European Proceedings of
Multidisciplinary Sciences
EpMS

www.europeanproceedings.com
e-ISSN: 2421-826X

DOI: 10.15405/epms.2024.09.46

MTMSD 2022
I International Conference «Modern Trends in Governance and Sustainable Development of Socio-economic Systems: from Regional Development to Global Economic Growth»

RESULTS OF INDICATION STUDY OF ECOSYSTEMS NORTH-WESTERN CASPIAN

Raisa Umarovna Bankurova (a)*, Madina Lecheevna Musaeva (b)
*Corresponding author

(a) Kadyrov Chechen State University, Grozny, Russia, b.larida@mail.ru
(b) Kadyrov Chechen State University, Grozny, Russia, dinamusaeva77@mail.ru

Abstract

Protection of the environment and its rational use require the study of ecosystems not in a stable state, but in dynamics. Such an approach can be implemented only if attention is paid not only to large transformations reflected on space photographs, but also to gradual changes occurring in the smallest elements of the structure of natural-territorial complexes. Arid plains are of great importance in the national economy, as they turn out to be the most important objects of both irrigation and pasture development. It is well known that the rational design of such measures requires an in-depth study of the landscape structure of those areas that are subject to this or that form of development. Since natural conditions and resources of ecosystems of the North-West Pre-Caspian are intensively developed, they are currently in a state of profound ecological transformation due to the natural evolution of landscapes associated with changes in the direction of the dynamics of sea level and anthropogenic influence, the purpose of our work is a comprehensive study of ecosystem structure and their dynamics to forecast processes occurring in this area under the influence of natural and anthropogenic factors.

Keywords: Ecosystem, ecosystem dynamics, indicators, plant communities

https://doi.org/10.15405/epms.2024.09.46
Corresponding Author: Raisa Umarovna Bankurova
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2421-826X

1. Introduction

Environmental protection and its rational use require the study of ecosystems not in a stable state, but in dynamics. Such an approach can be implemented if attention is paid not only to major transformations reflected in space photographs, but also to gradual changes occurring in the smallest elements of the ecosystem structure.

Indicator studies of arid plains are mainly based on remote survey data, on which indicators are clearly defined (Dedova et al., 2022; Lushchekina et al., 2022). However, the problem of variability of indication positions depending on the scale of the study requires a more detailed approach, including a variety of levels (structural and geomorphological work, land reclamation and engineering geological surveys). Indicator studies have been carried out for several years and include the following stages: pre-field, cameral, field and final (descriptive) (Dedova, 2019).

Ground-based studies make it possible to identify indicators at the early stages of the development of natural and anthropogenic processes.

2. Problem Statement

Such an expanded understanding of the dynamics is justified by the fact that a huge number of major changes in the ecosystem structure of the territory occur through the gradual accumulation of small or even the smallest, sometimes hardly noticeable changes. For example: various initial forms of erosion and deflation, described by Bankurova (2006), Mamai et al. (2004), vegetation change studied by Beideman (1951), Belgibaev et al. (1982), Whittaker (1980), (Yaoming) (2009), Yusufov (2006).

Briefly listing and somewhat summarizing the various areas of research that are necessary to understand the modern dynamics of the ecosystems of the North-Western Caspian, we can indicate the following:

i. study of saline, sandy desert and flooded coastal areas, as well as their dynamics, under the direct influence of the sea;

ii. study of further ways of evolution of formed solonchaks (in drainless depressions and outside them) taking into account the processes of salt deflation, phytogenic relief formation, as well as the processes of formation of solonetzes and the development of solonchak meadows;

iii. study of ecological and genetic series under the influence of grazing and anthropogenic destruction of soils on the watershed plains;

iv. analysis of series created by different stages of modern deflation and overgrowth of sands under the influence of grazing, technogenic destruction, anthropogenic fixation;

v. study of the dynamics of ecosystems under the influence of the formation of accumulations of local waters (mainly in sands);

vi. identification of ecological and genetic series created by irrigation (and, in particular, by the formation of canal lenses of groundwater);

https://doi.org/10.15405/epms.2024.09.46
Corresponding Author: Raisa Umarovna Bankurova
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2421-826X

vii. analysis of ecological and genetic series characterizing the processes of swamping in estuaries;

viii. study of technogenic series formed under the influence of drilling operations and self-flowing wells.

