Monitoring researches of steppe nature management on the example of Orenburgskaya oblast: peculiarities, dynamics, prospects

I G Yakovlev

Institute of Steppe of the Ural Branch of the Russian Academy of Sciences, Orenburg
Russia

E-mail: russo-turisto01@mail.ru

Abstract. One of the urgent problems of current steppe land use is forming the unclaimed and non-demanded land fund and the chaotic, periodically fragmentary use of agricultural lands in the steppe zone. These processes demand regular monitoring to track positive or negative dynamics of impact on steppe ecosystems, agricultural production and predict variants of the development. Practically all actual problems of nature management in the region is closely interconnected: plowing and abandoning of croplands, low productivity, climate aridization, overgrazing or undergrazing of livestock and degradation of the soil-vegetation cover, bushing, and formation of wild grasses' fallows, activation of steppe fires, the dynamics of wildlife and change of hunting resources' amount, depopulation in the rural areas, exploitation of natural resources' deposits – all influence on the formation the current view of the steppe zone. Actual problems of land use in the steppe zone have been examined. A comparative analysis concerning a change of the agroecological situation in the steppe region has been conducted in monitoring research for more than ten years. Despite the total recession of agricultural production in comparison with the 1990-s, the program of closedown and transfer of low-productive croplands in mowing and grazing lands was not realized, land resources continue to be exhausted, crop rotation was broken, technical crops' acreage increases, particularly sunflower, and fertilizers are not practically added. Simultaneously, reserves to restore steppe ecosystems have remained at the expense of seed-stocks in inarable lands, ravines, gullies, hills' slopes. A correct approach to management and maintenance of the balance in land use promotes harmonic development and the use of agro-resources in the region's steppe zone.

1. Introduction

The formation of a few-demand land fund has happened in agrolandscapes of the steppe zone since the 1990-s. A periodical change of areas cultivated and little-used in agriculture is noticed in steppe land tenure.

Ongoing annual field expedition studies of the steppe zone regions, including Orenburgskaya oblast, promote conducting detailed monitoring of changes in agrolandscapes' structure. Based on studies conducted in the areas of the steppe zone [1-3], an analysis of received field data together with an analysis of statistical materials and satellite images accessible for everyday use promote to track processes of changing in the structure of lands, cultivated areas abandonment and repeated involvement them in an agricultural turnover.

We have studied steppe areas in different regions of Russia and the Republic of Kazakhstan for the last few years. Detailed situational monitoring of a state and use of agricultural lands in other parts of
Orenburgskaya oblast was conducted in 2020 (Figure 1). Key territories of the study were steppe post-virgin land's regions: Pervomayskiy in the west of the oblast, Sol'-Iletskiy, Orenburgskiy, Belyaevskiy in the central part, Dombarovskiy, Yasenskiy, and Svetlinskiy in the east of the oblast, as well as areas belonging to Orenburgskiy and Orskiy urban districts.

Figure 1. The region of the research and routing points of the study.

2. Materials and Methods
The principal methods of the study were field expedition, analytical, cartographic. A methodology of expedition work consisted of field inspection of plots of lands of agricultural designation with the fixation of an actual state of the use of the different plots (cultivated fields and a type of crops, virgin and secondary steppe plots and their quality, pastures, and hayfields, etc.) using NextGIS Mobile Software. When possible, we entered attributive data for the previous periods of the use or compared it with already existing data received during the earlier studies. The following received data on the land use was compared with information taken using common accessible Landsat images for 1989-2020. Also, we defined areas with potential plots of fallows, secondary steppes, and massifs of active land use in plant growing using analysis of satellite images and critical points on the country and plotted them on a cartographical base with the help of ArcMap.

3. Results and Discussion
The main challenges of steppe land use are connected, in the first line, with the unreasonable approach to agricultural lands uses: without accounting of their characteristics and possible fertility with the following their abandonment, irrational use of mowing and grazing areas, steppe fires, bushing of the site, change of hunting resources amount, annual dynamics of steppe fauna's representatives. These processes are closely connected with natural changes, socio-economic aspects, and anthropogenic impact.

