Acta Sci. Pol.
Formatio Circumiectus 25 (2) 2026, 63–75
ENVIRONMENTAL PROCESSES

www.acta.urk.edu.pl ISSN 1644-0765 DOI: http://doi.org/10.15576/ASP.FC/218446

ORIGINAL PAPER Accepted: 23.02.2026

# THE ROLE OF COMPENSATING WATER RELEASES IN THE FUNCTIONING OF THE SHIDERTY-OLENTI NATURAL ECOSYSTEM

Zarina Sergazinova[1] 0000-0003-3437-8717, Nazymgul Akimbekova[1] 0000-0001-6889-6606, Danil Gerstner[1] 0009-0003-0737-7716, Anton Chashin[2] 0009-0003-3162-9901, Diyar Kairkenov[3] 0009-0007-9361-3314, Kamshat Jumasheva✉[4] 0000-0003-0105-787X

[1] Toraighyrov University, Department of Biology and Ecology, Pavlodar, Kazakhstan
[2] Landscape Design Pavlodar, LLP, Pavlodar, Kazakhstan
[3] Environment and Water Resources of Pavlodar Region, Department of Subsoil Use, Pavlodar, Kazakhstan
[4] Yessenov University, Department of Ecology and Life Safety, Aktau, Kazakhstan

## ABSTRACT

### Aim of the study

The article presents research findings on the ecological state of the Shiderty-Olenti natural zone (ShONZ) during and after maximum environmental water releases. The analysis focused on the soil cover, flora, and fauna.

### Material and methods

The study area was divided into five sample sections for the convenient identification of changes that occurred after the cessation of water releases (Fig. 2): 1 section – limans in the Sarykamysk rural district of the rural zone of the Ekibastuz city; 2 section – limans in the Komsomol rural district of the rural zone of the Ekibastuz city; 3 section – territory adjacent to the Shikyldak lake in the Komsomol rural district of Ekibastuz's rural zone; 4 section – territory adjacent to the Shikyldak lake in the Komsomol rural district of Ekibastuz's rural zone; 5 section – territory adjacent to the lake Shureksor in the Akzhol rural district of the rural zone of the Aksu city.

### Results and conclusions

According to the survey data, the area of unsalted soil is equal to 7% (734 ha) of the total study area (9510 ha). The fifth study section has the largest area of the territory with virtually no salt, occupying 21% (122 ha) of the total research area. In the fourth study section, all the soil is saline. In the other sections (1, 2, 3) the area of non-saline soil is equal to 8% (295 ha), 16% (177 ha) and 4% (140 ha) respectively.

**Keywords:** Shiderty-Olenti natural ecosystem, water release, soil cover, plants, fauna

## INTRODUCTION

The hydrological regime is key to ecosystem stability and plays a vital role in human society. Restructuring it can lead to changes in vegetation and land cover, as well as the extinction of rare plant and animal species. It also contributes to soil erosion and reduced soil fertility. When that happens, water quality deteriorates, leading to the extinction of fish and other aquatic organisms, as well as causing a rise in morbidity of the human and animal populations.

In some countries, the construction of hydrological structures is one of the most effective measures to maintain and manage the water regime. Rational use of

✉e-mail: kamshat.dzhumasheva@mail.ru

water resources, as well as the assessment and maintenance of requirements for the natural regimes of rivers and lakes prevent damage to the ecosystem and society as a whole. Preventive water releases are a means of preserving biodiversity and restoring damage to nature caused by human activities.

One of the local monitoring zones of the Pavlodar region, which has great ecological and economic importance, is the Shidertinsko-Olentinskaya natural area. The red-listed *Salsola schoberi*, *Tulipa patens* Agardh ex Schult. et Schult. fil. etc., endemic and relict species, many medicinal species *Sanguisorba officinalis* L., *Glycyrrhiza uralensis* Fisch. etc., as well as large number of fodder plants *Elytrigia repens* (L.) Nevski, *Bromopsis inermis* (Leyss.) Holub, *Poa* L., *Medicago falcata* L. (Tugalbev and Chiryov, 2003), are found here. Water bodies play an important role for migrating waterfowl and waterfowl birds, such as *Calandrella brachydactyla* Leisler, 1814, *Oenanthe oenanthe* Linnaeus, 1758, *Cygnus cygnus* Linnaeus, 1758, *Ciconia nigra* Linnaeus, 1758, *Anas penelope* Linnaeus, 1758, *Anas platyrhynchos* Linnaeus, 1758, etc. These water bodies are equally essential for insect life, as 28 identified rare and endangered species can be found there Solomatin (2007). They sustain the local residential population, stability of growth in all agricultural sectors, especially animal husbandry (Yang et al., 2021; Kassouri, 2021).

The construction of the Irtysh-Karaganda canal in 1960–1970 within the Ekibastuz district of Pavlodar region disrupted the natural flow of the Shiderty River (Tsaregorodtseva, 2014).

After redistribution of water resources in the Shiderty-Olenta zone, changes in vegetation cover and soil reclamation conditions occurred, developing many exogenous processes. This led to a decrease in the productivity of hayfields in farms located near the Shiderta floodplain and created conditions for estuary farming within the floodplains of the Olenta and Shiderta rivers in 1973, as the estuaries, including those in the Sarykamysky and Komsomolsky rural districts, being fully flooded with water from the K.I. Satpayev canal (Tsaregorodtseva, 2014).

Since 1997, the volume of water supplied through the canal has been reduced by approximately three times compared to the initial regulatory indicators. This has significantly disrupted the established hydrological regime of the floodplain areas. Since 2000, the water supply was completely stopped, leading to a sharp decline in surface and groundwater levels, increased soil drying, degradation of vegetation cover, and intensification of exogenous processes.

Although, the water supply was partially restored in 2004, the volumes of water supplied remained insufficient to stabilize the hydroecological conditions and restore the previous levels of ecosystem productivity. The restoration was irregular and failed to provide the floodplain areas with sustainable moisture.

Only in 2011 were water supply volumes were increased to a conditionally optimal level, making it possible to partially normalize the hydrological regime and create the conditions for the gradual stabilization of the ecological state of the natural zone (Fig. 1).

