grounds) and migration routes of the saiga antelope, a member of the Betpakdala population. The purpose of the Reserve is also to preserve the unique wetlands of the Irgiz-Turgay lake system, as one of the places of most significant concentration of wetland birds during seasonal migrations and moulting; nesting grounds for flamingos, waterfowl and waterfowl, and fish spawning grounds. The area of the Reserve is 711,549 hectares.

The study area is a part of the Aktobe region. The Aktobe region is comprised of three climatic zones that have latitudinal extents. The northern part of the region lies in the steppe climatic zone, below latitude 50° - semi-desert zone, passing in the south to the shores of the Aral Sea – in the desert zone. The climate is sharply continental. The average annual temperature is positive: in the steppe zone, the average temperature for the year is 3-4 °C; in the more southern semi-desert and desert areas, the temperature rises to 7.5° C. The absolute maximum air temperature in the region varies from 41 to 45 °C in some years. In some years, the absolute minimum air temperature ranges from -40 to -49 °C.

The annual precipitation in the steppe zone averages 240-400 mm; in the semi-desert and desert zones, it equals 150-250 mm. Throughout the territory, a large percentage of precipitation falls during the warm period of the year (from April to October, 58-70%) [5].

Analyzing meteorological data, we found that 2010 was the driest year [6]; summarized precipitation during the vegetation season did not exceed 1.3 mm. 2020 is moderated by a moistening regime [7], and the total precipitation of the vegetation season was about 2.2 mm. During the wettest year (2016), the yearly precipitation was 148 per cent of the norm [8].

Data from the Irgyz meteorological station [9] confirmed the classification of wet, moderate and dry years within the study area.

According to Irgyz station, total rainfall varies from 70.3 mm in the dry 2010 year to 72 mm in moderate 2020 and 122 mm in the wettest 2016 year (figure 2). It should be noted that in 2024, when the flooding occurred, the precipitation was just slightly higher 87.1 mm) if considered the moderately wet year 2020.