Remained virgin and restored secondary steppes represent a unique nature conservation value in the steppe region as they are unique steppe refugia. They can mostly be met within the Orenburg-Kazakhstan transboundary area; this part of the steppe zone considerably differs from Russia's...
westerner and easterner territories and the Russian-Kazakhstan border zone where extensive land plowing happens. In Orenburgskaya oblast, thank broken relief, a gully-ravine network, hills' slopes, natural conditions are formed to conserve the landscape-biological diversity, and seed-stocks of steppe vegetation that promotes rapid secondary restoration of steppe ecosystems on abandoned and little-used lands. The positive dynamics of title species of steppe flora and fauna are noticed, and these areas can serve as native pastures.

The majority of fallow and mowing and grazing plots or lands suitable for these purposes on the public cadastre map being in open access, is listed as "lands of agricultural designations" with permitted use "for agricultural production" or "for placement of objects of agricultural designation and agricultural lands." On the one hand, this regulation opens a vast specter of opportunities for such plots' use in agriculture. Still, in practice, it leads to the fact that fallow plots formed on the former arable areas can be used only as cultivated fields. Permitted use was worked out more detail only for few fallows, for example, several plots of a so-called "Gorodishchenskiy" fallow (a secondary-steppe massif) situated to south from Gorodishche village and belonging to the Orenburg urban district – "lands of agricultural designation suitable for plowed areas, hayfields, pastures, occupied by fallows, long-time plantings, in-house roads, communications, forest plantations purposed to protect lands from negative (harmful) environmental and anthropogenic phenomena, as well as water objects purposed to secure intraeconomic activity, for agricultural use (plant growing) (group 1, attachment 1 to the resolution of the Government of Orenburgskaya oblast from 13.10.2011 1003-p "On the statement of results of the state cadastre assessment of lands of agricultural designations in Orenburgskaya oblast").

It should be noted that plots of arable lands, virgin and secondary steppes, fallows, and mowing and grazing grounds with a not fixed category of use are often met on the public cadastre map. We know from experience of expedition studies that arable lands or uneven-aged fallows are located on such plots.

As a rule, agricultural production support directs to the development of extensive land use that supplies the production growth at the expense of crop areas increase. The only reserve to such expansion of the broadening is uneven-aged fallow lands, many of which represent themselves secondary steppe massifs. Such massifs were formed in many post-virgin land's regions after the cessation of land use in the 1990-2000-s. Periodical introduction of such areas into the arable turnover put a threat of subsequent plowing of these massifs, which are often low-productive from the harvest of various crops. Simultaneously, they can be used as native hayfields and pastures and promote the livestock sector's development and local habitats of steppe flora and fauna.

In field studies, we discovered very rapid self-restoration of steppe vegetation on a speed of restoration similar to the technology of agrosteppes [4] during 8-10 years under the good seed-stocks in closeness. Such seed-stocks remain in secondary and fallow lands for the post-virgin lands' regions of Orenburgskaya oblast and under their plowing pastures, and inarable lands (ravines, gullies, slopes) serve as grass seeds. We should note here an impact of anthropogenic factors, including pyrogenic. Many researchers ascertain that steppe vegetation restoration to secondary steppes or secondary virgin lands has taken from 30 to 60 years and more [5, 6]. Accumulation of above-ground phytomass on unused or little-used lands is connected with an increase of unclaimed lands that grows a risk of steppe fires [7]. But together with a negative impact on steppe ecosystems, in particular on wildlife, we can note a positive effect as burning of dry steppe wild grasses on unused lands with the following renovation of grass stand. Under such conditions, steppe vegetation begins to dominate in the second – the third year after arable lands' abandonment. It is worth mentioning that seats of uneven-aged fallow lands' plowing emerge along with steppe ecosystems restoration. We found massifs that were plowed in the period of the observations for plots. A wavy vibration of plowing areas and self-restoration has been noticed for 30 years in all key regions where monitoring was realized. The study's principal territories were municipal districts in the steppe regions of Orenburgskaya oblast: Pervomayskiy, Dombarovskiy, Yasenskiy, Svetlinskiy. The districts' choice was based on positive processes of steppe ecosystems' restoration and the potential introduction of prospective restored areas into nature conservation activity.
The Pervomayskiy district. We examined the southern part of the region with the square more than 150 thousand ha and 140 field-routing points (figure 1) and singled out three critical land-use sectors only in this part. Most of this sector has not practically been used for the last ten years. Active land reclamation is concentrated on Uralskiy settlement's outskirts, where agricultural holding companies develop lands and cultivated land areas increase. Land use in agriculture has a local character, and secondary steppe ecosystems restore themselves. Several sites, as a rule, are remote and hard-to-reach; they were abandoned from the beginning of the 1990-s. The total area of croplands in the region has reduced from 242 thousand ha in 1990 to 124 thousand ha in 2019 (figure 2), [8-10]. Simultaneously, massifs of secondary steppes are continuous in the southern part of the region, creating an original environmental corridor to restore steppe ecosystems and reduce anthropogenic impact. Repeated introduction of lands into the cultivated turnover is noticed in the last years. As the studies show, lands closest to roads and settlements are introduced into the turnover, in the first line, after 8-10 years of disuse. In the analysis of satellite images and online resources of NDVI indicator's detection based on Landsat and Sentinel satellites, in some plots, we could not manage to identify dates of fallow's plowing with the accuracy to several days.

