

Regularities and Dynamics of Vegetation Distribution in the Ecosystem of the Atyrau region

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In course of the botanical surveys on the territory of the Atyrau region, 136 species of the most common plants that belong to 83 genera and 28 families were identified. The prevailing number of species refers to three leading families – Cereal, Chenopodiaceae, Compositae, which are most economically important. These are the main plants in pastures and hayfields. Less widespread are representatives of Leguminosae, Cyperaceae, Polygonaceae, Labiatae.

Key words: Vegetation, Ecosystem, Rehabilitation, Association, Monitoring.

The problem of studying the biological diversity of the Atyrau region is one of priority tasks, since it makes it possible to identify biological diversity of ecosystems, and to consider the issues of spatial organization. The resulting moment of this research is studying patterns and dynamics of spreading vegetation ecosystems in the Atyrau region, which will make it possible to optimize the species composition in the regions through the use of plants that meet the zonal criteria in the area. Vegetation is one of the key comprehensive indicators of changes in natural conditions. In order to study the dynamics of ecosystems, various botanical indicators are used. Peculiarities of changes in the natural ecosystems of the region are manifested in the

structure of vegetation cover: in the set of associations and in patterns of their mutual arrangement. The aim of our work was to identify the dynamic phenomena in vegetation of the Atyrau region as a result of a botanical survey.

The area of the research

The Atyrau region is located in the Caspian lowland, below sea level. The region is a major oil and gas development area located in the West of the Republic of Kazakhstan. In the West, the region borders with the Astrakhan region of the Russian Federation, in the North – with West Kazakhstan, in the East – with the Aqtobe region, and in the South-East with the Mangystau region. The total area of the region is 118,631 sq. km. The Atyrau region includes 2 cities: Atyrau, Kulsary, and 7 administrative districts: the Kurmangazy, the Isatai, the Makhambet, the Inder, the Kzylgogynsk, the Makat and the Zhylyoi regions. In accordance with climatic conditions, characteristics of soil-forming rocks, terrain, soil cover and vegetation,

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four zones have formed in the territory: coastal, riverine-alluvial, semidesert-steppe, and sand zone. Forest occupies 0.4% of the territory. The climate is sharply continental and dry. Summers are dry, long and hot; winters are snowy and cold. The average temperature in January is -8, -11 °C, in July – +24, +25 °C, the annual rainfall is 100 to 200 mm¹.

The greatest part of the area is mostly located in the vast Caspian Plain, and is a low or slightly elevated plain in the semi-arid and arid zones. Territories of Naryn, Taysogan, Karakum of the Caspian Plain are occupied by ridge and dune sands, there are salt marshes in many places (my article).

The aridity of the Caspian Plain has always hindered economic development of this area due to salinity and low productivity of vegetation. Since long ago it has been a region of nomadic transhumance².

MATERIALS AND METHODS

This research is based on the materials obtained from researching the state of ecosystems and studying the flora in these areas during a three-year period (2012-2014). In 2012-2014, the geobotanical map of the Atyrau region territory was adjusted, based on the botanical and forage study performed in 1995, in order to identify the ecosystem and species diversity.

The whole complex of traditional methods was used for vegetation ground route mapping. These methods were used during the detailed route survey for outlining the contours of their typological composition with reference to environmental conditions. With that, vegetation was described, yield and state of the grassland were defined. All work was conducted according to the requirements of approved methods. Field geobotanical researches and the surveys were performed using the routing method. The routes were laid with the use of a vehicle. The route network was broken down with regard to crossing the main forms of the terrain, and the route network was built so that all paths identified in the topographic map could be visited. Routes directions were built perpendicular to changes in the relief elements, and depending on terrain practicability. According to the instruction, the routes were laid parallel to each other at 1000, 1200

m. distance. When moving along the route, homogeneous land plots were distinguished and described all along the route, which are the elementary units of vegetation (phytocenoses, elementary ecosystems) attributable to various types of grassland – pastures or hays. They were described in special geobotanical forms of the ecosystem³⁻⁵. A herbarium was collected along the routes, which was identified using special identifiers^{6,7}.

