Territorial Cores of the Steppe Vegetation Recovery in West Kazakhstan Region

Nurlan Khabibullovich Sergaliev, Kazhmurat Maksutovich Akhmedenov, Raushan Kauysovna Amenova

West Kazakhstan Agrarian Technical University named of Zhangir Khan, Zhangir Khan Street 51, 090009, Uralsk, Republic of Kazakhstan

Abstract. The geobotanic and floristic characteristics of steppe lands are given in the article. On the West Kazakhstan territory there have been distinguished 41 remained key steppe areas, serving as the resource base for the collection of seeds for the seed-plot. The analysis of life-forms has been carried out, and the vegetation of the key steppe areas has been described. Key steppe areas of the secondary steppes within the West Kazakhstan region have been identified. Geobotanical description of steppe standards has been done. Steppe standards are the source of seed fund for the formation of wild steppe flora nursery at the experimental site. Tracts of secondary steppe on lands not in use are characterized on the grounds of field expedition observations, their conservational value and prospects of steppe natural areas of preferential protection development are apprised.

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1. Introduction

Drier steppe zones are mainly used for livestock production (mainly cattle, sheep, horses and camels). Livestock numbers have decreased since the end of the Soviet Union and are relatively low nowadays. Overgrazing in specific areas of the steppe, e.g., near settlements, causes substantial damage to the natural steppe vegetation [1]. In the northern regions of the steppe zone (moderate dry and dry steppe), cattle numbers have exceeded the pasture loads of the limited grassland areas, and year-round grazing has caused the rapid degradation of vegetation cover resulting in soil compaction, which alters the soil's physical and chemical characteristics, and also contributes to the loss of some species. First of all the nowadays endangered characteristic feathergrass (*Stipa spp.*), wild tulips and other typical flowering plants, followed by other steppe grasses like *Festuca spp*., disappear. This leads to an incrimination of *Poa bulbosa*, which can be considered as a typical grass species of overgrazed areas. Finally these are being encroached by *Artemisia austriaca*, which is not found in natural steppe [2, 3].

Agricultural reclamation of the Eurasian steppes and the North American prairies was going simultaneously. Having almost simultaneously started a barbaric, haphazard plowing of the steppes and prairies, and also the destruction of trees and shrubs in the steppe zone, in Eurasia and America, at the turn of the XIX-th and XX-th centuries, there were all the prerequisites for the world's first global environmental crisis caused by the mass plowing of virgin land.

At the same time, there was going the scientific justification of the effective land conservation in the steppe zone of northern Eurasia, and the related to them overseas prairies.

North America's prairies – both waves of tallglass as well as the more arid mixed grass and shortgrass prairies – once stretched from Indiana west to eastern slopes of the Cascade Range, south to Texas and north into Canada. Today, a fractional percentage of North America's original native prairie ecosystems remain.

Regeneration of steppes by the seeding method has at least, the 30-year history on the post-Soviet space [4-13]. Unfortunately, to this day, it remains the occupation of the few scientists, within the testing sites. But with all this, in the USA and Canada, the restoration of prairies from seeds has already become a widespread practice. Tens (if not hundreds) of thousands of farmers cultivate the prairies on their sites. There are many non-governmental organizations, professionally involved in the restoration of the prairie, and the societies, bringing the amateurs together, often, on the lands especially bought for this purposes.

Among the first attempts at habitat reconstruction has involved the tallgrass prairie, and the first of these prairie restorations was started at the University of Wisconsin-Madison Arboretum. Aldo Leopold and John Curtis provided the early leadership and the early stages of work utilized crews from the Civilian Conservation Corps between 1935 and 1941. The two prairie restorations at the Arboretum, Curtis and Greene, now total more than 110 acres (46 hectares) making them among the largest prairies now occurring in that state. More than 300 species of native vascular plants have been recorded from the restorations, and they provide excellent habitat for numerous prairie insects, small mammals, and birds [14].

The restoration of ecosystems is a practical science and generally not based on rigidly controlled and monitored experimental plantings. Rather, increases in knowledge are acquired by the arduous process of trial and error. One example is the paper by Peter Schramm entitled "Prairie restoration: a twenty-five year perspective on establishment and management," which was published in the Proceedings of the Twelfth North American Prairie Conference. The reference given below by Scott Weber (1999) have a very good discussion on the issue of seed mixes and suggestions for improvements that will result in prairie restorations and plantings that contain more species diversity, including "conservative" species [15].