The restriction of water resources in favor of supplying industrial areas and agriculture in Central Kazakhstan seriously affected the river's hydrological regime. And this in turn has had a significant impact on the ecosystem. Changes in the hydrological regime can lead to changes in the vegetation and soil cover, resulting in the extinction of rare plants and animals species, as well as the development of soil erosion processes and reduced fertility (Kurbonov, 2019; Nosov et al., 2010; Tang et al., 2018). The consequences of deteriorating water quality are the extinction of fish and other aquatic organisms, as well as human and animal diseases (Li et al., 2015; Malik et al., 2020).

Therefore, the purpose of the study was to identify changes in the soil, vegetation and fauna of the Shiderty-Olenta natural zone in the absence of compensatory water releases.

## MATERIAL AND METHODS

Field research was conducted in 2019 in the Shiderta-Olendinskaya natural zone, covering the estuary depressions and areas adjacent to the lakes. Estuaries are defined as floodplain depressions that are periodically flooded by regulated waters and used as hayfields. The study focused on soil cover, floristic and faunistic composition, the structure of plant communities, their dominant species and edifiers, as well as the productivity of hayfields and pastures.

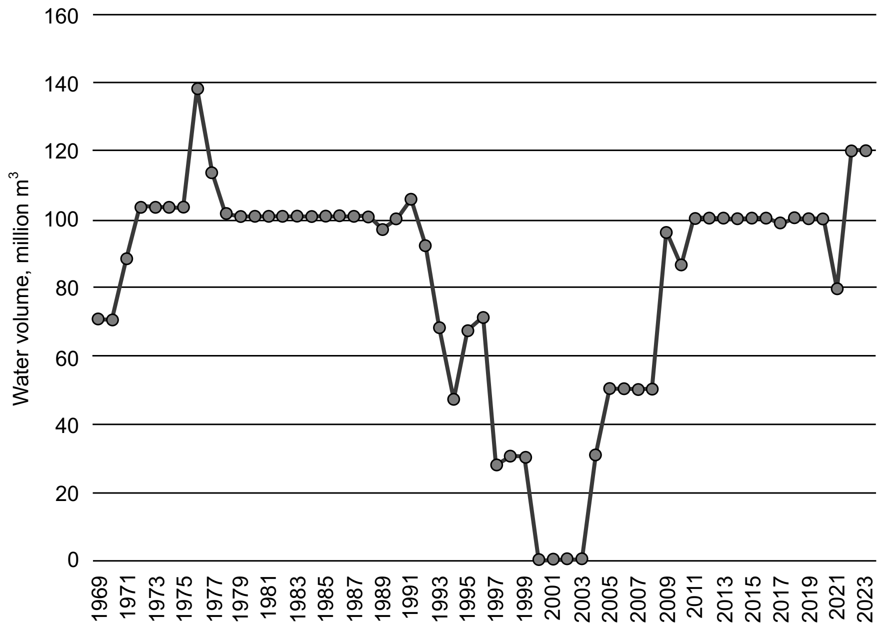


**Fig. 1.** Volume of water releases from the Irtysh-Karaganda canal (Source: Authors' own elaboration)

The study area was divided into five sample sites (Fig. 2) in order to identify changes that occurred after the cessation of water releases: site 1 – estuaries of the Sarykamysh rural district of the rural zone of the city of Ekibastuz; site 2 – the estuaries of the Komsomolsky rural district in the rural area of the city of Ekibastuz; site 3 – the territory adjacent to Lake Shikydak in the Komsomolsky rural district of the rural zone of the city of Ekibastuz; site 4 – the territory adjacent to Lake Shikydak in the Komsomolsky rural district of the rural zone of the city of Ekibastuz; site 5 – territory adjacent to Lake Shureksor in the Akzol rural district of the rural zone of the city of Aksu.

Limans are low-lying floodplain areas that are periodically or regularly flooded by floodwaters or regulated waters. They are characterized by a specific hydrological regime, increased soil moisture, and the formation of meadow or meadow-salt marsh phytocenoses.

A comparative analysis was performed for periods characterized by different hydrological conditions: 1986 and 1988 regular and complete flooding of the limans by canal waters; 2008 – a period after the cessation of water supply (since 2000); 2019 – the partial restoration of the water supply. For comparison, materials from geobotanical and soil surveys for the specified years were used, as well as data from land monitoring on the Sarykamysh limans, carried out by the Pavlodar Scientific and Production Center for Land Resources in 2002 and 2006.

The vegetation cover was studied using standard geobotanical methods. In the field, the species composition of phytocenoses, dominant and edifier species, community structure, and grass yield indicators were recorded. In order to measure the changes quantitatively, the method of ecological assessment of forage lands according to the tables of L.G. Ramensky was adopted. This method determines the position of communities in the ecological series of moisture and calculates the integral indicator of moisture supply of habitats Ramensky et al., (1956).

In the office work stage, areas were calculated by vegetation type and contour, a typological list was compiled, and ecological series were calculated on a moisture scale: 1–17 – desertified desert; 18–30 – semi-desert; 31–39 – dry steppe; 40–46 – medium steppe; 47–52 – meadow steppe; 53–63 – dry meadow (including stages 61–63 fresh meadow); 64–76 – wet meadow (including stages 68–76 wet meadow); 77–88 – wet meadow (Tsatsenkin et al., 2019). The areas were calculated based on mapping materials using desk-based processing of cartographic data and planimetric