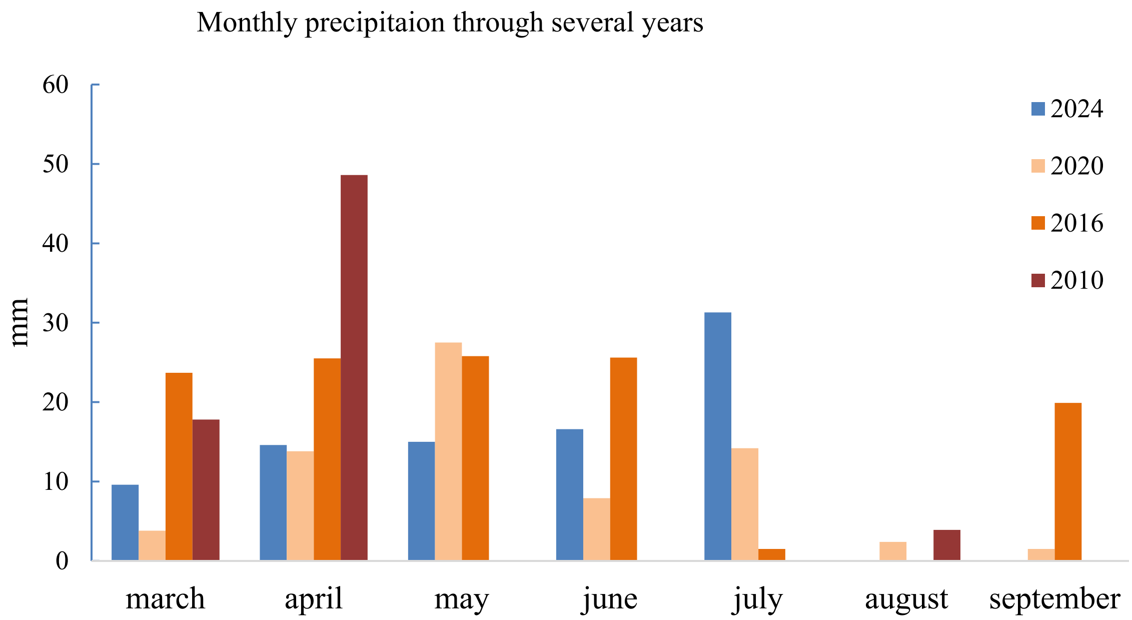

Figure 2 – Monthly precipitation of compared years

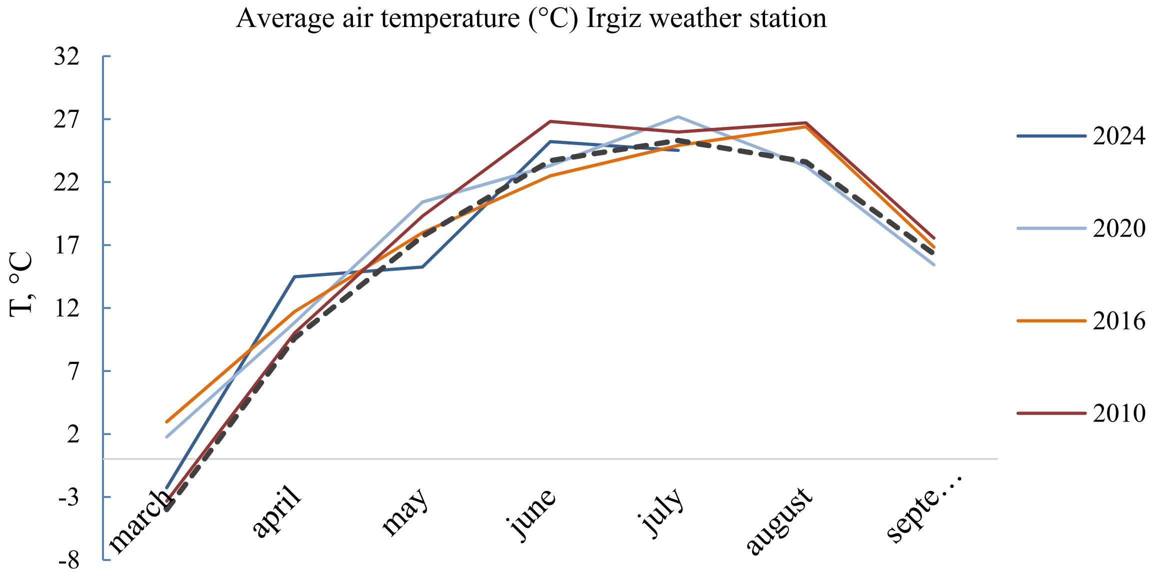

Figure 3 – Average air temperature per month

Temperature dynamics by Irgyz station data demonstrated almost equal values within dry and wet years (figure 3). In the year 2024, the average temperature was even lower compared to other years (2024 (flooding year) – 15.4 Celsius degree; 2020 (moderately wet year) – 17.5 Celsius degree; 2016 (wet year)

– 17.6 Celsius degree; 2010 (dry year) – 17.6 Celsius degree). Figure 3 illustrates the monthly temperature dynamics by Irgyz Station data [9].

Materials and methods. Data on the biodiversity were taken from our field observations and partially provided by colleagues from ACBK.

To calculate the area of waterbodies, we used NDWI (Normalised Difference Water Index) [10]. The index based on the interaction of green and near infrared bands was developed to: a) enhance the spectral response of open water bodies by using the green channel, b) minimize the low NIR-signal of water, and c) enhance the high NIR-signal of vegetation and soil.

NDWI formula is:

$$NDWI = \frac{Green - NIR}{Green + NIR},$$

where Green and NIR are the respective bands of a satellite image. NDWI values greater than zero resemble open water surfaces.

The water bodies area was calculated for May of 2010, 2016, 2020 and 2024, as May was a period of high-standing water in 2024. The average monthly area from cloud-free Sentinel 2 or Landsat 8-9 scenes was calculated using Google Earth Engine.

The EVI index assessed the vegetation condition for moderate 2020 and post-flood 2024 years [11]. August was a reference month since the water level returned to normal in 2024. Change Detection calculations were performed between EVI readings in 2020 and 2024 to assess the possible loss in biomass after the flooding of 2024. EVI and EVI change detection were calculated using Sentinel-2 data by Google Earth Engine.

Results. Fieldwork in the Aktobe region conducted during June and August 2024 revealed a series of deviant phenomena. For exitances, an almost complete absence of waterfowl in June may result from flooded nesting areas. The absence of certain amphibians and reptiles (toads and Grass snakes: our data), is obviously due to shelter inundation. The reduction in the number of birds of prey noted by specialists of the Association for the Conservation of Biodiversity of Kazakhstan (S.Sklyarenko, pers.comm.) may be caused by the lack of rodents, representing the major food base for birds of prey. All listed animals were likely affected by high water levels in spring and summer (figure 4, 5), which resulted in long-term flooding of terrestrial amphibians and reptiles' refuges and their deaths, as well as in flooding of waterbird nesting sites.