In Canada, the prairies stretch to the south across the Great Plains of the United States up to the north of Mexico, starting from the southern part of Canada's three Prairie provinces (Alberta, Saskatchewan and Manitoba). In this region, on the area of more than 450 km², the mixed prairie is the most common of all the types of natural grass ecosystems, where the grass stand is characterized by an intermediate (compared to the types of tallgrass and shortgrass prairies) height. But of the initial area of even this type of grassland ecosystems there have remained only 24%, and half of those are destroyed by overgrazing. As for the tall prairie - some of a percent of its former area remains. The research results have showed that the Canadian prairies - one of the most intensively development landscapes in the world [16]. In line with this, the prognosis for survival of the remaining natural grasslands is sad.

After 1991, in the virgin areas of Kazakhstan and Russia in many pasturable plots and old deposits there are very favorable conditions for the preservation of landscape and biological diversity that are not possible in the existing reserves. This is due to a more active vegetation of gramineous-grassland steppes in a post-pasturing period and due to the formation of unique zoo-complexes on older deposits (habitats of such red book species as the great bustard, little bustard, steppe eagle, etc.). Therefore, at this stage of nature reserve fund formation it is very important to reveal the focuses of high biodiversity during the monitoring process and, by soft handling these ecosystems, include them into the modern ecological network. Further, the reserves islands in the steppe should not be isolated from each other and do not have to keep the defense from the outside world, as it was in the reserves during the Soviet period. It is particularly important for the steppe zone to implement the thesis of the Pan-European Strategy for the protection of wildlife, "From Islands to Networks", which provides harmonious transformation of single steppe reserves into the ecological network [17, 18, 19].

2. Materials and methods. During the territory survey, with a view to select the typical representatives of flora, taking into account the biological characteristics the conventional techniques were used [20]. The main objective during the field study was an inventory of steppe flora, which stipulated the choice of the main work method – the reconnaissance-routing. The routes covered all the accessible parts of the investigated sectors, which differ by the originality of floristic composition and vegetative cover. The total route length was 1,500 km, with a total survey area of about 20 km².

In some cases, a herbarization of samples was carried out for further clarification of taxonomic affiliation. Besides the routing method, the method of random samples of flora has also been used, consisting in the description of ecosystems in the designated areas (45-60 points on random samples at each site). Random sample, the coordinates of which are recorded using GPS, in the description, besides the list of species must contain the data about the average height of each species (cm), its projective cover (%), its phenological phase and the regeneration (in scores).

On steppe arrays, which are of significant environmental value, a geobotanical description of steppe associations and microcomplexes was carried out. Geobotanical descriptions were conducted on the reference sites of 100 m². Descriptions of phytocoenoses were recorded on specially designed forms. The description points reflected the phytocoenotic diversity of the investigated territory and the degree of anthropogenic transformation of plant communities.

The species were identified using existing floristic reports and determinants. Monographic reports were also used on specific taxonomic groups and regions close to the investigated territory. Manuals of the Red Book of Kazakhstan were used at the marking out the rare and endemic species. The range of species has been completed as per the data sheet of S.K. Cherepanov (1995) [21]. Life form was determined as per I.G. Serebryakov and H.K. Raunkier [22, 23], and the geographical element (type and class of range) and the ecology – as per T.I. Plaksina [24, 25]. Localization of observation points was implemented using a GPS system with 12-channel GPS-receiver of the Garmin eTrex Vista model. Borders of areas have also been pointed out on the landscape maps obtained from the "Google Maps" database. The GIS ArcGis 9.2 package was selected as a means of map drawing, which allows the processing and displaying the spatial information.

3. Results and discussions. The most important properties of the geographic cover are continuality and discreteness. The discreteness of territorial geographical systems is described by many different common factors: polarization, nodal cores, clusters. The latter, as the territorial entities, combine both inter-component interactions of the landscape cover and include a wide range of natural and anthropogenic interactions, including social and economic processes that serve as the leading factors in the organization of geographical systems. The peculiarities of formation of the ecological and landscape clusters are most exerted in the West Kazakhstan region when comparing the areas involved in agricultural production with the territories occupied by prairie etalons and secondary prairies.

The current dynamics of prairie landscapes of the West Kazakhstan region is characterized by the formation of agro landscape clusters. two types of agro landscape clusters have been marked out according to the results of field studies, analysis of the arable land valuation, areas and farmland structures, the availability of reserve land: 1) cluster with depressive state of agriculture with the reduced acreage by 50-70%, and the restoration of natural ecological potential, including the formation of large arrays of long standing fallow lands; auto regeneration processes of prairie geosystems; 2) cluster with agriculture that develops due to the expanding arrays of sown areas by engaging in turnover of secondary and fallow prairies.

