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Environmental and landscape significance of steppe mega-projects

Levykin S.V.¹, Chibilev A.A.¹, Gulyanov Yu.A.¹, Silantieva M.M.², Kazachkov G.V.¹, Yakovlev I.G.¹

¹*Institute of Steppe, Ural Branch of the Russian Academy of Sciences
Pionerskaya St. 11, Orenburg, 460000, Russian Federation. E-mail: orensteppe@mail.ru*

²*Altai State University
Lenin St. 61, Barnaul, 656049, Russian Federation. E-mail: msilan@mail.ru*

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For the development of fundamental bases of strategy of rational steppe land use and its realization we analyzed the most significant steppe megaprojects - "Stalin's plan to transform the nature of forest steppe and steppe", the Virgin Lands Campaign of 1954-1963, Agrarian Reform of the 1990s. Both specific consequences of each project and their cumulative impact determining the modern appearance of steppe landscapes and their agro-ecological problems are established. The Altai Territory, primarily the Kulunda steppe, is considered a special arena of megaprojects in the steppes of Siberia, bearing all the features of the old-developed region, where the most positive effect of these projects was achieved. The interrelation between the main problems of modern steppe land use and the results of the considered megaprojects has been presented. The main problems of agrarian steppe land use have been revealed. Taking into account modern tendencies of development of agrarian and industrial complex three most probable scenarios of development of steppe agriculture landscapes are considered. They are neo-wildland, stagnation, and optimization scenario with adaptation of agricultural lands structure to natural-climatic conditions and requirements of market conditions, with concentration of intensive agriculture on the best lands and transformation of low-productive lands into long-term managed steppe fodder lands of adaptive animal husbandry.

Key words: Steppe agriculture landscape; Megaproject; Stalin's plan; Virgin Lands Campaign (1954-1963); Kulunda; Strategy of rational steppe land use; National project.

Introduction

In modern Russia, there is a project style of development, which became an alternative to the Soviet five-year plans and the spontaneity of the 1990s. Russia and Kazakhstan continue to implement a number of agricultural projects in the form of national, mega-project-based projects aimed at the development of large agricultural holdings, primarily agricultural holdings, and support for the farmers' movement. These projects have led to a significant revival of agricultural production and restoration of agriculture, including through the redevelopment of fallow lands in the steppe zone (Chibilev et al., 2018; Brinkert et al., 2016; Kamp et al., 2016; Petrick et al., 2014; Kraemer et al., 2015). In our view, such projects should pay more attention to agro-ecological problems, first of all, the maintenance of soil fertility and solving the problem of survival of steppe ecosystems, including those on agricultural land. The purpose of this study was to identify the main causes and factors that determined the current state and main agro-ecological problems of steppe agro-landscapes. The main solvable tasks were: determination of the most significant stages of transformation of steppe landscapes and their interrelationship with state projects; identification of the main agro-ecological problems of steppe regions of Russia; development of the fundamental principles of the strategy of rational steppe land use.

The best model object for studying the consequences of large state projects are the steppes of Northern Eurasia and the prairie of North America, this work is limited to the Eurasian steppes. One of the first global steppe projects was a nomadic project of nomadic Turkic peoples on the use of steppes for pasture cattle breeding. This, on the one hand, contributed to the preservation of steppes in their virgin form, the development of close interrelationships between steppe and nomadic crops, but on the other hand, it caused low population density, risks associated with weather events and constant movements, which provoked waves of migration, including militant ones. Later on, the steppe zone of Eurasia experienced a number of development projects, including particularly large ones with the support of the state and with the participation of millions of people. The latter include Soviet agrarian and social projects that defined the landscape, the structure of lands and the problems of modern steppes. Achieving their consequences is necessary for the development of the fundamental principles of the concept of rational steppe land use, which can become the scientific basis of the modern national steppe project.

Methods

Logical methods, methods of comparative-historical and comparative-typological, statistical analysis, cartographic methods, methods of field landscape studies and remote sensing, geobotanical methods are used.

Nomadic economy from the XVIII century began to be replaced by the priority of agricultural use, which was realized by a number of stages and projects. Despite progressive agricultural ideas that emerged in the 18th century (Kompanejec, 1971; Seeders and Custodians, 1992), agriculture developed extensively, steadily expanding in the direction of the steppe southeast. Having passed such stages and projects as assistance to the development of the Black Sea steppes by climatic migrants from Europe, a number of "wheat fever" grain exports, the abolition of serfdom, resettlement movement, Stolypin's agrarian reform - steppe farming reached

the boundaries of about 100 million hectares of arable land with almost complete plowing of European steppes and selective plowing of the most fertile black earths of Siberia.