Figure 4 − Kargala Reservoir, June 12, 2024. Submerged woody and shrub vegetation

Figure 5 − Territory of the Turgay Nature Sanctuary, August 16, 2024. Dried algae on bushes show the water level during the flood period. The absence of pronounced herbaceous vegetation cover is noticeable

The absence of herbaceous cover and suppression of woody shrub vegetation due to flooding is reflected by EVI calculations (figure 6). The vegetation cover is the fundamental food resource for the number of herbivorous animals. The food deficit caused by prolonged and high flooding should not be underestimated, especially for territories like Nature Reserves, where wild animals are expected to be abundant.

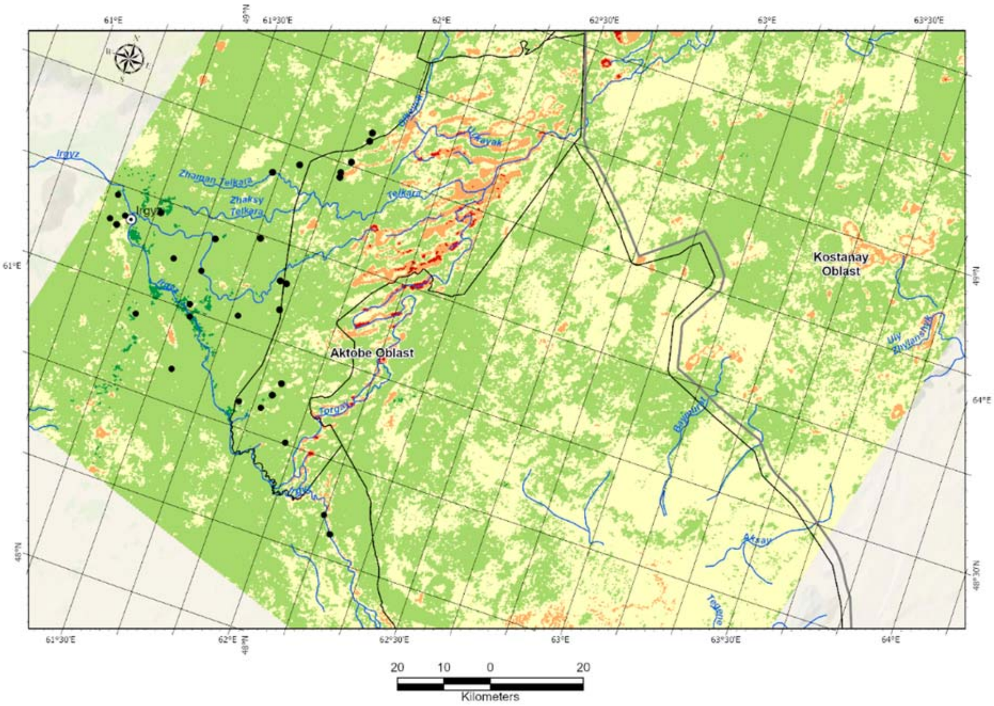

Figure 6 – Change in EVI in 2024 compared to the year of moderate humidification.
Red and orange indicated the fall in the level of green biomass

The EVI comparison showed a sharp drop in green biomass in the most productive, near-water environments. Within areas not subject to flooding, the EVI of August 2024 remained at the level of August 2020.

Calculation of water body areas (figure 7) showed that twice as much area was under water in May 2024 compared to a wet year of 2016.

Water area dynamics within dry, moderate, wet and flooded years

	Dry year 2010	Wet year 2016	Moderate year 2020	Flooding year 2024
Waterbodies area, hectares	119 648	273 314	109 820	492 638