The peculiarity of all this is that the more quality cropland stretch to the northern border of West Kazakhstan, and the maximum of the agricultural crops account for the internal rural districts of Zelenovsky, northern part of Taskalinsky, Syrym, and central part of Terektinsky regions. These rural districts form a ring at a certain distance around the regional center – Uralsk city. At the same time, right around Uralsk, there is a large amount of uncultivated lands.

As per the available data, it is possible to suppose the pulsating nature of the dynamics of areas, occupied by agricultural production. Currently, in the west of the West Kazakhstan region a plowing of secondary prairies that directly adjacent to the boundary is observed, i.e., there is an expansion of agricultural cluster with the grain specialization in a northerly direction. At the same time, in the eastern regions, such as Burlin and Chingirlau, the formation of large arrays of secondary prairies is observed that is probably due to the involvement of workforce in the gas industry at the Karachaganak oil and gas condensate fields. Akzhaik, which is located along the Ural river is the area with minimal crop areas.

In general, it should be stated that, due to the modern economic processes the agricultural clusters are forming in western Kazakhstan, the allocation of which does not always correspond to the soil-land potential and is related to regional economic factors. Due to this, an explanation of the expansion of crop areas both in the West Kazakhstan, and in other regions of Kazakhstan should be looked for in clustering of agricultural production. Some of the clusters have formed around the big cities, mainly regional centers, where from their expansion starts under a favorable economic environment for agricultural raw materials. Other clusters are formed within the areas of new development (newly built highways, the centers of the mining industry). They are, generally, short-lived and their development is mainly determined by the large public investments in specialized spheres (industry, transport). It can be explained by clustering sometimes strange geographic processes, when the territories with a favorable resource potential turn out to be the depression regions with endangered settlements, large arrays of fallow lands and with the regenerating number of species.

It should be stated that the processes of economic use of border territories, apparently have a pulsating character. In some cases there is a plowing of large arrays up to the border. But at the same time the traces of former "ecologization" still remain - in the form of large colonies of marmots, little bustard nests, fragments of feather-grass communities on old virgin and fallow lands. These include Zelenovsky district of the West Kazakhstan. On the contrary, in Chingirlau district of West Kazakhstan a "holdout" of the economic development zone from the border is observed, where the big settlements, such as Otradnoe village, turned out to be abandoned and unpromising.

High level of plowing is not always determined by arable capability of land, soil and environmental condition of which is characterized by less than 20 points of bonitet. The most prominent examples are Krasnovsky and Yanvartsevsky rural districts of Zelenovsky region; Pugachev rural district of Burlin region. Thus, the lands, which need the restoration of fertility level, are involved in the crop rotation.

The current structure of agricultural lands of the West Kazakhstan region has an unbalanced character due to the hypertrophied high plowing level in Priuralie regions (Zelenovsky and Taskalinsky). At the same time in Burlin, Terektinsky and Chingirlau regions, despite the availability of pretty arable lands is quite the contrary - the availability of large fallow arrays is observed. As it was already mentioned, the reason for this is mainly destructive impact of gas industry towards the agricultural production. Thus, there is a disbalance between the regions, really overloaded with crop areas within the which an ecologically crisis situation is being developed, and by regions, where the recovery dynamics of natural geosystems is observed. Large reserves of lands reserve and special land fund in Chingirlau and Syrym regions can be used for the formation of large grassland nature reserves, with an area of 20,000 ha and 35,000 ha, which will be 5% and 5.5% of the reserve land fund in each of these regions.

Sources of the seed material for the creation of the wild steppe flora nurseries are the zonal prairie reference sites, revealed on the West Kazakhstan territory. As a result of studies, 49 standard etalons of steppe ecosystems have been distinguished on the West Kazakhstan area by K.M. Akhmedenov [26, 27] together with the Institute of Steppe of Ural Branch of the Russian Academy of Sciences in 1998, 2001-2013, of which 46 etalons have been studied on agricultural lands, 3 etalons - on the military ground.

Secondary prairie sites, formed on the place of the derived from crop rotation arable land, are in various stages of recovery.

In this regard, the main criteria (based on common methodic approaches and recommendations) [28] in the choice of steppe sites, promising to use them as a seed fund of steppe plants, for expanding the natural reserve fund of the region, and for distinguishing them as key botanic areas, were:

1. Coverage of a maximally large territory of the prairie zone of West Kazakhstan region;

2. Availability of large enough arrays (not less than 200 ha) on the wild and recovered prairies, with a high level of biodiversity, typical coenotic structure, and with the fullness of plant complexes;

As a result, during field research in 2013 the current state of the steppe vegetation of 10 sites have been identified and studied. Their location and names are shown on Figure 1.