Figure 2. The dynamics of croplands in key districts of the study (according to official statistical data) [8-10].

* - no official data for 1990-1995 and for 2005-2012
** - no official data for 2016-2019 about the Federal regulation of 29.11.2007 № 282-FL.

Such a situation is characteristic for other Central Orenburzhie, with stages of reducing a portion of arable lands and restoration of steppe ecosystems. The sharpest decrease in croplands happened after the 1990-s, the total trend to decrease was noticed in the following years. Still, since 2000, areas of arable lands have reduced slower and even periodically increased. The dynamics of changing areas of plowing and abandonment of lands become smoother. It is connected with the various natural and socio-economic processes, including state programs concerning support of agriculture, agro-holding companies' activity, droughts influence, precipitation, etc. Active introduction of earlier abandoned lands into the agricultural turnover is noticed in the eastern part of the Ilekskiy district and the Sol'-Iletskiy urban community since 2018. In this period, the unique feature of farming is the division of large fields into tiny share plots and their following random use or disused, leading to a mosaic structure of agricultural areas.
The Svetlinskiy district. In the expeditions of 2020, we examined in detail the south-east and north-east parts of the area in more than 200 routing points (figure 1).

According to the official statistics [8-10], arable lands occupy 289.5 thousand ha in the district – it is more than 50% of the region's total area. However, an actual annually cultivated area is about 145-165 thousand ha (figure 2).

At present, most of the territory has a state of fallows with winter cress and wild rye. Such species composition was probably formed due to fires of previous years, partly provoked by wild grass stages of fallows and their disused and climatic conditions for the last years with the frequent summer droughts and little precipitation in the winter.

In the southern-east part of the district, a little cultivated massif with crops is noticed; it is confined to a migration corridor of hunting species of avifauna and serves as a place of additional food. Such "grain" corridors are widely spread in the steppe zone in the south of West Siberia, particularly in Omskaya oblast in the Steppe reserve and adjacent territories. In the district's northern-east sector, arable lands are incomplete; a considerable part of the land fund has a state of fallows formed, mainly after 2010. Simultaneously, three peak periods of agriculture abandonment are noticed – in 1999, 2003, and 2013 (figure 2) when the areas of cultivated fields considerably reduced. The gradual growth of arable lands was seen since 2015 at the expense of repeated introduction of fallow lands into the turnover. In Kazakhstan's neighboring regions of the Aytekibiyskiy district, the situation considerably differs, and many fallow lands entered into the turnover after 2008-2009. The species' composition of fallows is represented by Lessing feather grass, wheatgrass, forbs grassy communities, and, partly, used as hayfields. Rocket cress-wild rye variants of fallows are located in post-pyrogenic sites; these fallows were occupied by wild grass before. This part of the district is characterized by the repeated introduction of fallows into the turnover and extension of already used arable lands to the west from the Svetliy-Tobolbiskiy highway. Large colonies of marmot were formed during the disused years, and according to answering data, other steppe species, including saiga, became to be met more frequently. Thus, based on the nature conservation prospects, it is necessary to revise arable land's chaotic introduction into the turnover and subsequent abandonment.

The Yasnenskiy urban district (the Yasnenskiy district till 2016). In 2020, we examined the eastern part of the region in more than 600 routing points. The fundamental character of land use is similar to that in the Svetlinskiy district. There are two stages of reduction of arable lands' portion and fallows formation in 1990. As a result, by 1999, the area of cultivated fields reduced two times compared to 1990. These lands' sites reduced to 15-20% in the 2000-s [8-10]. At present, there are wavy dynamics with a slight variation of croplands (figure 2). Repeated introduction of fallows into the turnover activated in 2018-2020. Simultaneously, in the district's southern-east sector, we can find plots with young fallows (2-3 years) where steppe vegetation becomes formed. The interesting feature of such massifs is the presence of fragmentary arable sites inside. Their presence can be caused by a share system of farming, or they can be unaccounted plots introduced into the turnover. We met such plots in Kazakhstan; they, as a rule, are situated at a considerable distance from settlements and cannot be accounted for in the statistics.