In our opinion, the Stolypin agrarian reform was the first to have the main features of the state megaproject, but since it did not provide for the total plowing of steppes, creation of a forest reclamation framework and other difficult transformations of steppes, and was not fully implemented, we have no opportunity to objectively consider its landscape consequences, especially later on the arena of implementation of this reform was imposed much more powerful and large-scale projects that fully meet the criteria of the megaproject. The October Revolution and the creation of the USSR itself became a basic agrarian and social mega-project that made it possible to concentrate around the state and mobilize huge material and human resources in the future. In general, the Soviet system, despite its own criticism of Malthusianism, had to develop the same extensive way of farming, while attempting to develop the steppe agro-landscapes in the fight against drought. A characteristic feature of the Soviet era were particularly large projects of socio-economic development, including agricultural development, which over the years were the main priority of the entire country, involving millions of people and covering global areas. We propose such projects, first of all of agrarian and social orientation, to consider as megaprojects, the main features of which are the term of implementation of more than 5 years, the number of people involved is not less than one million people, not less than half of which are young mobile participants, the area involved is not less than 10 million hectares. Our understanding of the scale and significance of the megaproject is close to S. Zhuravlyov's views on the virgin campaign of 1954-1963, which is considered as a set of measures, the scale and consequences of which can be compared only with the famous Stolypin agrarian reform in pre-revolutionary Russia (Zhuravlyov, 2018).

The retreating catastrophic steppe drought of the end of the XIX century, which stirred up scientific and cultural thought of Russia, returned to the 1930s, actually after the completion of mass collectivization in the USSR. The new agrarian system faced the problem of steppe droughts, the struggle against which began in the second half of the 1930s (On measures of provision..., 1938), but only after the Second World War has acquired the scale of a national megaproject known as the "Stalin's plan of nature transformation" and initiated by the Resolution of the Council of Ministers of the USSR and the Central Committee of the All-Union Communist Party of Bolsheviks (Bolsheviks) of 20.10.1948 "On the plan of sheltering forest plantations, the introduction of grassland crop rotations..." (hereinafter referred to as the Stalin plan) (On the plan of the field defenders..., 1948). The scientific core was the doctrine of Dokuchaev-Kostychev-Williams, which justified a set of structural and agrotechnical methods aimed at reducing climatic and agro-ecological risks of steppe land use associated with high plowing, disappearance of forests and reduction of water components in landscapes. The megaproject was focused on the forest-steppe and steppe of the European part of the USSR, including the Orenburg region. Till 1965 it was planned to create the world's largest system of state forest belts with the length of more than 5 thousand km and the area of 118 thousand hectares and to completely cover the fields of crop rotations and sowing of perennial grasses by the network of forest belts on 5.7 million hectares, for which purpose to create 570 forest protection stations; to construct more than 44000 ponds; to introduce a grass-farming system of farming with allocation of a quarter of arable land for perennial grasses; to increase the culture of farming.

In fact, it was a question of creating a unique steppe forest reclamation framework, the example of which was followed by a number of countries. Implementation of the Stalin plan started in 1949 with the scale and enthusiasm worthy of a megaproject, by 1953 about of 2.3 million hectares of forest belts were created, perennial grasses occupied a quarter of the arable land, thousands of ponds and reservoirs were created. This megaproject, building an agro-ecological framework on the basis of watering and forest reclamation, pushed steppe farming on an intensive path of development (Levykin et al., 2018).

The Stalin plan was actually curtailed after the change of the political leadership of the USSR: the herbal system was sharply criticized, up to the point of ridicule in the magazine *Crocodile*, and was actually banned, forest reclamation stations are being liquidated, and care for the created forest crops is being stopped. By the end of 1956, no more than 0.65 million hectares of 2.3 million hectares of planted land had survived. But the most important thing is that the steppe megaproject in the European part of the USSR was replaced by a new even more ambitious transformation megaproject aimed at plowing new lands in the eastern sector, commonly known as Virgin Land Campaign, which this year turns 65 years old, and its comprehensive assessment - 25 years old. The whole megaproject was the largest in history in terms of the scale and timing of plowing 43 million hectares of virgin and fallow lands, three times greater than its own plan. The leaders in Russia are the Altai Territory (2.9 million ha) and the Orenburg Region (1.8 million ha). Almost all the agro-ecological costs of this project and its role in the catastrophe of the steppes of Northern Eurasia are well known and have been repeatedly discussed.

By the 60th anniversary of Virgin Land Campaign, the contradictory and incredible rapidity of the project implementation and, most importantly, the need to plough low-productive soils over vast areas became clear. We came to the conclusion that it was not a purely agrarian project, but a complex one that solved a number of strategic tasks (Levykin et al., 2015). To study the consequences of this project it is important to have doubts about its ecological and economic efficiency, expressed 10 years later by its main initiator in an interview with the New York Times newspaper dated 23.02.1964, N.S. Khrushchev stated that the former virgin lands subjected to drought and erosion, having fulfilled its mission in a difficult period of development of the USSR, will be transferred to pastures, and efforts to intensify agriculture will be directed to more favorable old-fashioned regions (Einaudi, 1964). However, due to his imminent retirement, not only has there been no structural change in Virgin Land Campaign, but also the addition of an arable wedge of at least 5 million ha of chestnut soils. The consequence of the virgin project was a particularly careful ploughing of the steppe zone with almost complete destruction of zonal steppes on full profile soils. At that time, it was believed that the steppes were irrevocably lost to conservation and science, but the Orenburg school of steppe studies was able to prove the opposite. The state support of the virgin experiment on the Virgin Land Campaign area against the background of growing agroecological and socio-economic problems contributed to the development of another agro-landscape crisis of steppes by the end of the 1980s (Chibilev, 2016; Chibilev et al., 2011).