Areas that to the greatest extent reflect the typical zonal features of the soil cover and biota under the upland terrain conditions, and characterized by deep groundwater occurrence, the lack of significant washout and the overwash of mineral matter can be referred to zonal prairie etalons. The role of prairie etalons, as the sources of expansion of titular steppe biological objects allows considering them as regional cores of prairie self-rehabilitation. The availability of such cores contributes to the self-starting of spontaneous prairie replication processes by their distribution on a deposit.

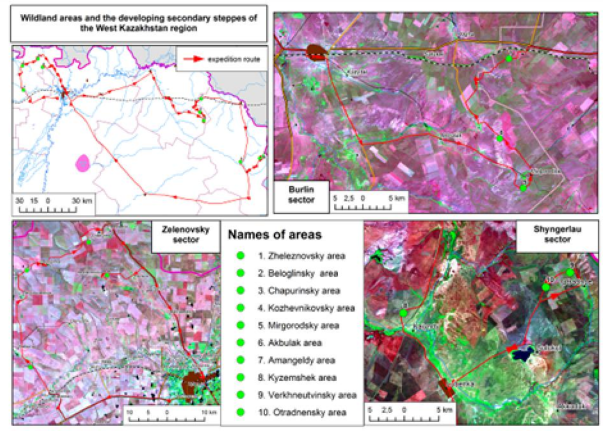

Figure 1 – Wild land areas and the developing secondary steppes of the West Kazakhstan region

Further, the deposit became a secondary source of prairie candling as it was recovered. The width and configuration of the influence zone of prairie etalons shall be defined by wind diagram. As part of the carried out research we have once again proved that with the availability of certain, previously defined favorable factors system an accelerated recovery of deposit lands and a peculiar Lessing-feather grass "blitzkrieg" are observed. According to the initial data, including cartographic ones, the formation process of secondary feather-grass steppes may pass 5-8 years, which is 4-5 times faster than the traditional.

The value of prairie etalons in the formation of sustainable steppe management consists in the initiating of recovery processes through the feather self-seeding, which gives the prairie etalons the functions of territorial ecological cores.

The recovery process of the zonal prairie vegetation consists in the building of the deposits system around the steppe etalon that is on various stages of seral dynamics and plays the role of ecotones. Thus, among the environmental cores the active and passive ones are distinguished. The first (“core of pressure”) have movable boundaries and are capable of self-expansion, providing a restorative and/or stabilizing effect on the natural processes beyond their borders, for example, increasing the thickness of the humus horizon in soil or reducing intensive erosion processes and planar flush. The steppe etalons were referred to those ones. Passive environmental cores (“cores of presence”) have clear boundaries and almost do not affect the surrounding territory.

Geo-botanical description of one of the etalon sites - Kozhevnikovsky steppe is given below.

The Kozhevnikovsky steppe site is located near the Kozhevnikovo village of Zelenovsky district of West Kazakhstan. Kozhevnikovsky steppe (area of 400 ha) is the site of the recovered secondary steppe and is the former meadow plot of Kozhevnikovo village. During the last decades this area is not used as meadow land. Preservation of this site and acceptance as the steppe etalon is also associated with the peculiarities of its location. It is located in an area surrounded with a forest on the north side, with a dirt road from the west side, and with a power line and a pipeline from the south side; the eastern part of the plot ends with ravine. The major area of Kozhevnikovsky steppe territory is occupied by the herb-wheat grass and the lessing-feather grass communities, where the main role is played by cereals: *Agropyron cristatum, A. fragile (Roth), Stipa lessingiana, Festuca valesiaca* and prairie herbs. The total projective cover of grass stand - 90-95%. Flora of the site was studied by the route surveys method in the summer 2013. Plants were identified according to the field guide of different authors.

We identified 60 plant species belonging to 51 genus and 16 families [22-25]. The ratio of the large taxonomic groups has showed that the largest number of species belong to the class of *Magnoliopsida* (48 species of 80%). *Compositae (Asteraceae*) is the largest by number flora species in 16 families (30.0% of the total number of families). This includes 18 species, and then a *Gramineae (Poaceae)* family goes – 10 species (16.6%), and also 5 *Labiatae* species (8.3%).