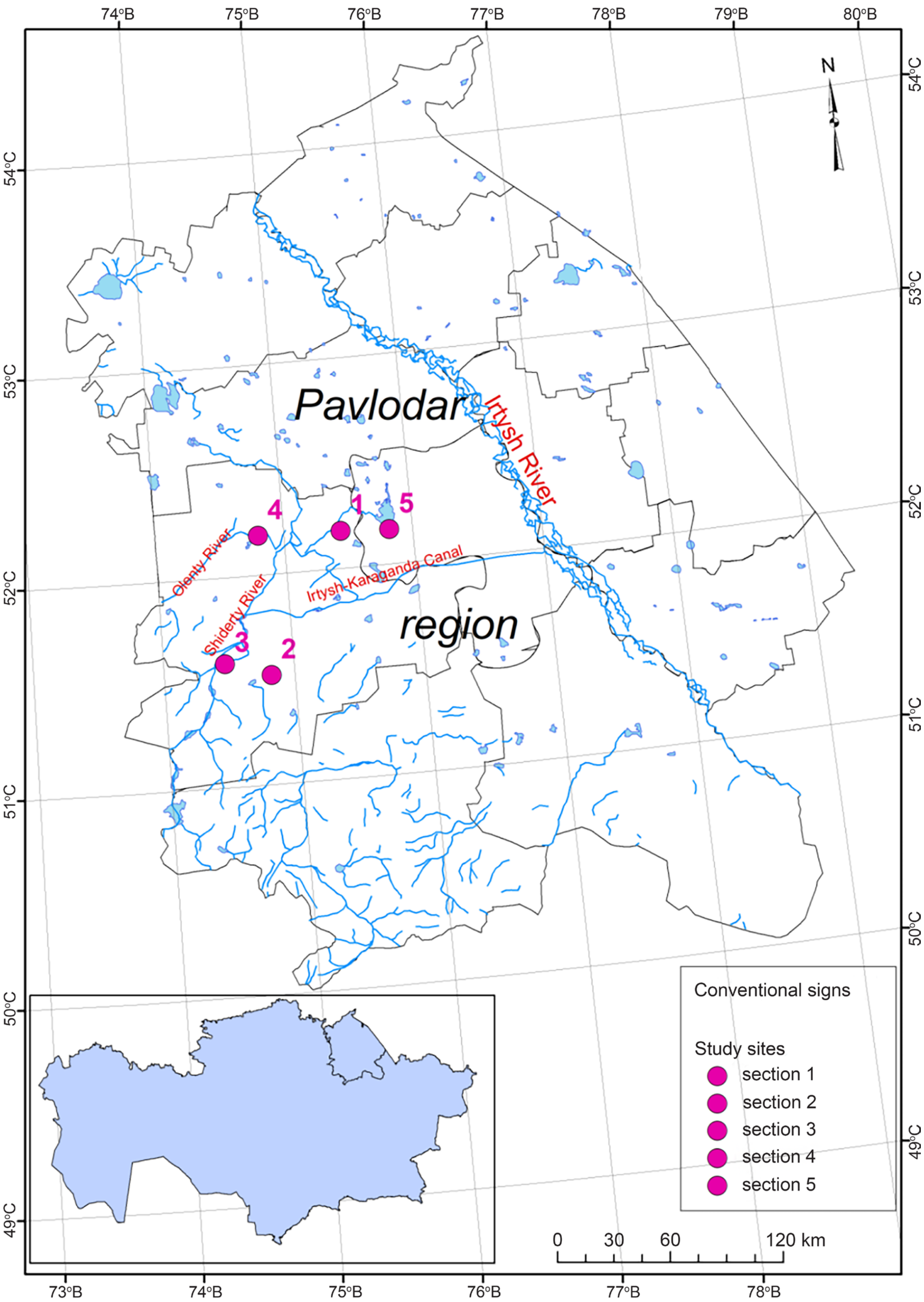


**Fig. 2.** Sections of the Shidertinsko-Olentinskaya natural zone: 1 section – limans of the Sarykamysk rural district of the rural zone of Ekibastuz; 2 section – limans of the Komsomol rural district of the rural zone of Ekibastuz; 3 section – territory adjacent to the Shikyldak lake in the Komsomol rural district of the rural zone of Ekibastuz; 4 section – territory adjacent to the Shikyldak lake in the Komsomol rural district of the rural zone of Ekibastuz; 5 section – territory adjacent to the lake Shureksor in the Akzhol rural district of the rural zone of the Aksu city (Source: Authors' own elaboration)

analysis. The values obtained were converted into hectares and as a percentage of the total area of the study sites. Comparing moisture indices by year made it possible to identify the direction of changes in habitat conditions under different water supply regimes.

Chemical analyses of water samples determined the degree of soil salinity in the studied areas. Recommendations by N.I. Bazilevich and E.I. Pankova were used to classify soil regions according to the degree of salinity, depending on the chemical composition of salts. Soils were also classified according to the degree of salinity (Li et al., 2019).

Faunistic studies were carried out using standard zoological methods. Reptiles and birds were counted using the route method without limiting the width of the transect. Large and medium-sized mammals were recorded by visual observation along routes and at sites, as well as by traces of their activity. Amphibians and small mammals were studied using 50-meter trapping ditches and trap lines. In addition, the results of visual observations, survey data from hunters and other specialists, as well as literary sources were adopted. The assessment of fish stock dynamics is based on data from departmental monitoring of water bodies in the region and materials from ichthyological surveys of previous years. No quantitative ichthyological survey was carried out during this study (Solomatin, 2007).

Some of the materials used are retrospective, and we present them in aggregated form, with no access to primary measurements, repetitions, or variability indicators. This limits the applicability of formalized criteria of statistical significance. In this regard, the analysis was performed using descriptive statistics and spatiotemporal comparison of integral indicators (Ramensky's moisture index, grass yield, distribution of soil salinity levels). The stability of the identified trends was assessed based on their consistency between the soil, plant, and faunal characteristics of the ecosystem.

## RESULTS

### Assessment of soil cover condition in the Shiderty-Olenti natural zone

To assess the reclamation condition of the land in the Shiderty-Olenti natural zone after the cessation of water releases, the degree of salinization was studied as a result of soil surveys in the studied areas in 2008 (Fig. 3).

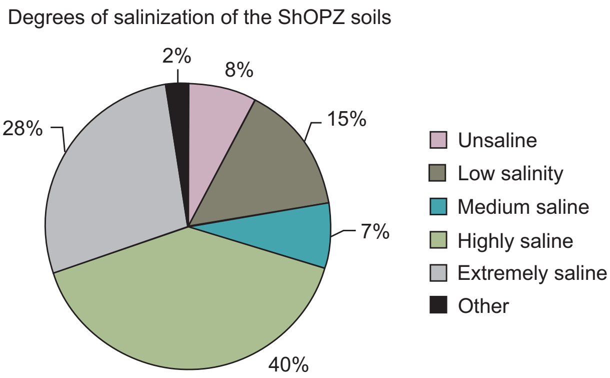


**Fig. 3.** Degrees of salinization of the soils in the Shiderty-Olenti natural zone (Source: Authors' own elaboration)

According to the survey data, the area of unsalted soil is equal to 7% (734 ha) of the total study area (9510 ha). The 5th study section had the largest area of the territory with virtually no salts, occupying 21% (122 ha) of the total research area. In the 4th study section, all soil is saline, meanwhile in other sections (1, 2, 3 sections) the area of non-saline soil is equal to 8% (295 ha), 16% (177 ha), 4% (140 ha) respectively.