Assessing the role of studying the nanostructure of ecosystems in solving the issues listed above, it should be noted that although it is essential, it is limited (Neuchudin, 2020; Shkarupeta, 2022). It would be erroneous to assert that the analysis of the nanostructure will provide a complete and final solution to all of the above problems. It can have the value of a practically independent direction of research, especially effective in recognizing the early stages of individual processes or traces of their presence in the recent past. In part, it can be useful in revealing the mechanism by which this or that process is carried out (Belgibaev et al., 1982).

3. Research Questions

The changes that are taking place in ecosystems now are a continuation of past or future processes and are considered as modern natural and anthropogenic dynamics (Keller, 1936).

Changes that have been recently or currently determined in the ecosystem can be considered as the initial phases of the processes that are most relevant in the future, making it possible to predict the situation for a certain time.

Different scale units of the ecosystem structure of the territory are considered as the dynamics of ecosystems. The general name of dynamics combines: dynamic relationships between groups and types of ecosystems, microecosystems, elementary ecosystems, elements of the physiognomic nanostructure.

4. Purpose of the Study

The article is based on factual material collected personally by the authors in the study area, as well as collectively during summer practices with students.

The methodological base of the study is based on the works of the classics of geobotany and outstanding scientists in the field of soil science, geochemistry and landscape dynamics, such as: F. Klements, Kühler, Skamoni, B.A. Kovda, V.V. Egorov, M.A. Glazovskaya, N.A. Gvozdetsky, A.G. Isachenko, N.S. Solntsev, S.V. Viktorov, E.A. Vostokova, B.V. Vinogradov, E.A. Galkina, V.P. Miroshnichenko and others.

In the course of the study, regional routes were outlined - profiles, on which geobotanical descriptions of intersected communities were carried out according to the previously outlined scheme, a characteristic of the relief, soil and other landscape features was given, and mosaic and complexity were described.

A total of 18 profiles were received. A number of smaller profiles have been described in individual sandy massifs of the Black Lands - Lejin, Tsagan-Elsin, Tinguta, Dzhanai, Kheren-Ulan, Banghanta, Chong, etc. The length of the profiles varied from 1 to 7 km from the main profile, as needed, side profiles were made waste, sometimes up to 2 km.

https://doi.org/10.15405/epms.2024.09.46
Corresponding Author: Raisa Umarovna Bankurova
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2421-826X

Processing, analysis and systematization of the results of field studies, allows us to define ectostages as indicators not only of ecosystems, but also of individual ecological and genetic series. In addition, the data obtained underlie the schematic construction of the processes of ecosystem dynamics, making it possible to determine the dependence on natural conditions.

5. Research Methods

When conducting this scientific study, such scientific methods as the method of comparative analysis, statistical analysis, comparative analysis, functional analysis, positive and normative analysis were applied. The scientific research was carried out in accordance with the problem-chronological principle, the principles of consistency and scientific objectivity.

6. Findings

Analysis of the physiognomic nanostructure of the ecosystems of the North-Western Caspian makes it possible to indicate mechanisms and processes on semi-desert, desert and desert-steppe plains that determine the main directions of modern ecosystem evolution.

In the ecosystems of the North-Western Caspian, a number of changes in plant communities (psammogenic, halogen, hydrogen) can be outlined, which depend on the gradual change in environmental conditions, and 4 evolutionary processes can be distinguished (Gazieva & Ferzauli, 2022; Hasanov et al., 2019):

1. the process of evolution from coastal solonchaks and coastal meadows to complex ecosystems;

2. process of evolution solonchak depressions - depressions with wormwoods;

3. the process of evolution from waterlogged estuaries to solonchak depressions;

4. the process of estuary meadows.