RESULTS AND DISCUSSION

According to botanical-geographical zoning, the territory of the Atyrau region is located in the Sahara-Gobi desert region, Iran-Turanian sub-region, North-Turan province and the Caspian and the West-North Turan sub-province, in the sub-zone of northern and medium deserts¹⁴.

Semi-arid (desert-steppe) zone is transitional between the steppe and the desert, and has features of both the former and the latter. The extreme North-Eastern part of the area within the Kyzylkorginsk district belongs to more favorable semi-arid zone. This is an area of deserted turf cereal-absinthial steppes with light chestnut soils with depleted species composition of steppe plants, strongly absinthiated, alternating with desert vegetation on saline and alkali soils, and zonal soils in some places. The nature of the steppe ensures its dominance in the part of the territory of real tufted and loose-bush turf plants: *Stipa sareptana*, *Agropyron desertorum* and *Agropyron fragile*, occasionally *Stipa capillata*. *Artemisa Lercheana* is widespread.

Zonal desert vegetation belongs to the North-Turanian type and unites sub-zones of the northern and central (or middle) deserts, with absolute predominance of the former.

In general, the flora of the Caspian Sea region is quite poor and has no more than 800 species. According to the materials of botanical-forage study, it has little over 100 species of the landscape value. Out of these, only about 60 species have some forage value, about 20 widely spread species are either weeds, or pioneers of colonization of broken sands and desertified grasslands.

In the sands, the most common plant is *Artemisa arenaria*, also *Agropyron fragile*, *Elymus*

giganteus, *Artemisa terrae-albac* and *Artemisa Lercheana*, *Calligonum aphyllum* and *Tamarix ramosissima* are met. In case of an overgrazing, *Bromus tectorum*, *Syrenia saliculos*, *Heliotropium arguzioides* grow. Meadows usually have *Agropyron repens*, marshy meadows have *Phragmites australis* and *Bolboschoenus maritimus*, and saline meadows have *Puccinella distans* and *Aeluropus litoralis*.

In the extreme South-East, within the Ustyurt plateau, on gray-brown soil landscapes of the Central deserts are formed with tree-like *Salsola arbuscula*.

In view of the young age of the territory, and due to natural salinity of the soil-forming rocks and groundwater, the deserted part of the Atyrau region is characterized by predominance of huge spaces of *Salsoloideae* (*anabasis-salsa*, *salsoloideae*, *sarzasan*, *Atriplex cana*) associations on saline and alkaline lands, and only in the East, the sub-Ural plateau is dominated by sagebrush associations on zonal soils. Sands and brown sandy soils are also dominated by sagebrush vegetation with cereals, ephemers, wild herbs and shrubs.

Part of the North-East region is a semi-arid zone, its Western part is located in the Caspian Plain, and its Eastern part is within the sub-Urals plateau. The sub-Urals plateau is dominated by *lercheana-poaceae*, *lercheana* and *sareptana-lercheana* associations on light-brown loamy soils on sloping and steeply-sloping plains. The flat Caspian Plain is also dominated by *lercheana* associations, but mostly on light-brown sandy loam soils. They are more dense and polluted, with lots of bulbous bluegrass (*Poa bulbosa*), *Ceratocarpus arenarius* and *Anabasis aphylla*. Closer to the sand, *agropyrum sibiricum* associations grow in some places.

Atriplex cana, *Anabasis salsa*, *Artemisieta pauciflorae* and one-year *Salsoloideae* vegetation on saline light chestnut is found in sor lowerings and in the valley of the Sagyz River, as well as in complex allotments in zonal vegetation.

Steppified sands of Taisogan and Biyruk with their typical mix of hilly and plain areas are typically dominated on the rough sands by *Artemisia arenaria* and *agropyrum sibiricum*, the vegetation is much infested with milkweed. In lowland areas, *artemisia arenaria* vegetation prevails

together with in combination with licorice-gramineous vegetation in the lowest places.

The meadows in the flood land and in the valley of the Uil River are dominated by wheatgrass. In the flood land meadows soils due to haphazard use of these grasslands, a sharp reduction of their areas is observed, in a significant area wildrye turned into weed-cereal, weed-sagebrush and weed-saltgrass modificational grass stands.