Non-saline soils include: dark ordinary chestnut, ordinary chestnut, incompletely developed chestnut, ordinary meadow-chestnut, ordinary meadow, sedimented meadow, ordinary liman-meadow, sedimented liman-meadow, sedimented liman-meadow soils of the natural zone.

Weakly saline soil occupies 15% (1398 ha) of the total area. The second section covered 51% (550 ha), which is the largest among weakly saline soils. Next came the fifth (17%, 99 ha), fourth (11%, 95 ha), third (11%, 358 ha), first (8%, 296 ha) sections.

Mid-saline areas as well as non-saline areas make up 7% (703 ha) of the total area of the study zone, and they are the least widespread soil types by salinization. They occupy comparatively smaller parts of their respective sites: site 1 – 12% (419 ha), site 2 – 3% (35 ha), site 3 – 6% (195 ha), site 4 – 3% (27 ha), site 5 – 5% (27 ha). The percentage distribution of soil salinity levels across the study areas is shown in the diagram (Fig. 4).

Strongly saline soil type dominates and occupies the major part in 3 counties – 67% (2264 ha) and 5 counties – 48% (276 ha). A small proportion is found

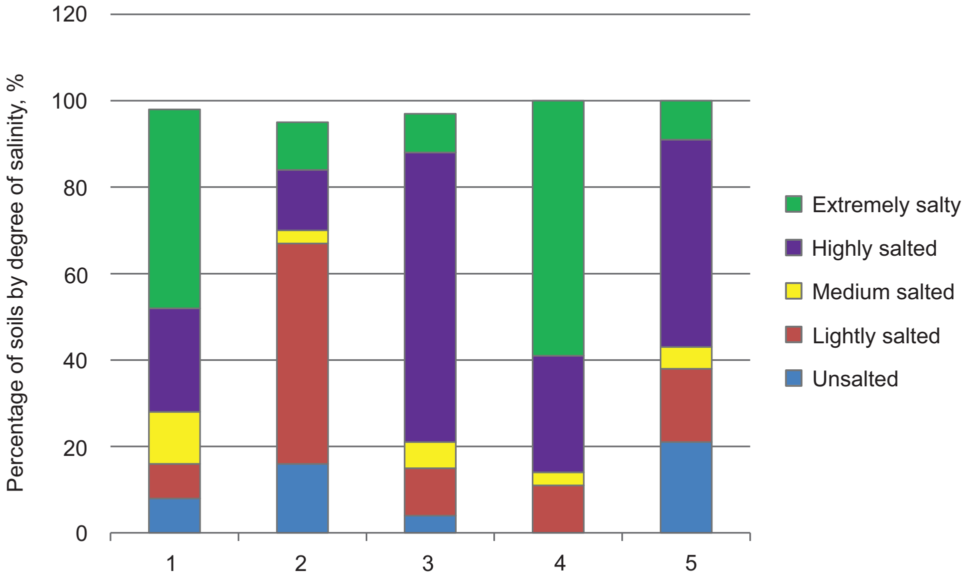


**Fig. 4.** Percentage distribution of soil salinity levels in the study area (Source: Authors' own elaboration)

in the second studied site – 14% (153 ha). In the first and fourth sites they occupy 24% (871 ha) and 27% (231 ha) of total area, respectively. It is the second most widespread type of soil salinity in these sections. The total area of highly saline soils is 3795 ha (40%) they cover the largest part of the study area.

Extremely highly saline soils were the second most common by soil salinity distribution – their share is 28% (2640 ha). They occupy the most part on the territory of the 1st study area – 46% (1646 ha), and the 4th study area – 59% (497 ha), and comparatively smaller share in other sections: the 2nd study area – 11% (120 ha), the 3rd study area – 9% (323 ha), the 5th study area – 9% (54 ha). Types of saline soils of the natural zone are presented in Table 1.

3% (240 ha) of the sum of the area of all sites belong to other types of soil salinization degree. Site 1 – 2% (73 ha), site 2 – 5% (47 ha), site 3 – 3% (120 ha), site 4 – 0%, site 5 – 0%.

Thus, due to the disturbance of water availability in estuaries, the process of land salinization was developing intensively, leading to a decrease of herbage yield and a deterioration of fodder species composition. Nearby massifs of solonts, solonchaks and highly saline meadow soils served as 'centers' of secondary soil salinization. Large areas on estuaries turned into wastelands (Fig. 5).

## Changes in the vegetation cover of the Shiderty--Olenti natural zone

To determine the state of the vegetation of the natural zone after the cessation of compensatory water releases, data on the degree of plant moisture availability (Fig. 6) and yield of the study areas (Fig. 7) in 1986, 1988 (under water release), and 2008 (after the cessation of water releases) were analyzed in a comparative aspect.

In 1986, during a geobotanical survey, six types of vegetation were identified in the section 1: grass-wormwood; mixed grass; grass-sedge; saltwort-wormwood; reed-cattail; saltwort (salt marsh), which were dominated by mesophytic grasses (e.g., *Elytrigia repens*, *Bromus inermis*). By 2008, after the water supply was cut off, the vegetation structure shifted towards xerophytic and halophytic communities, dominated by Artemisia species and salt-tolerant species. The average yield decreased from 16.1 cwt/ha to 2.3 cwt/ha, and the moisture index decreased from 59.6 to 46.5, indicating a gradual retreat of the limans.