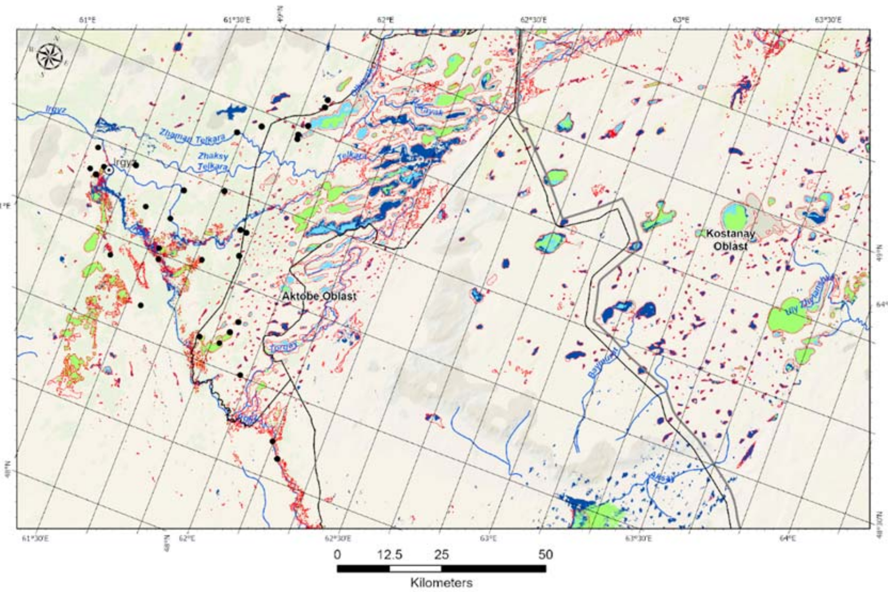

Figure 7 − Water bodies area dynamics. Dark blue – the wet year 2016, blue – the moderate year 2020, green – the dry year 2010, red contour – the flooding year 2024

Discussion. Flood of 2024 can be considered catastrophic for several regions of Kazakhstan [12]. The inundated area of 2024, as shown by our calculation, may provide additional support to this statement.

Floods can significantly impact biodiversity, from individuals and species to communities and ecosystems. Flooding can alter ecosystems' structure and composition, reduce resource availability, increase exposure to pathogens and pollutants, and cause mortality and displacement of species [13]. There is no single point of view, as the impact of prolonged flooding on animals may vary from one climate to another. Regarding ecosystem impacts, as accepted here and below, we are not referring to the immediate effect of killing animals directly affected by flooding but to the larger-scale effects, such as biodiversity loss, change of dominant species, extinction or appearance of species in the flooded area, etc.

Floods seriously affect all terrestrial animals in the submerged area and may lead to their extinction. The degree of impact primarily depends on four main factors: the ratio of flood duration to survival time of animals in floods (D), the ratio of flood depth to plant height (S), the migration ability of animals (M), and temperature (T) [14].

The magnitude of absolute and relative maximum precipitation also influences these four factors. Real et al. [15] suggested that high values of absolute maximum precipitation allow the coexistence of more species in each basin. On the other hand, relative maximum precipitation, which represents the importance of the absolute maximum precipitation about the mean annual precipitation, is an expression of the severity of the disturbance and measures the definitive damage caused by the floods to the communities, whose effects exceed the tolerances of the species.

In particular, flooding of nesting territories is one of the threats to European pond turtles [16]. Our data on the lack of fossorial amphibians, snakes, and lizards provides evidence of the serious disturbance caused by high flooding of herps. The conditions of an extraordinary flood in 1946 in the Volga River, when the entire delta land was under water for a month, are described [17]. During the flood, amphibians and reptiles persist only in so-called "experience stations", e.g., in reed beds, in emerged haystacks and reed beds. Cannibalism - feeding on their own juveniles – is widespread in frogs during high-standing water, when the usual food objects - terrestrial insects – are inaccessible. Common Grass snakes swallow prey on land, and the snakes' feeding conditions worsen under flood conditions. In addition, the absence of frogs, concentrated in "survival stations", leads to further deterioration of feeding conditions for snakes.

High floods lead to later breeding dates for reptiles due to a lack of suitable staging areas or, as in the case of the leaping lizard, high soil moisture [18]. Late oviposition and, consequently, late hatching lead to the mortality of juveniles who have not had time to gain weight before winter.

Herps, in general, are less able than other terrestrial vertebrates to avoid drowning and slower to recolonise after floods subside – they are susceptible to flooding [18].

Regarding birds, a diving predator, like the kingfisher, did not suffer from starvation, whereas chasing predators like the great cormorant face certain food limitations [19].