Environmental analysis of vegetation has showed that in relation to the moisture among the flora vegetation of the studied area, the most numerous environmental group were xerophytes -19 species (31.6%). On the second place are the xeromesophytes and mesoxerophytes - by 13 species (21.6%); on the third place – mesophytes -12 species (20.0%), evkserophytes - 3 species (5.2%).

Analysis of the life forms of the investigated area as per the system of I.G. Serebriakov has identified 17 life forms [22]. The overwhelming majority of plants – are the redivive of 45 species (75.0%). Much of the plant accounts for biennials of 5 species (8.3%). Least of all speces account for dwarf semishrubs - 4 species (6.3%), subshrubs and annual plants – by 3 species (5.2%). Among the redivives thirteen groups show up: taproot plants- 18 species (30.0%), creeping-rooted – 6 species (10.0%), long-creeping and short-creeping, by 4 species (6.3%), solid sod-shaped, bunch-grass and perennial monocarpic– by 2 species or 3.3%; the others – by one specie or 1.6%. Biomorphological analysis as per the system of Kh.K. Raunkier has showed that more than half of all plant species – are the hemicryptophytes - 52 species (85.3%). Many of the plants account for chamephytes – 6 species (10.0%), therophytes – 2 species or 3.3%, geophytes – 1specie or 1.4% [23].

Geographical element has showed that more than half of all plant species - pontic - 13 species (21.6%). A significant part of plants accounts for eurasian - 12 species (20.0%), old-mediterranean and euro-siberian (7 species or 11.6%); mediterranean (6 species or 10.0%); Holarctic (4 species or 6.3%); East European-Kazakh, Pontic-Zavolzhsky-Kazakh and European – by 2 species or 3.3%, and the rest by one specie or 1.4%, [25].

As is evident from the foregoing, the unique flora of this steppe area needs protection and is an excellent source for the gathering of planting seed fund when creating a nurseries of the wild steppe flora for the rehabilitation of steppe biodiversity.

4. Conclusions. 10 sectors of zonal steppe have been revealed and described on the investigated territory. The vegetation of each sector has been characterized. In the species composition of summer flora of the investigated sectors 151 species of vascular plants have been ed. For each site there has been identified the availability of rare and declining species. The analysis of the flora has been carried out from the standpoint of the evaluation of its botanical-geographic specificity, the availability of endemic species and other valuable species, sozological capacity; their seeds have been collected also.

Degree of development of the secondary steppes on deposits has a rather large value for the preservation and restoration of prairie ecosystems than the area of deposits, as the secondary steppes determine the value of agricultural lands both for the adaptive animal breeding and for the territorial protection of steppes. The best conditions for the development and a long-term existence of secondary steppes are on those lands that are being free of plowing for a long time. In this regard, we consider it inappropriate to return the unused arable land to the arable circle. First of all, it concerns the relatively fertile lands that are losing their demand, and where there are the processes of self-rehabilitation of rare and declining species. Therefore, a principal agreement and the relevant amendment of the environmental and land legislation are required.

We have distinguished the most valuable, with respect to environment, sectors of fully formed secondary steppes. A number of areas have been distinguished, on which with the different degree of intensity the formation process of secondary steppes is going on, which is reflected in our grading assessment. The distinguished by us the plots of virgin and secondary steppes are of particular environmental interest for the establishment of trans-border steppe natural areas of preferential protection. Observations made during the research allow us to supplement the existing ideas about the possible mechanisms of formation of Holocene steppe communities at the beginning of modern interglacial phase. The results of this study allow us to assume that Lessing feather-grass at the beginning of the modern interglacial phase could play the role of the pioneer specie in the initial formation of the Holocene steppe ecosystems in the West Kazakhstan region.

Due to the severity of the issue on the lands reservation for the development of system of the protected areas and for the formation of regional ecological networks in the steppe zone, the problem of forecasting the success of deposits demutation should be solved in the context of theory and practice. It is especially important, even now, to develop the methodology and techniques of the steppe vegetation remote sensing and the identification of “promising” deposits. Some positive results have already been obtained in the framework of one of our project’s goals, related to the identification of remaining sectors of steppe vegetation. The accumulated knowledge of the secondary succession of steppe vegetation allows using it to justify the expansion of the area of the protected territories, to identify new promising (with regard to the formation of close to climax) steppe sectors, to plan the measures for saving a steppe biodiversity and rare plants and animals species, and for the ecological restoration of disturbed ecosystems and stimulating of demutation of deposits vegetation.

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Corresponding Author:
Dr.Sergaliev, West Kazakhstan Agrarian Technical University named of Zhangir Khan, Zhangir Khan Street 51, 090009, Uralsk, Republic of Kazakhstan.

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