In 1986, ten types of vegetation were identified during a study of the vegetation cover in the site 2, among which grass-wormwood and grass communities (*Festuca* spp., *Poa* spp.) were the most widespread. Hay yield ranged from 1.1 to 7.4 cwt/ha, with an average of 4.3 cwt/ha. The moisture index ranged

**Table 1.** Types of salinization and degree of salinity of soils

| Soil types | Solinity type | Degree of solonetzization of soils |
|---|---|---|
| chestnut carbonate-saline | chloride | – |
| meadow-chestnut salted | sulfate, sulfate-chloride, chloride | solonchak, almost solonchak, deep solonchak |
| meadow-chestnut merged | | – |
| meadow solonetzified | sulfate, chloride | – |
| meadow fused | chloride-soda | saline |
| liman meadow steppe meadow saline | – | weakly, moderately, strongly, and very strongly saline-alkaline |
| saline liman meadow meadows | – | slightly brackish |
| liman meadow carbonate | sulfate | almost solonchak |
| saline liman meadow | chloride-sulfate salinization predominates | weakly, moderately, strongly, and very strongly saline-alkaline |
| meadow-marsh | chloride-sulfate, sulfate-chloride | strongly saline |
| steppe solonetzes | chloride, sulfate-chloride, chloride-sulfate salinization | – |
| meadow-steppe solonetzes | | – |
| meadow solonetzes | | – |
| meadow solonchaks | sulfate, chloride-sulfate | – |

from 45.5 to 60.5, with an average of 50.6, which corresponded to a humid steppe regime.

By 2008, after the cessation of water discharge, average productivity had decreased to 3.3 cwt/ha (0.9–6.3 cwt/ha). The moisture index decreased to 47.7, reflecting a transition to a meadow-steppe regime. The vegetation structure showed an increase in the proportion of xerophytic and halophytic species, primarily wormwood communities, indicating the steppeification of the territory and a decrease in floodplain moisture.

A comparison of the results of geobotanical surveys in the site 3, conducted in 1986 and 2008, indicates a decrease in pasture productivity from 3.7 to 2.5 cwt/ha. Moisture level data calculated using the method developed by L.G. Ramensky also indicate a decrease in the moisture content of the area around Lake Shikydak. The indicator decreased from 51.3 in 1986 to 47.3 in 2008, which corresponds to the transition from a meadow-steppe regime to a more pronounced steppe state in some areas.

An analysis of the results of geobotanical studies conducted in 1986 and 2008 on the site 4 revealed a steady trend towards a decrease in the productivity of pasture vegetation. The average yield decreased from 3.3 to 2.1 cwt/ha, indicating the degradation of forage lands, while the moisture index also showed a negative trend: its value decreased from 50.5 in 1986 to 43.5 in 2008. This change reflects a significant reduction in the moisture supply for the territory, and indicates the transformation of the meadow-steppe regime into a more arid, medium-steppe regime. The decrease in moisture content and productivity is interrelated, and it confirms the process of steppe formation in pasture ecosystems against the backdrop of a disturbed hydrological regime.

During a geobotanical survey of site 5 in 1988, six types of vegetation were identified, reflecting the relative mosaic nature of the vegetation cover in the steppe zone. Yields ranged from 2.6 to 6.4 cwt/ha with a weighted average of 3.5 cwt/ha, which characterizes the moderate productivity of pasture lands. Meanwhile, moisture indicators ranged from 44.8 to 49.4, with an average value of 46.0, corresponding to the average steppe regime. These values indicate limited moisture availability in the studied area and the predominance

**Fig. 5.** Signs of soil degradation and salinization in the Shiderty-Olenti natural zone (Photos by Z.M. Sergazinova, 2019)