Duration and intensity of flood determine the effect on the small mammal community, but this effect lasts less than one year. Even in the years of the highest flood, the number of small mammal species and their abundance was already high by summer to autumn. Thus, restoration occurred in just a few months in the territory of our study [20]. However, severe flash floods have a heavier toll on terrestrial fauna, and a single such flood has been shown to have catastrophic effects on populations and disrupt gene flow in aquatic and terrestrial animals [18].

Vegetation cover is less vulnerable to short-term high floods; however, [21] floods may have elevated the growth and spread **of invasive species** with enough potential to deplete the species density and abundance of the native population.

The intermediate disturbance hypothesis is the most prominent theory relating disturbance to species diversity, which predicts maximum diversity in environments that experience moderate disturbance [22].

According to this theory, intermediate-magnitude disturbance removes only a subset of the preexisting vegetation, thus making only a portion of the affected area available for colonisation. Diversity is enhanced by the combination of disturbance survivors and newly arrived disturbance exploiters [22]. In riparian settings, flooding is a significant form of disturbance. A flood's destructive impact may be felt in several ways: through the imposition of anaerobic conditions by inundation, the mechanical breakage of plants by floodwaters and/or the sediment they carry, or through erosion of the substrate in which the plants are rooted. Apart from the direct impact on vegetation, alteration of site conditions is particularly significant at flood-affected sites where the deposition of fresh alluvial substrate further facilitates colonization by new species.

However, inter-annual severe floods and droughts can impact the biome ecosystem and, consequently, affect the local ecological communities, causing damage to regional wildlife and livestock. These extreme inter-annual events of floods and droughts are the result of regional climate changes, but their effects have exacerbated the risks of hydrological extremes due to human intervention and land use changes, such as deforestation, with consequences even more pronounced because of human environmental disruptions [23]. Seasonal flood pulses drive important seasonal ecosystem changes, trigger ecological processes that control organisms' spatial and temporal distribution and life-history strategies, and are considered a key ecological process that shapes floodplain diversity [19].

Conclusion. Despite the lack of a unified point of view on how floods affect the state of biodiversity, it should be recognised that high and catastrophic floods have a profound negative effect, which is expressed in the disappearance of certain species of animals and plants and the replacement of native species by invasive species. A separate factor of disturbance of the natural state of ecosystems, which may have long-term consequences, is the decline in ecosystem productivity. We are unaware of any special studies devoted to this issue. However, we can assume a decrease in the number of ungulates (in our case, wild boar and saiga) due to a lack of fodder supply or migration of ungulates outside their natural range. For vast areas, like the area of Nature Reserves mentioned here, objective control and damage estimation methods strongly depend on the infrastructure and logistics of a given area. In the case of this study, we did not meet any staff of the Reserves during our fieldwork, and we were unable to find comprehensive information on the flooding effect on biodiversity provided by the local administration. In such a situation, when the localities are remote and hard to access during the flooding event, the remotely sensed approach appears as the reliable method of quick and objective assessment, allowing objective assess changes in ecosystem productivity caused by floods and, in case of significant negative changes, to take specific steps to conserve biodiversity in areas affected by catastrophic floods.

Acknowledgements. Fieldwork and satellite data analysis were funded by the Committee of Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. BR21882122). Our thanks are due to the two anonymous reviewers for providing useful comments that helped us to improve the manuscript.

REFERENCES

[1] Nigmetov G. M., Filatov Y. A., Pchelkin V. I., Yuzbekov N. S. Tendency of growth of catastrophic floods on the territory of the Russian Federation // Civil Security Technologies. 2003. No. 1-2. P.37-44 (in Russ.).

[2] [Electronic resource]. URL: https://newtimes.kz/obshchestvo/199717-navodnenie-v-kazakhstane-2024-goda-itogi (accessed 04.10.2024) (in Russ.).

[3] [Electronic resource]. URL: https://24.kz/ru/tv-projects/aktsenty/item/672991-ushcherb-ot-pavodkov-v-kazakhstane-prevysil-300-mlrd-aktsenty (accessed 04.10.2024) (in Russ.).

[4] Red Book of the Republic of Kazakhstan. Volume 1. Animals. Edited by Dr. R.V. Yashchenko. Edition 5th, revised and supplemented. Almaty: Institute of Zoology CS MSHE RK, 2024. 532 p.

[5] [Electronic resource]. URL: https://www.kazhydromet.kz/ru/klimat/klimat-kazahstana-po-oblastyam (accessed 01.12.2024) (in Russ.).