The main reason for changes in plant communities are changes in the regime of the Caspian Sea level, so they can be called exodynamic, that is, those that have arisen in connection with an external impact on vegetation (Goldvarg et al., 2021).

The study covers the area below 100 m a.s.l. and largely below the 0 mark. By the nature of the surface structure, the study area is the scene of a number of Caspian transgressions. By the nature of the relief, the region is an undulating plain, slightly inclined to the east.

Modern erosion-denudation processes are weakened by small slopes of the surface, causing a relatively good preservation of the relief of the primary accumulative plain. Sand deposits are practically devoid of vegetation, are intensively blown by the wind, forming the eolian relief of hilly sands.

The soil cover is heterogeneous. It combines bog soils of floodplains, meadow-bog soils of meadow-boggy floodplains, various solonchaks (meadow, typical, hydromorphic, solonchaks of dried lagoons, etc.). Separate soil contours create sands of varying degrees of dispersion: from mobile sand dunes to completely fixed sands. Deeply humus sandy soils are found in depressions of fixed sands, at the locations of subsand lenses of groundwater (Keller, 1936).

https://doi.org/10.15405/epms.2024.09.46
Corresponding Author: Raisa Umarovna Bankurova
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2421-826X

According to the ecosystem zoning of the Northern Caspian Sea, the region under study is included in the Caspian Desert Province.

In the vegetation cover, the Phragmites, Salicornia, Tournefortia, Halocnemeta strobilacei, Leymeta, Elytrigia, Climacoptera formations are dominant in terms of the area they occupy. In general, the vegetation of the North-Western Caspian region is characterized by great heterogeneity. Complexity and mosaicity are widespread. Disturbance of vegetation cover by human activity is moderate.

On most of the western border, coastal solonchak ecosystems are in contact with vast wavy semi-desert plains, characterized by the dominance of light chestnut soils or (in the Kalmyk part) brown Caspian soils and various wormwood-grass and wormwood-grass communities (Beideman, 1951).

In the extreme western parts of the region, dominance passes to dark chestnut soils with cereal formations. In order to study the genetic relationships of ecosystems with different types of coastal solonchaks, it seems appropriate to study in detail the areas of contact between the coastal solonchak desert and the above-mentioned lowland ecosystems. So, for example, in the extreme western parts, in the mosaic of solonchak microcenoses, peculiar elements of the physiognomic nano-structure begin to occur, characterized by the dominance of a special group of halophytes, called “dry” (Kulik et al., 2020; Yusufov, 2006). The microcenoses of dry halophytes at the bottom of those dried-up lagoons, which immediately turn into coastal solonchaks, bypassing the stage of drying floodplains, are most widespread. Here they are very abundant, especially in the peripheral parts. All this gives the vegetation cover the character of a continuous whole, that is, a continuum (Bankurova, 2006).

In the course of evolution, due to the “leveling” of environmental conditions, there is a redistribution and interpenetration of the components of associations, which led to the formation of modern vegetation cover. We observed similar ratios not only on the periphery of the lagoon of the Agrakhan Bay, but also on others located in the peripheral parts of the Kuma delta and on the shores of the Kizlyar Bay.

An analysis of plant communities in drying lagoons that were not occupied in the past by flood-plains, but directly evolving into coastal solonchaks, shows that the development of vegetation (in most cases associated with the development of relief nanoforms) can be represented in two ways (Beideman, 1951).

One of them goes from a flat coastal solonchak devoid of vegetation, through communities of herbaceous succulent halophytes (solerosa, ofayston, petrosimonium, climacopter) on the leveled bot-tom of the lagoons to the dominance of dry halophytes (camphorosm, kermeks, etc.), then to camphor sagebrush complexes and sagebrush. This series corresponds to the evolution from coastal solonchaks to solonetzes.

Another row in its initial links is similar to the previous one, but the succulent herbaceous halophytes are replaced by sarsazan, which creates accumulative nanoforms of the relief, which, merging, form larger mounds, on which highly gypsum-bearing substrates with gypsum-bearing flock).