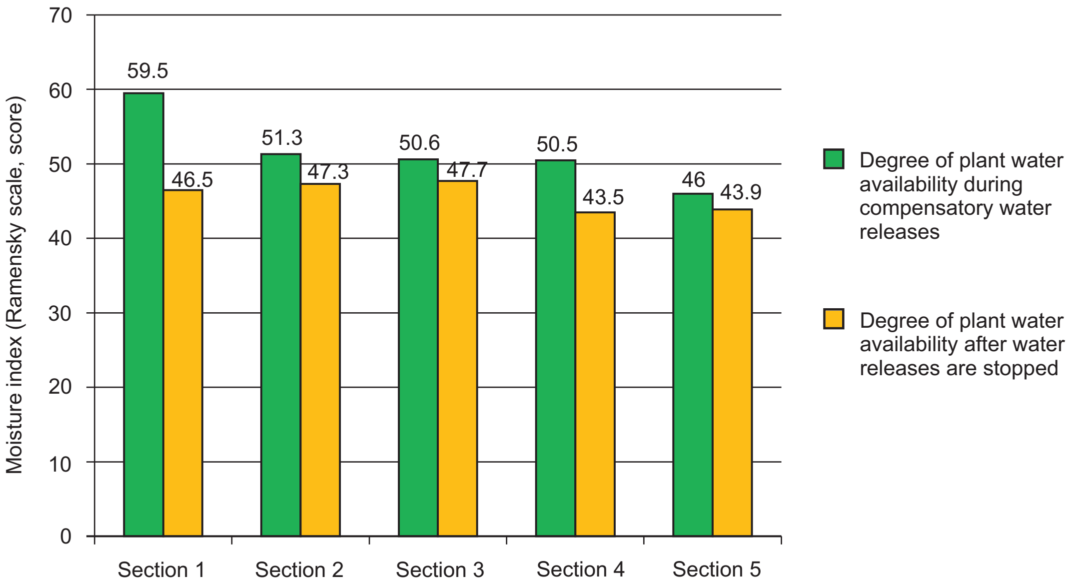


**Fig. 6.** Moisture availability for plants during compensatory water releases (Source: Authors' own elaboration)

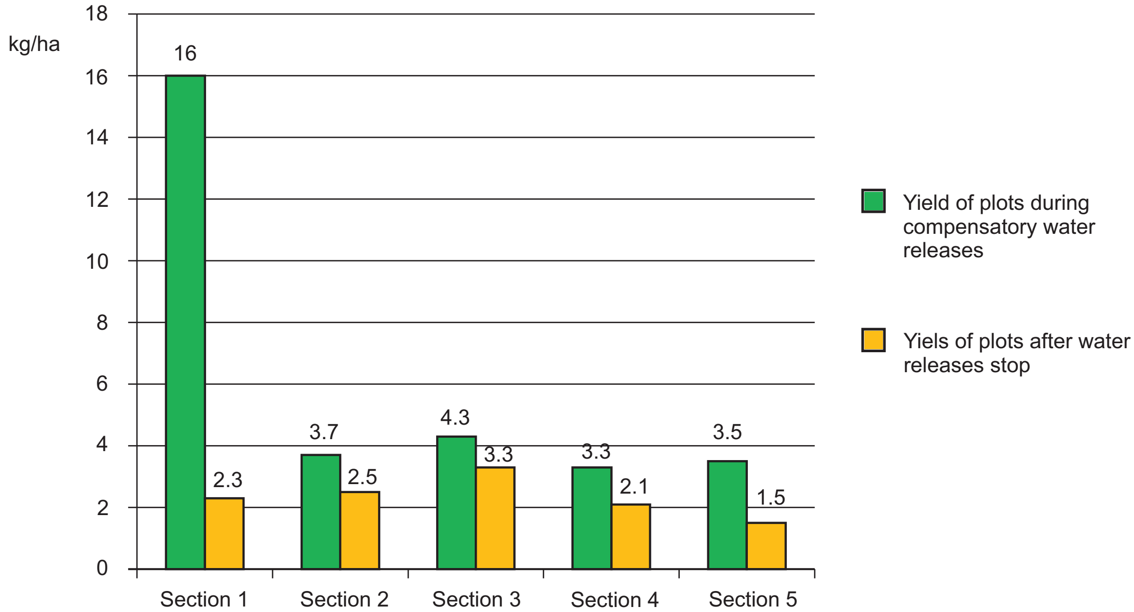


**Fig. 7.** Yield of the study sections during compensatory water releases (Source: Authors' own elaboration)

of steppe conditions, which determine the structure and productivity of plant communities.

The average yield on the plots during the period of regular water releases was 6.2 cwt/ha, and after the water releases ceased, it decreased to 2.6 cwt/ha, i.e., by 3.6 cwt/ha. The moisture index decreased from 52.7 (dry steppe regime) to 45.8, corresponding to the average steppe regime, reflecting an overall decrease in moisture availability in the area.

During a field survey of vegetation in the reserve zone in 2008, a significant deterioration in the condition of rare and protected species was identified. The survey recorded three endangered species, three species with significantly reduced populations, six endemic species with shrinking ranges, and 15 species with an established downward trend in population size (Table 2).

The data obtained indicate that a significant part of the flora in the protected area is in an unfavourable condition. A high proportion of the identified species are endangered or declining taxa, including endemic forms, which indicates a sustained negative trend in vegetation cover. The decline in the number of rare and economically valuable species reflects the overall deterioration of the ecological conditions of the area and the transformation of the phytocenosis structure.

**The fauna of Shiderty-Olenti natural zone**

Field studies in recent years have revealed significant changes in the structure and population size of animal communities in the study area. There has been an overall decline in hydrophilic species, accompanied by a shift in nesting areas and disruption of trophic links.

A significant decline in fish stocks has been recorded in water bodies, which has affected the status of aquatic and semi-aquatic birds. A number of fish-eating species, such as the gray heron (*Ardea cinerea*) and the black-necked grebe (*Podiceps nigricollis*), have shown a decline in breeding success and a shift in nesting areas in the northern parts of the studied area. At the same time, species adapted to shallow water conditions, such as the mallard (*Anas platyrhynchos*), have maintained stable or even increasing populations.

Rare and sporadically occurring species include the black-throated loon (*Gavia arctica*), whooper swan (*Cygnus cygnus*), bean goose (*Anser fabalis*), red-necked grebe (*Netta rufin*a), and spotted crake (*Porzana porzana*). In addition, species listed in the Red Book of Kazakhstan have been recorded in the area, including the black stork (*Ciconia nigra*), the grey crane (*Grus grus*), the red-breasted goose (*Branta ruficollis*), and the bustard (*Otis tarda*),

**Table 2.** Structure of rare and declining plant species (2008)

| Status category | Number of species | List of species |
|---|---|---|
| Endangered | 3 | *Salsola schoberi*, *Tulipa patens*, *Astragalus candidissimus* |
| Significant decline in population size | 3 | *Cypripedium calceolus*, *C. guttatum*, *Stipa pennata* |
| Endemic species with declining range | 6 | *Potamogeton macrocarpus*, *Ceratophyllum affine*, *Medicago trautvetteri*, *Astragalus brachypus*, *Euphorbia microcarpa*, *Saussurea robusta* |
| Downward trend in population size | 15 | *Fritillaria meleagroides*, *Dactylorhiza fuchsii*, *D. majalis*, *Dianthus uralensis*, *Nymphaea candida*, *Nuphar pumila*, *Pulsatilla patens*, *P. patens subsp. flavescens*, *Delphinium elatum*, *Adonis sibirica*, *Potentilla erecta*, *Astragalus brachylobus*, *Hypericum perforatum*, *Echinops ritro*, *E. tricholepis* |

which underscores the high conservation significance of the region.

Among small mammals, there has been a decline in the number of hydrophilic species, including the common water shrew (*Neomys fodiens*), the water vole (*Arvicola amphibius*), and the common vole (*Microtus oeconomus*). At the same time, the proportion of ecologically plastic species is increasing, leading to a change in the structure of dominance and a decrease in the overall level of biodiversity.

Fish stocks in the Shiderta, Olenta, and Karasu river basins have declined by 2–3 times compared to the 1980s. The number of economically valuable species such as pike (*Esox lucius*), perch (*Perca fluviatilis*), ide (*Leuciscus idus*), and roach (*Rutilus rutilus*) has decreased significantly.

## DICUSSION

The results obtained indicate a systemic transformation of the ecosystem of the Shiderta-Oleta natural zone related to changes in the hydrological regime. A decrease in moisture levels from 52.7 to 45.8, coupled with a 3.6 cwt/ha reduction in the average yield of forage lands, reflects the progressive aridization of floodplain areas. These changes have been accompanied by a restructuring of plant communities: hydrophilic species are being displaced by xerophytic and halophytic forms, the proportion of steppe elements is increasing, and the number of rare and endemic plants is decreasing. At the same time, a decline of 27 plant species in unfavorable conditions was noted, indicating degradation of the phytocenotic structure and a decrease in ecosystem stability.

Disruption of the compensatory water release regime led to a change in the natural hydrological dynamics of the floodplain. The lack of regular flooding contributed to a decrease in soil moisture and an increase in secondary salinization processes, which directly affected the structure of vegetation. In addition, the natural mechanism of fish reproduction, which previously ensured successful fish reproduction, was disrupted.