The desert part of the Atyrau region is characterized by the so-called "band" arrangement of vegetation from the coast to the periphery (North and East), associated with the influence of the Caspian sea and unequal age of the territory that was freed from the water at different time, which is expressed by clear alternation of subclasses of natural forage grassland vegetation, duly changing each other within the Caspian Plain [8].

The coastal region (North coast) was occupied by a narrow discontinuous band of reed and *bolboschoenus* vegetation used as grassland.

Meadows are preserved to a greater extent in deltas of the rivers, especially in the delta of the Volga River, and to a lesser extent – in the deltas of the Ural and the Emba rivers.

In the delta of the Volga River, grass-sedge, gramineous and gramineous-grass meadows are located, dominated by *Agropyron repens*. In the estuaries of deltas of the Ural and the Emba rivers, *aeluopus* and *salsoloideae* meadows are mainly found.

Behind the band of meadows on the North shore and along the whole of the East shore, from the water edge, a stretch of juicy *salsola* associations in a band 15 to 50-70 km wide are located, often in combination with bare sor salt marches, sometimes very extensive.

On the northern shore, associations of annual plants are common in the meadowy coastal soils, dominated by *Climacoptera*, *Petrosimonia*, *Suaeda*, *Atriplex*, *Salsola nitraria*, *Kalidium foliatum*, *Salsola paulsenii*, etc. They alternate with monogynous absinthial and marsh-beet communities, associated with weak relief lowering. In deeper lowerings and dishes with coastal salt marshes associations of *Halocnemum*, *Suaeda physopora*, *Kalidium* and *Halost0chys* are formed.

On the second coastal terrace along the North and around the Eastern shore of the Caspian Sea, glasswort, mainly *Halocnemum*, become

dominant in the vegetation cover, and mono-cyclic glasswort vegetation becomes less intense. Here separate spots are estuary lowerings with poaceous vegetation.

Saltmarsh vegetation of the coastal plain is replaced by *Anabasis salsa* that occupies vast areas of brown alkali soil in the plains of the Caspian Plain. *Anabasis salsa* can be met both in homogeneous massifs, and in complexes and combinations with absinthial and mono-cyclic glasswort vegetation groups. The latter are usually of secondary origin. Here sors are also numerous, and are occupied by sor salt marshes, often surrounded by *sarzasan*. In the North and the East of the desert zone within the Atyrau region, along with *anabasis salsa*, large areas of brown alkali soil are occupied by *Atriplex* and *absinthium* associations, but they are rarely homogeneous, usually form various complexes with zonal and semi terrestrial vegetation.

The extreme band of desert vegetation along the periphery of the region is formed by *absinthium* associations on zonal soils. In the Caspian plain, sagebrush associations are found in the most elevated areas, mainly on brown sandy loam and sandy soils adjacent to the sandy soils⁹.

On brown alkali loamy soils, *artemisia terrae-albae* associations are dominated by vegetation in the East of the region within the sub-Urals plateau, and in the North of the area of the Inder rize, usually in combination with *anabasis-salsa*, by *atriplex cana* and sagebrush vegetation on brown alkali soils.

Vegetation of the sandy massifs of the desert zone is richer and more diverse, which is caused by preservation and accumulation of moisture in the sand and shallow fresh groundwater. *Agropyrum sibiricum*, *artemisia terrae-albae*, *artemisia lerceana* and *agropyron* plant formations prevail. Also common are *calligonum*, *ephemers*, mixed herbs, *ceratocarpus*, *elymus giganteus* associations of anthropogenic origin.

The small area of the Ustyurt plateau in the South-East of the region is characterized by complexes of *artemisia terrae-albae*, *salsola arbuscula* and *ephemers* communities on gray-brown soils with *anabasis salsa* on salt soils.

The once-rich in bottom-land meadows valley of the Urals is currently deserted. Now there

are few meadows and they are located in small areas on artificially flooded lowerings. The North of the region, in the floodplain of the Ural River, was dominated by secondary wild-growing grass, *ephemers*, *atriplceae*, *alhagi*, and *ceratocarpus* vegetation. Out of weed grass, the largest area was occupied by *anabasis aphylla*. The southern part of the valley was dominated by *salsoloideae*, *atriplceae*, *chenopodioideae* with the *ephemers* and weed grass.