The first path is realized mainly on the flat bottom of the lagoons, the second - in those areas where the bulkiness of the surface horizons contributes to the eolian transport of this material and its local accumulation (Belgibaev et al., 1982).

https://doi.org/10.15405/epms.2024.09.46
Corresponding Author: Raisa Umarovna Bankurova
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2421-826X

Thus, the solonetz process forms a transitional link that prepares the evolution of meadows into sagebrush semi-deserts. Summarizing what was said earlier about the role of solonetz areas in the dynamics of the natural conditions of lagoons, which in their development pass through the phases of floodplains, riparian and firth meadows, it can be argued that the ecosystems created by the solonetz process are an element of ecological genetic evolutionary series located between the totality coastal floodplains, meadows, solonchaks and ecosystems of wavy upland semi-desert plains.

In the extreme southeastern regions of the Kalmyk part of the Northwestern Pre-Caspian, complexes were found with a predominance of solonetzic microareas with microcenoses of dry halophytes, which are replaced by there are areas that do not reveal any connection with the forms of the nanorelief, with the microrelief, and partly even with the mesorelief.

However, the idea that further modern transformation of landscapes does not take place on the plains with sagebrush communities is incorrect. Almost everywhere there is a process of surface aeolian transformation of horizons subjected to various mechanical influences, mainly pasqual (pasture), we also note the little taken into account, but very frequent formation of a zoogenic nanorelief created by the activity of rodents on moist clayey and loamy substrates (Hasanov et al., 2021; Rybashlykova et al., 2020).

Against a complex background, numerous tiny nanoelements are found, indicating the processes of a recent, but active redistribution of salts. There are several types of them: “tyue-taban” - traces of camels; car gauges; wagon tracks, which contribute to the local accumulation of salts (Keller, 1936).

The influence of rodents should be attributed to the phenomena of redistribution of salts. Colonies of the latter are noted mainly on solonetzes formed on loams or heavy sandy loams. We have studied the occurrence of ground squirrels on substrates of different mechanical composition in the Naryn-Khuduk area (Figure 1).

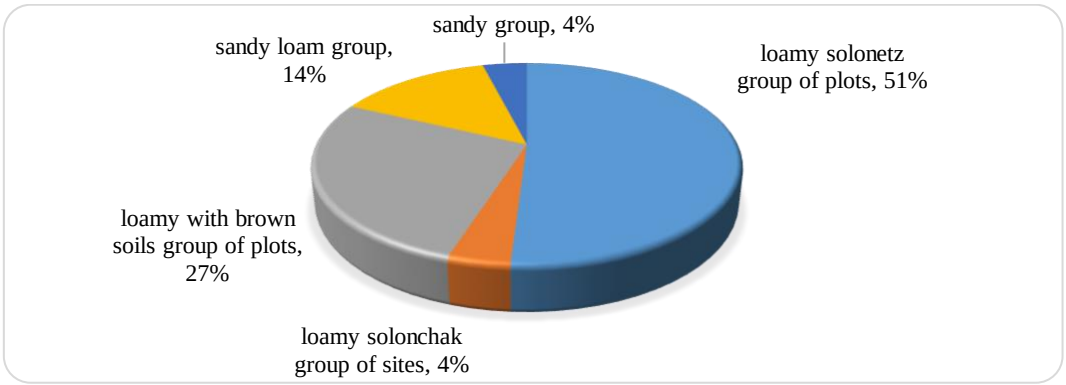

Figure 1. The number of ground squirrels encountered in different groups of sites (as a percentage)

According to Bananova the formation of ground squirrel on the solonetze leads to a decrease in the humus content in it, since the alkaline solutions contained in the ground squirrel cause leaching of humus into deeper horizons. At the same time, ground squirrel enriches the surface horizons of the soil not only under it, but also around it, since during precipitation, nanoflows are formed, forming a certain area of increased salinity around each of the hillocks.

https://doi.org/10.15405/epms.2024.09.46
Corresponding Author: Raisa Umarovna Bankurova
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2421-826X

Our observations confirm that the formation of complexes and their evolution are an external reflection of the general dynamics of the ecosystems of the Caspian Sea and are closely related to the gradual release of the lowland from the effects of marine transgressions and, first of all, from excess salts.