[6] Annual bulletin of monitoring of the state and climate change of Kazakhstan: 2010 - Astana: Republican State Enterprise 'Kazgidromet', Ministry of Environmental Protection of the Republic of Kazakhstan, 2011. 32 p. [Electronic resource]. URL: https://www.kazhydromet.kz/ru/klimat/ezhegodnyy-byulleten-monitoringa-sostoyaniya-i-izmeneniya-klimata-kazahstana (accessed 04.10.2024) (in Russ.).

[7] Annual bulletin of monitoring of the state and climate change of Kazakhstan: 2020 - Nur-Sultan: Research Centre.Republican State Enterprise 'Kazgidromet'. Ministry of Ecology, Geology and Natural Resources, 2021. 67 p. [Electronic resource]. URL: https://www.kazhydromet.kz/ru/klimat/ezhegodnyy-byulleten-monitoringa-sostoyaniya-i-izmeneniya-klimata-kazahstana (accessed 04.10.2024) (in Russ.).

[8] Annual bulletin of monitoring of the state and climate change of Kazakhstan: 2016 - Astana: Research Centre. Kazgidromet Republican State Enterprise.Ministry of Energy, 2017. 58 p. [Electronic resource]. URL: https://www.kazhydromet.kz/ru/klimat/ezhegodnyy-byulleten-monitoringa-sostoyaniya-i-izmeneniya-klimata-kazahstana (accessed 04.10.2024).(in Russ.).

[9] [Electronic resource]. URL: http://ecodata.kz:3838/dm_climat_ru/ (accessed 01.12.2024) (in Russ.).

[10] McFeeters S. K. (1996) The use of the Normalized Difference Water Index (NDWI) in the delineation of open water features // International Journal of Remote Sensing, 17:7. P. 1425-1432. DOI:10.1080/01431169608948714

[11] Huete A., Didan K., Miura T., Rodriguez E. P., Gao X., Ferreira L. G. Overview of the radiometric and biophysical performance of the MODIS vegetation indices. Remote Sensing of Environment 83 (2002) P. 195-213. DOI:10.1016/S0034-4257(02)00096-2

[12] Medeu A.R., Makhmudova L.K., Myrzakhmetov A.B., Zagidullina A.R. Kanai M. (2024). Flood situation on the river Zhaiyk (Ural) in 2024.Geography and water resources. No. 4. P. 14-23 (in Russ.).

[13] Ebrahimi E., Araújo M. B., Naimi B. Flood susceptibility mapping to improve models of species distributions // Ecological Indicators 157 (2023). https://doi.org/10.1016/j.ecolind.2023.111250

[14] Yadong Zhang, Zongkun Li, Wei Ge, Xudong Chen, Hongyin Xu, Hongyan Guan. Evaluation of the impact of extreme floods on the biodiversity of terrestrial animals // Science of the Total Environment 790 (2021). 12 p. DOI: 10.1016/j.scitotenv.2021.148227

[15] Real R., Vargas J. M., Antiunez A. Environmental influences on local amphibian diversity: the role of floods on river basins// Biodiversity and Conservation 2. P. 376-399 (1993).

[16] Mieza-Paez E., Martínez-Martínez D., Tarragó A., Such Sanz A., Nogués Vera J. (2016). Current situation and environmental factors affecting the distribution of Emys orbicularis in Sèquia Major (NE Iberian Peninsula) in syntopy with Mauremys leprosa. Basic and Applied Herpetology 30 P. 47-59.

[17] Dinesman L. G. 1950. The role of floods in the ecology of amphibians and reptiles of the Volga delta (To the question of the influence of floods on the forage base of vertebrates) // Bulletin of MOIP, Department of Biology. Vol. LV (5). P. 53-58 (in Russ.).

[18] Crowley G. M., Preece N. D. (2019) Does extreme flooding drive vegetation and faunal composition across the Gulf Plains of north-eastern Australia? // Austral Ecology 44. P. 1256-1270.

[19] Čech M., Čech P. The role of floods in the lives of fish-eating birds: predator loss or benefit? // Hydrobiologia (2013) 717:203-211. DOI 10.1007/s10750-013-1625-3

[20] Balčiauskas L., Balčiauskiené L., Janonyté A. The influence of spring floods on small mammal communities in the Nemunas River Delta // Lithuania. Biologia 67/6: 1220-1229, 2012. Section Zoology. DOI: 10.2478/s11756-012-0116-8

[21] Aleem Yoosuf N., Unaisudheen T.P. Impact of flood on biodiversity of Kerala: A case study from Malappuram district of Kerala, India // International Research Journal of Environmental Sciences. Vol. 10(4), 8-19, October (2021).