Spring floods created conditions for spawning and fry development in warm shallow areas, while the subsequent rise in water levels ensured their migration to deeper water bodies. The cessation of water releases in 2000–2005 led to the death of a significant portion of the young fish and, as a result, to a two- to three-fold reduction in fish stocks. The decline in fish resources affected the status of fish-eating birds and disrupted trophic links, while the decline in hydrophilic mammals and the growth in the number of ecologically plastic species led to a change in the structure of dominance and a decrease in biodiversity.

The identified patterns are consistent with the results of studies of regulated rivers and wetland ecosystems. For example, Tang et al. (2018) showed that changes in the flow regime lead to the degradation of floodplain vegetation and a reduction in ecosystem services Tang et al. (2018). Nikitina et al. (2020) also note that reducing maximum flows disrupts the functioning of freshwater and floodplain ecosystems, despite reducing the risk of flood damage (Zhan et al., 2020). Similarly, in the Shiderta-Oleta nature reserve, a decrease in peak water levels has led to the transformation of floodplain ecosystems and a decline in their productivity, confirming the dependence of the sustainability of such areas on the maintenance of an ecologically sound flow regime.

The limitations of this study should also be taken into account. The comparison was made on the basis of two time intervals (1986 and 2008), which does not allow tracking the intermediate dynamics of changes. In addition, the analysis was conducted without the use of advanced statistical modelling, and the impact of climatic factors and certain types of economic activity was assessed indirectly. Nevertheless, the consistency of changes in the hydrological regime, vegetation, and fauna indicates a high probability of a causal relationship between reduced water releases and ecosystem degradation.

Thus, maintaining an ecologically sound water supply regime is a key condition for preserving biodiversity and the sustainability of floodplain ecosystems. The restoration of periodic water releases that ensure floodplain inundation, reduce salinization, and create conditions for natural fish reproduction should be considered a priority water management measure, which takes into account climate change scenarios and the need to protect areas from extreme flooding.

Analysis of the dynamics of moisture, salinity, and ecosystem productivity shows that a water supply of 100–120 million m³ per year only partially maintains surface moisture, but does not create conditions for the sustainable restoration of hydroecological processes. With such volumes, the necessary depth and duration of flooding of estuarine depressions is not achieved, which does not allow for full replenishment of near-surface soil horizons, stabilization of groundwater levels, and removal of easily soluble salts from the root zone.

In the arid climate of the region, a significant part of the incoming water is lost due to evaporation and filtration, and is also distributed throughout the system of floodplain and lake depressions with varying degrees of hydraulic connectivity. This means that the actual volume of water reaching key biotopes is considerably smaller than the nominal volume of water released. Consequently, in order to ensure an ecologically significant effect, a volume exceeding the minimum hydraulic parameters of water supply is required.

The calculation of water resource requirements must take into account the water balance of the territory, including the area of potential flooding, the average depth of the flood layer, the seasonal frequency of releases, as well as losses due to evaporation and infiltration. When assessing the area of estuary depressions and adjacent areas requiring periodic flooding, the total volume of water required to form a stable hydrological regime is close to 200 million $m^3$ per year. This volume allows not only surface moistening, but also maintenance of the hydrological connectivity of the "floodplain-estuaries-lakes" system, which is a key condition for fish reproduction, preservation of hydrophilic phytocenoses, and prevention of secondary soil salinization.

Thus, the figure of 200 million m³ should be considered as an indicative, ecologically justified volume that ensures the restoration and sustainable functioning of the floodplain ecosystem. While its refinement requires specialized hydrological modelling, the field and comparative data obtained indicate that smaller volumes are insufficient to compensate for degradation processes and do not ensure the stability of ecosystem functions.

## CONCLUSION

The study revealed that a threefold reduction in water releases from the K. Satpayev Canal in 1997 and their complete cessation since 2000 were key factors in the degradation of the Shiderta-Olendinskaya natural zone ecosystem. The disruption of the hydrological regime led to a decrease in moisture levels, increased secondary salinization, and the steppeification of floodplain areas. Valuable forage species (*Elytrigia repens*, *Bromopsis inermis*, *Lotus corniculatus*) and their replacement by low-value salt-tolerant and xerophytic forms (*Limonium gmelinii*, *Puccinellia hauptiana*, *Artemisia* spp.), which resulted in a decrease in the productivity of meadow ecosystems.

The shallowing and partial drying up of lakes due to the lack of compensatory water releases has caused a decline in the number of fish, waterfowl, and moisture-loving mammals. A 2–3-fold drop in fish stocks and the transformation of trophic relationships indicate a profound disruption in the functioning of aquatic and floodplain ecosystems. The degradation of the food base has also affected the economic value of the area, resulting in cattle numbers falling to 30% of their 1991 levels.

The availability and restoration of fresh water depend on a complex interaction of elements, including precipitation patterns, geological formations, and anthropogenic impacts. Since 2011, thanks to the optimal volume of compensatory releases in the natural zone, the water management situation has improved, the groundwater level has risen, water sources have been restored, and floodplains provide high grass yields. Overall, the productivity of biosphere resources in the protected area has increased, and the yield of not only floodplains but also natural hayfields and pastures is growing.

The results indicate that a water supply below 120 million $m^3$ does not ensure the sustainable restoration of hydroecological processes. To maintain the hydrological connectivity of the floodplain-estuary-lake system and prevent secondary salinization, it is necessary to increase the volume of water releases to about 200 million $m^3$ per year. This should serve as an ecologically sound management guideline.

Thus, maintaining an optimal water supply regime is a determining condition for the preservation of biodiversity, the productivity of meadow ecosystems, and the sustainability of the natural zone in the context of climate change and anthropogenic pressure.

**Aknowledgments**

The authors would like to thank Zhazira Zhapar for her assistance in data processing.

## REFERENCES

Fujii, H., Sato, M., Managi S. (2017). Decomposition Analysis of Forest Ecosystem Services Values. Sustainability, 9(5), 687. https://doi.org/10.3390/su9050687

Kassouri, Y. (2021). Monitoring the spatial spillover effects of urbanization on water, built-up land and ecological footprints in sub-Saharan Africa. Journal of Environmental Management, 300. https://doi.org/10.1016/j.jenvman.2021.113690

Kurbonov, Nomvar B. (2019). Dynamics of Changes in Meteorological Conditions and Their Impact on the Water Resources of the Zerafshan River Basin. Abstract of the Candidate of Technical Sciences dissertation. Dushanbe: Institute of Water Problems, Hydropower and Ecology, National Academy of Sciences of Tajikistan.