Summarizing the results of our observations, we can assume that the influence of the modern redistribution of salts turns out to be an important, but locally acting factor. Nevertheless, given that the area of pasqual and mechanogenic forms of human impact on the ecosystem of the North-Western Caspian Sea is constantly expanding, and will be actively expanding in the future, the relative importance of modern redistribution can greatly increase and, indeed, will become one of the significant factors in the process modern ecosystem differentiation. Complexes with the participation of solonetzic elements of the physionomic nanostructure of ecosystems appear initially as centers of transition from coastal ecosystems to semi-deserts, deserts and desert steppes. Subsequently, these foci, in the course of their growth and development, interacting with a number of other plant communities and micro-relief, develop into a real complexity in the usual sense of the word, and the farther we move away from the area of development of coastal ecosystems, the more the complexity weakens and the less the participation of halophytes in the vegetation cover. This allows us to consider the general tendency to desalinization as the most common in the North-Western Caspian region, the idea of which was formed for the first time under the influence of the works of Keller (1936).

Thus, the analysis of the physiognomic nanostructure of the ecosystems of the North-Western Caspian Sea makes it possible to outline the presence of the following processes on semi-desert, desert and desert-steppe plains (Keller, 1936):

i. evolution from coastal salt marshes and coastal meadows to complex landscapes characterized by a combination of saltwort–wormwood, wormwood and grass–wormwood communities, occurring through the formation of solonetz elements of the nanostructure with their subsequent transformation into elements dominated by light chestnut and brown soils;

ii. evolution from solonchak depressions to depressions with solonchak-meadow vegetation;

iii. evolution from solonchak depressions to depressions with sagebrush (during the presence of burial of the bottom of the depression with material brought along runoff troughs);

iv. evolution from swampy estuaries to solonchak depressions;

v. progressive meadowing of estuaries under the influence of the growth of lenses of sublime waters.

The first of these processes is a reflection of the general trend towards desalinization, which has been repeatedly noted for the Caspian lowland by many scientists, the rest are of a local nature (Mamai et al., 2004).

7. Conclusion

Communities that make up the vegetation cover of the North-Western Caspian, in addition to indicating processes, can be used for an approximate assessment of individual properties of soils and

https://doi.org/10.15405/epms.2024.09.46
Corresponding Author: Raisa Umarovna Bankurova
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2421-826X

subsoils (salinization, mechanical composition) during the economic development of the territory, as well as for indicating adverse anthropogenic impacts on coastal ecosystems.

The series of communities formed in the course of changes in plant communities form on the ground, in most cases, spatio-temporal ecological-genetic series. The latter are used as indicators of processes occurring in the environment. Indicative interpretation of changes in vegetation and ecological and genetic series determine the direction of changes in natural conditions.

References

Bankurova, R. U. (2006). Modern dynamics of landscapes of semi-deserts and watershed plains of the North-Western Caspian region. *Geoecological problems of the North Caucasus. Materials of the scientific-practical conference* (pp. 96-98). Dagestan State Pedagogical University.

Beideman, I. N. (1951). Vegetation changes along the banks and the bottom of the bay them. Kirov in connection with the retreat of the Caspian Sea. *Botanical Journal, 1*, 80-85.

Belgibaev, M. E., Zonov, G. V., & Parakshina, E. M. (1982). *Ecological-geographical conditions of soil deflation in Northern and Central Kazakhstan*. Nauka.

Dedova, E. B. (2019). Degradation of pasture lands of the Republic of Kalmykia. *Norwegian Journal of Development of the International Science, 33-2*, 4-7.