These plots are used mainly as hayfields and pastures. Fragmentary plots are characterized by various periods of arable disused and uneven-aged fallows different on species' diversity due to nonsimultaneous stages of the abandonment from 1990 to 2020. Due to seed-funds on old-aged fallows and in a gully-ravine network, steppe vegetation rapidly restores itself. Secondary steppes plots become to be formed already in 8-10 years of disuse.

Analyzing available Landsat images, we identified prospective plots for the formation of fallow massifs and secondary steppes in the district's northern-west sector surrounded by the Kumak River from the west and south, the Adamovskiy district in the north, the Komarovo-Adamovka highway from the east. Fragmentary massifs of fallows are formed to the south and west of Elenovka village.

The Dombarovskiy district. In the expedition research of 2020, we examined the western part of the region bounded by the Or River and the border with Kazakhstan. There is fragmentariness in the formation of fallow massifs. As a rule, they are located in the most remote plots and the transboundary
Fallow massifs are partly used as mowing and grazing lands that promote fallows' formation missing the wild grass stage and simultaneously sparing use of agricultural lands. By 2018, the total area of plowing reduced by 40-50% compared to 1990, but there are three stages of the dynamics of a change of arable lands' sites. The period 1990-1999 showed an intensive annual reduction of arable lands' areas and increase of fallows. The area of arable lands decreased more than 50% from 106 thousand ha in 1990 to 47 thousand ha in 1999.

Later, there was a trend to the slow insignificant increase of arable land areas and stabilized land use until 2012. After that, a gradual reduction of the cultivated regions happened. A minor annual variation of croplands and fallows' areas promoted rational use of more fertile lands in plant growing and the formation and use of fallow massifs and secondary steppes as mowing and grazing lands. We registered such an application all-around in the steppe zone of Orenburzhie and some transboundary regions of Kazakhstan. Formed fallows practically restored themselves to the stage of secondary steppes [11, 12]. Sparing use of such plots in the economy promotes to increase in the speed of fallows and secondary steppes' formation at the expense of shortening the wild grass stage. Shortening of the wild grass stage in the fallow's construction is possible due to grasping of such sites by wheatgrass, Lucerne [13].

Dynamic land use processes are noticed within all studied territory, especially the introduction of abandoned and little-used lands into the turnover. The increasing legislative pressure causes it in the field of designative use of lands and the practically total absence of opportunities to transfer agricultural lands from arable to mowing and grazing areas and vice versa.

Simultaneously, such draft laws do not consider the quality of lands and the opportunity of their rational use as arable lands.

4. Conclusion
Reduction of the rural population and cultivated fields, low productivity, climate aridization promote the unclaimed and non-demanded land fund in the steppe zone of the oblast. There is a total trend towards increasing arable lands at the expense of introducing fallow lands abandoned in various periods from 1990 to 2020 into the turnover. Since 2013-2014, the arable areas were stabilized; there was not intense vibration of its dynamics; there was a gradual growth in some regions.

In its turn, a presence of agricultural inarable lands as a ravine-gully network, stony plots, large pastures, hills' slopes, etc. bordering with croplands promotes to rapidly restore steppe ecosystems due to a seed fund on such plots as opposite to steppes of other regions where relief is less broken. A problem concerning unclaimed land fund's use as mowing and grazing lands is more rational. Still, the question arises about types of permitted lands' use inside the category "lands of agricultural designations." Also, the Federal law of 3 June 2016 N 354-ФЗ regulating confiscation of disused agricultural lands influences the randomness of land use and active introduction of grounds into the arable turnover despite their quality characteristics, including soil properties.

Field studies proved that non-demanded land funds and forming secondary steppes were a significant space to restore title species of steppe such as marmot, little bustard, saiga, Lessing feather grass (Stipa lessingiana), Stipa zalesskii. Such plots have a considerable nature conservation value as habitats of the mentioned species and have economic importance as hayfields. Use of these areas as mowing and grazing lands will promote the application of grounds in farming; fallows will miss the wild grass stage at the expense of biomass' removal that will considerably reduce the risk of fire development in this territory protect wildlife in the steppes.

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