[22] Bendix J. Flood disturbance and the distribution of Riparian species diversity. The Geographical Review, 87 (4): 48-43. October (1997).

[23] Cleber J. R. Alho, João S. V. Silva. (2012). Effects of Severe Floods and Droughts on Wildlife of the Pantanal Wetland (Brazil) A Review. Animals, 2, 591-610; DOI:10.3390/ani2040591.

Д. В. Малахов*[1], О. В. Долбня[2], Р. А. Құрбанова[3]

[1 *]ЖҚЗ және ГАЖ бөлімінің меңгерушісі
(Зоология институты, Алматы, Қазақстан; ***dmitry.malakhov@zool.kz***)
[2] Ғылыми қызметкер
(Зоология институты, ЖҚЗ және ГАЖ бөлімі, Алматы, Қазақстан; *olga.dolbnya@zool.kz*)
[3] Кіші ғылыми қызметкер
(Зоология институты, ЖҚЗ және ГАЖ бөлімі, Алматы, Қазақстан; *rekhangul.kurbanova@zool.kz*)

ТОРҒАЙ-ЫРҒЫЗ ӨЗЕНДЕРІ АРАЛЫҒЫНДАҒЫ 2024 ЖЫЛҒЫ СУ ТАСҚЫНЫ: ЖАСАНДЫ ЖЕР СЕРІКТЕР ДЕРЕКТЕРІ БОЙЫНША БИОӘРТҮРЛІЛІККЕ ӘСЕРІ

Аннотация. Қашықтан зондтау деректеріне сүйене отырып, Ақтөбе облысы аумағында 2024 жылы орын алған төтенше су тасқынының қоршаған орта мен биоәртүрлілікке әсері бағаланды. Нәтижесінде құрғақ, ылғалды және орташа ылғалды жылдардағы климаттық жағдайлары мен 2024 жылғы су тасқыны кезіндегі жағдайлар салыстырылды. Шалғай және сирек қоныстанған аудандар үшін жасанды жер серіктер деректерін пайдаланумен, бұлттылықты есептеу негізінде аймақтағы су тасқынына әсерін бағалаудағы сенімді әдіс екені анықталды. Басқа елдердің мысалында су тасқынының биоәртүрліліктің кейбір құрамдас бөліктеріне (өсімдік жамылғысына, құрлықтағы омыртқалыларға) ықтимал салдарлары талқыланды.

Түйін сөздер: су тасқыны, экологиялық залал, биоәртүрлілік, қашықтықтан зондтау, бағалау.

Д. В. Малахов*[1], О. В. Долбня[2], Р. А. Курбанова[3]

[1] *****Заведующий отделом ГИС и ДЗЗ (Институт зоологии, Алматы, Казахстан; ***dmitry.malakhov@zool.kz***)
[2] Научный сотрудник (Отдел ГИС и ДЗЗ, Институт зоологии, Алматы, Казахстан; *olga.dolbnya@zool.kz*)
[3] Младший научный сотрудник (Отдел ГИС и ДЗЗ, Институт зоологии, Алматы, Казахстан; *rekhangul.kurbanova@zool.kz*)

НАВОДНЕНИЕ 2024 ГОДА В ТОРГАЙ-ИРГИЗСКОМ МЕЖДУРЕЧЬЕ: ВЛИЯНИЕ НА БИОРАЗНООБРАЗИЕ ПО СПУТНИКОВЫМ ДАННЫМ

Аннотация. По данным дистанционного зондирования для Актюбинской области проведена оценка воздействия экстремального паводка 2024 г. на окружающую среду и биоразнообразие. Сравнивались климатические условия для сухого, влажного и умеренно влажного годов, а также условия в год наводнения 2024 года. Для отдаленных и малонаселенных районов было показано, что использование спутниковых данных и облачных расчетов является надежным методом оценки воздействия наводнений. Обсуждаются различные возможные последствия наводнений для некоторых компонентов биоразнообразия (растительности, наземных позвоночных) на примере других стран.

Ключевые слова: наводнение, экологический ущерб, биоразнообразие, дистанционное зондирование, оценка.