The zonal vegetation of the semi-arid area (637 thousand ha) includes *cyperaceae*, *artemisia lerceana*, plain associations on light-brown loamy, sometimes salty soils. They occur on billowy, sometimes steeply-sloping plains of the sub-Urals plateau, and much less within the Caspian lowland.

The main associations of *cyperaceae* communities are *stipetum-lercheana*; significantly less frequently – *ceratoides-agropyron-lercheana* and *agropyron-lercheana*. In the areas of intensive grazing, *Artemisia austriaca* and *Anabasis aphylla* occur widely.

Lerceana communities are represented by: *lercheana*, *lercheana poaceae*, *lercheana agropyron*, *lercheana-stipetum*, *lercheana-salsoloideae*.

Sandy massifs of semi-arid areas cover the area over 230 thousand ha and are represented by two large sand massifs – *Taisoigan* and *Biryuk* located along the above flood-plain terraces of the Uil River and its waterways. The *Biryuk* massif is located to the North, and the *Taisoigan* – to the South of the Uil River, the South-Eastern part of the latter is already in the desert zone.

Vegetation in the sands is steppe-like. Large areas (over 25 thousand ha), especially in the leveled areas, are occupied by *agropyrum sibiricum* represented by several communities: *agropyrum sibiricum*, *fescue*, *fescue-lercheana* and several modifications caused by overgrazing: *fescue-mixed herbs*, *fescue euphorbia*, *fescue-agropyron-euphorbia*.

On the tops and slopes of hills, mostly in the sands of *Taisoigan*, *calligonum* communities occur that occupy 10-15% of the area of the contours among *artemisia arenaria* and *agropyrum sibiricum* communities. In the South and the South-West of the sand massif of *Taisoigan*, *calligonum* communities dominate in the vegetation of the sands, occupying up to 60% of the contours area.

In most parts of the sands, agropyron communities are met, with the area of about 130 thousand hectares. *Artemisia arenaria* communities on sands occur everywhere, and they all are of anthropogenic origin, i.e. appeared as a result of human activity, namely, haphazard heavy use of sand communities that were previously dominated by *Agropyrum sibiricum*, *Artemisia lercheana* types of communities, and *Agropyron* only accompanied them in small amounts as a natural component of sand vegetation.

Artemisia arenaria is presented by two communities: *Artemisia arenaria* and *Agropyrum sibiricum*, which are found together with *Agropyrum sibiricum*, *Calligonum*, *Artemisia lercheana*, *Eremosparton aphyllum*, weed grass communities, occupying from 10 to 100% of the area of the contours. Very often they form large contours of almost pure *Artemisia arenaria* thickets.

The desert plains zonal vegetation on all types of brown and gray-brown soils (except sand) and brown saline soils is prevalent on 4,663.8 thousand hectares.

Mixed herbs communities are widespread on sandy massifs. Their development is associated with grazing and breaking sands. The composition of these communities is variegated, dominated by sandy mixed grass, from which most wide-spread are *Centaurea bella*, *Syrenia siliculosa*, *Achillea micrantha*, *Helichrysum arenarium*, *Gypsophila paniculata*, *Heliotropium arguzioides*, usually of several species at once, but often evident predominance of one of them is observed, especially of *Syrenia* in some years. Mixed herbs are accompanied by ephemers (*Anisantha tectorum*, *Alyssum desertorum*), *Artemisia arenaria*, and in some places – by *Calligonum*, *Burgun*, *Astragalus paucijugus*. In case of overgrazing in these communities, *Peganum harmala* runs wild^{9,10}.