Li, M., Yang, W., Sun, T. (2015). Effects of Freshwater Releases on the Delivery of Ecosystem Services in Coastal Wetlands of the Yellow River Delta Using an Improved Input-State-Output Approach. Wetlands, 36, 103–112. https://doi.org/10.1007/s13157-015-0630-x

Li, Y., Tan, M., Hao, H. (2019). The impact of global cropland changes on terrestrial ecosystem services value, 1992–2015. Journal of Geographical Sciences, 29, 323–333. https://doi.org/10.1007/s11442-019-1600-7

Malik, D.S., Sharma, A.K., Sharma, A.K., Thakur, R., Sharma, M. (2020). A review on impact of water pollution on freshwater fish species and their aquatic environment. Advances in Environmental Pollution Management: Wastewater Impacts and Treatment Technologies, 1, 10–28. https://doi.org/10.26832/aesa-2020-aepm-02

Nikitina, O.I., Dubinina, V.G., Bolgov, M.V., Parilov, M.P., Parilova, T.A. (2020). Environmental Flow Releases for Wetland Biodiversity Conservation in the Amur River Basin. Water, 12(10), 2812. https://doi.org/10.3390/w12102812

Nosov, A.V., Krylov, A.L., Kiselev, V.P., Kazakov, S.V. (2010). Modeling of radionuclide migration in surface water, R.V. Arutyunyan (ed.). Institute of Problems of Safe Development of Atomic Energy of the Russian Academy of Sciences, Nauka, Moscow.

Ramensky, L.G. Tsatsenkin, I.A., Chizhikov, O.N., Antipin, N.A. (1956). Ecological Assessment of Forage Lands Based on Vegetation Cover. Research Institute of Forage, Moscow.

Slyusarev, V.N., Osipov, A.V. (2019). Meliorative Soil Science: Textbook. KubGAU, Krasnodar.

Solomatin, A.S. (2007). Fish and Terrestrial Vertebrates of the Pavlodar Irtysh Region (Field Guide): Handbook. PGPI, Pavlodar.

Tang, C., Yi, Y., Yang, Z., Zhang, S., Liu, H. (2018). Effects of ecological flow release patterns on water quality and ecological restoration of a large shallow lake. *Journal of Cleaner Production*, 174, 577–590. https://doi.org/10.1016/j.jclepro.2017.10.338

Tsaregorodtseva, A.G. (2014). Geoecological condition of the Shidertinsko-Olentinskaya natural zone estuaries. Hydrometeorology and Ecology, 3, 173–178.

Tsaregorodtseva, A.G. (2014). Hydroecological Monitoring of Small Rivers in the Pavlodar Region of the Irtysh

River Basin. In: Ecosystems of Small Rivers: Biodiversity, Ecology, Conservation. Proceedings of the II All--Russian School-Conference, ed. A.G. Tsaregorodtseva. I.D. Papanin Institute of Biology of Inland Waters, Filigree, Yaroslavl, 1, 103–111.

Tsatsenkin, I.A., Dmitrieva, S.I., Belyaeva, N.V., Savchenko, I.V. (1974). Methodological Guidelines for the Ecological Assessment of Forage Lands in the Forest-Steppe and Steppe Zones of Siberia Based on Vegetation Cover. All-Union Williams Fodder Research Institute, Moscow.

Tugelbaev, A.B., Chiryov, V.A. (2003). On the creation of a protected area in the Shidertin-Olentin natural territory. Biological Sciences of Kazakhstan, 2, 65–68.

Yang, Q., Gao, D., Song, D., Li, Y. (2021). Environmental regulation, pollution reduction and green innovation: The case of the Chinese Water Ecological Civilization City Pilot policy. Economic Systems, 45, 4, 100911. https://doi.org/10.1016/j.ecosys.2021.100911

Zhan, W., Cheng, H., Shen S. (2020). Evaluation of urban wetland ecosystem service value in Zhuzhou City. Nature Environment and Pollution Technology, 19(2), 453–467. https://doi.org/10.46488/NEPT.2020.v19i02.003

## ROLA KOMPENSACYJNYCH ZRZUTÓW WODY W FUNKCJONOWANIU NATURALNEGO EKOSYSTEMU SHIDERTY-OLENTI

### ABSTRAKT

**Cel badań**

W artykule przedstawiono wyniki badań nad stanem ekologicznym obszaru przyrodniczego Shiderty-Olenti (ShONZ) w trakcie i po okresie maksymalnych zrzutów wody do środowiska. Analiza skupiała się na pokrywie glebowej, florze i faunie.

**Materiały i metody**

Obszar badań podzielono na pięć odcinków badawczych w celu ułatwienia identyfikacji zmian, jakie zaszły po zaprzestaniu zrzutów wody (ryc. 2): 1. odcinek – limany w gminie Sarykamysk w strefie rolniczej miasta Ekibastuz; 2. odcinek – limany w gminie Komsomol w strefie rolniczej miasta Ekibastuz; sekcja 3 – terytorium przylegające do jeziora Shikyldak w gminie Komsomol w strefie rolniczej miasta Ekibastuz; sekcja 4 – terytorium przylegające do jeziora Shikyldak w gminie Komsomol w strefie rolniczej miasta Ekibastuz; sekcja 5 – terytorium przylegające do jeziora Shureksor w gminie Akzhol w strefie rolniczej miasta Aksu.

**Wyniki i wnioski**

Zgodnie z danymi z badań powierzchnia gleby niesolnej wynosi 7% (734 ha) całkowitej powierzchni obszaru badań (9510 ha). 5. odcinek badawczy charakteryzuje się największym obszarem, na którym praktycznie nie występują sole, zajmującym 21% (122 ha) całkowitej powierzchni obszaru badań. W 4. odcinku badawczym cała gleba jest zasolona. W pozostałych odcinkach (1, 2, 3) powierzchnia gleby niesolnej wynosi odpowiednio 8% (295 ha), 16% (177 ha) i 4% (140 ha).

**Słowa kluczowe:** naturalny ekosystem Shiderty-Olenti, zrzuty wody, pokrywa glebowa, roślinność, fauna