Dedova, E. B., Mashtykov, K. V., Konieva, G. N., & Goldvarg, B. A. (2022). Phytomeliorative methods of restoration of degraded pasture lands of the north-western caspian sea. *International Agricultural Journal, 4*(388), 348-350. https://doi.org/10.55186/25876740_2022_65_4_348

Gazieva, M. S., & Ferzauli, A. I. (2022). Agroecological potential of pasture ecosystems of the North-Western Caspian Sea. *Innovative approaches to the development of sustainable agricultural and food systems: Materials of the International Scientific and Practical Conference* (pp. 77-80). Limited Liability Company. Sphere.

Goldvarg, B. A., Tsagan-Manjiev, N. L., & Adyaev, S. B. (2021). Desertification of the territories of the North-Western Caspian Sea and the creation of sustainable feed production. *The Caspian in the Digital Age: materials of the National Scientific and Practical Conference with international participation in the framework of the International Scientific Forum Caspian 2021: Ways of Sustainable Development* (pp. 245-247). Publishing house Astrakhan University.

Hasanov, G. N., Asvarova, T. A., & Bashirov, R. R. (2021). Carbon balance and a way to improve it in the semi-desert landscapes of the Northwestern Caspian Sea. *Proceedings of the St. Petersburg State Agrarian University, 3*(64), 58-65. https://doi.org/10.24412/2078-1318-2021-3-58-65

Hasanov, G. N., Asvarova, T. A., Gadzhiev, K. M., Bashirov, R. R., Akhmedova, Z. N., Abdulayeva, A. S., & Salikhov, S. K. (2019). Phosphorus concentration, translocation and balance in grass ecosystems of semi-desert landscapes of the Northwestern Caspian Sea. *Arid ecosystems, 25, 2*(79), 52-58.

Keller, B. A. (1936). Occurrence and stages of development of a binary complex among saline soils on the outskirts of estuaries. *Proceedings of the Council for Proizv.forces (SOPS) of the Academy of Sciences of the USSR, ser. Volzhsko-Kaspiyskaya, 2*, 223-261.

Kulik, K. N., Petrov, V. I., Yuferev, V. G., Tkachenko, N. A., & Shinkarenko, S. S. (2020). Geoinformation analysis of desertification of the North-Western Caspian Sea. *Arid ecosystems, 26, 2*(83), 16-24.

Lushchekina, A. A., Karimova, T. Y., & Neronov, V. M. (2022). Ungulates of arid territories from the Red Book of the Russian Federation. *Arid ecosystems, 28, 4*(93), 104-114. https://doi.org/10.24412/1993-3916-2022-4-104-114

Mamai, I. I., Avessalomova, I. A., Dyakonov, K. N., Ivanov, A. N., & Belyakov, A. I. (2004). General provisions of the dynamics and functioning of the landscape. *Geography, society, environment*, 101-112.

Neuchudin, I. G. (2020). Urban ecosystem research. *Problems of Regional Ecology, 3*, 140-144. https://doi.org/10.24411/1728-323X-2020-13140

Rybashlykova, L. P., Belyaev, A. I., & Pugacheva, A. M. (2020). Monitoring Successional Changes in Pasture Phytocenoses in 'Exhausted' Areas of Deflation in the North-West Caspian Region. *South of Russia: ecology, development, 14*(4), 78-85. https://doi.org/10.18470/1992-1098-2019-4-78-85

Shkarupeta, E. V. (2022). The cenological approach in the study of industrial ecosystems in the conditions of transition to industry 5.0. *Digital transformation of industry: trends, management, strategies: Collection of scientific articles* (pp. 269-280). Institute of Economics of the Ural Branch of the Russian Academy of Sciences. https://doi.org/10.17059/978-5-94646-673-8-2022-23

Whittaker, R. (1980). *Communities and Ecosystems*. Macmillan.

Yaoming, L. (2009). Desertification and restoration of the bioresource potential of subarid and arid landscapes. *Abstract of the dissertation for the degree of candidate of geographical sciences.* St. Petersburg.

Yusufov, S. K. (2006). *Landscape structure and ecology of the Dagestan coast and shelf of the Caspian Sea*. Monograph. Makhachkala.