The previous survey of the district was made in the late 90s. Within the period from the previous survey, vegetation of the districts in the region has undergone significant changes. This was a result of human activity. Before, the sands of the Naryn Isatai and Kurmangazy regions were dominated by green absinthial (*Artemisia arenaria*, *Burgun*) and nitrariae-salsoloideae-ephemeral associations (*Nitraria schoberi*, *Climacoptera brachiata*, *Climacoptera lanata*, *Anisantha tectorum*). Now this area is dominated by

wormwood-ephemer-festuca Association (*Artemisia arenaria*, Marshal's wormwood) (coordinates N 47010.10 E 051039.43). The valley of the Ural River was dominated by ephemers with prevailing bulbous bluegrass, *Eremopyrum*, *Anisantha tectorum*, and by rank-grass-sagebrush associations. Now they have been replaced by *Artemisia terrae-albae* with glassworts and ephemers. Along the Ural River and in the sands, ephemers dominated, with prevailing bulbous bluegrass, *Eremopyrum*, *Anisantha tectorum*. Now this area is dominated by *Artemisia terrae-albae*-*agropyrum sibiricum* – ephemeral associations (*Artemisia terrae-albae*, bulbous bluegrass, *Carex physodes*, *Eremopyrum orientale*) (coordinates N 47030.074 E 049029.25). In the sands of the Karakum desert and in adjacent sandy plains of the Zhylyoi district, the landscape plant currently is *Ceratocarpus arenarius* that grows on congested grazing sagebrush and *agropyrum sibiricum* Vferme-sagebrush grasslands. In the early stages of pastures over grazing, *Ceratocarpus arenarius* appears among *Artemisia* and *Agropyron desertorum*; later the amount of the latter reduced, and the role of *Ceratocarpus arenarius* in the vegetation increases. Extreme degradation of native vegetation is represented by formation of almost pure thickets of *Ceratocarpus arenarius*. According to our observations, the sands of the Karakum and the adjacent sandy plains are dominated by *Elymus giganteus*, *Agropyron desertorum* associations (coordinates N 45055.203 E 053035.473), which showed *Elymus giganteus* as an indicator of recovery after ecosystem degradation^{10, 11}.

In course of survey on the territory of the region, 136 species of the most common plants were identified that belong to 83 genera and 28 families. The prevailing number of species refers to the three leading families – Poaceae (Gramineae), Chenopodiaceae, Compositae, which are economically most important. These are the main plants in the pastures and the hayfields. Less widely distributed are families of Leguminosae, Cyperaceae, Polygonaceae, Labiatae.

The plant communities selected in the territory of the districts of the region were systematized in the preparation of the legend for the natural pastures map within the three main landforms: mountainous, piedmont plains and

lowerings¹⁰⁻¹³.

The basic taxonomic unit in the legend for the natural pastures map is the grassland type (plant association) taken as a set of homogeneous and similar plant communities (phytocenoses = land lots), with similar floristic composition, structure, development rhythm, habitat conditions, forage quality and economical use. The most available physiognomic characteristic that can be used for distinguishing a plant association (type forage land) is plants domination. The value of pastures' forage value is also mainly determined by dominant plants that ensure the major part of green mass. They also determine possible use of pastures -seasonality, type of grazing cattle.

CONCLUSION

Complete elimination of the negative impact of anthropogenic factors on the natural complexes in the districts of the Atyrau region contributes to gradual recovery of plants. Monitoring of vegetation in the Atyrau region in the absence of anthropogenic impacts shows the steady recovery and expansion of plants ranges. Different level of anthropogenic load causes a response, and successional changes occur in vegetation. These shifts become evident in the vegetation cover through introduction of certain weeds, harmful, poisonous, nitrophilous, halophilous and other plants. The result of abandoning accompanied by construction of irrigation channels, plowing, and intensive grazing has resulted in domination of *Salsola* communities in the valley: *Atriplex tatarica*, *Chenopodium*, *Ch. ficifolium*), less frequently – of *Climacoptira crassa* and *Climacoptira lanata*. Also, other secondary vegetation that resulted from human activity dominated of *Alhagi pseudalhagi*, *Karelinia caspia*, *Vexibia alopecuroides* and *Xanthium strumarium*. The number of these plants can be used for assessing the level of changing the state of vegetation from the initial one. Thus, in all types of the described communities, the presence of typical species that are characteristic for this area was found. This testifies that the dynamics of vegetation in the area is steadily recovering. Further work will allow to study dynamic trends of the vegetation cover in the area.

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