A special place in the analysis of destinies and consequences of agricultural and social mega-projects is occupied by the Altai Krai, primarily the Kulunda steppe due to special natural conditions (flatness, sandy soils, ribbon pine forests) and the special activity of the Krai development: Since the 18th century, the Altai Territory has been attracting miners, industrialists, peasants and, of course, researchers. Therefore, despite all the remoteness from the historical center of Russia, the region, in our view, had all the features of the ancient development by the middle of XX century and thus represented one of the main enclaves of the old development in Siberia. The special agrarian importance of the Kulunda steppe was expressed in the fact that the "Stalin plan of nature transformation", designed for the European part of the USSR, has affected this area by creating two state wind-breaking forest belts, the beginning of regular work on protective afforestation is considered to be 1928, when 7 hectares of protective forest belts were planted (Diachenko, Zemlyanitsky 1947; Kukis, Gorin, 1973). Forest belts were created mainly from maple ash and yellow acacia (Hichenco, 1934).

In total, more than 60 thousand hectares of forest belts were planted from 1928 to 1951, of which only 26 thousand hectares remained by the end of this period. Since 1953, forest reclamation works, as well as in the country as a whole, have actually been curtailed (Paramonov, Simonenko, 2007). A specific feature of the Kulunda steppe was the resumption of the forest reclamation megaproject, which was interrupted by the Coreline campaign for 10 years. The simultaneous plowing of about 3 million hectares of potentially erosive and dangerous land in 1963 caused a severe wind erosion, the response to which was the active resumption of work on the construction of agro-forestry complex Kulunda. The impetus was the decision taken in 1964 to develop fundamental and applied research on forest reclamation by creating an agro-forestry station on the basis of Kununda state farm lands that suffered the most from erosion (Podgaetsky, 2015). Later, after the Decree of the Central Committee of the Communist Party of the Soviet Union and the Council of Ministers of the USSR "On urgent measures for the protection of soils from wind and water erosion" dated 20.03.1967 (On urgent..., 1967), only in 1968-1975, about 66 thousand hectares of forest belts were planted in the Altai Territory, later up to 2000 - 42 thousand hectares more. In general, for more than 80-year period of forest reclamation works more than 200 thousand hectares of forest belts of various purposes were planted, of which by 2011 about 100 thousand hectares remained, including 86 thousand hectares in the Kulunda steppe. The main results and consequences of forest reclamation in the Altai Krai have been thoroughly studied and highlighted (Paramonov, Simonenko, 2007; Paramonov, 2011; Paramonov, 2016; Podgaetsky, 2015).

In our opinion, it is in the Kununda steppe that a unique steppe forest reclamation framework, which meets all its scientific criteria and principles, was created. A fully completed system of forest belts has been built. This grandiose work, undoubtedly, deserves the status of a monument of forest culture of world importance. However, the problem of further survival of forest crops, especially in a changing climate, requires constant attention, and the future fate of tens of thousands of hectares of steppe lands, freed from the dead forest plantations, requires a scientifically sound decision. It is expected that forestry specialists will advocate the reforestation of these areas and bringing the area of forest plantations to a higher level, but from the point of view of steppe studies a part of this area, especially in the most extreme soil-climatic conditions, should be left for the development of secondary steppe ecosystems, including methods of cultivation and reintroduction of steppe phyto-dominants or the agristeppe method of Dzybov (Dzybov, 2010). Probably, the optimal solution will be a complex one, the substantiation of which parameters requires a separate study. Market reforms of the 1990s began with an even distribution of agricultural land among all rural residents without the right to change the structure of their share. The principle of equity instead of agro-ecological justice consolidated the late Soviet structure of lands, this time by the institution of private ownership. In terms of scale, speed and inconsistency, this reform is in line with the whole project. In the absence of investments instead of scientifically grounded optimization of steppe land use, the spontaneous land use has developed, which caused a collapse of sowing areas, exceeding the scale of ploughing of Virgin Land Campaign in the 1950s. Instead of the class of effective landowners, the low demand and even the lack of demand for part of the land, including the steppe lands, which was imposed on the heritage of the Stalin plan and Virgin Land Campaign, was obtained. Almost at the same time, at the beginning of the reforms, as in 1953, the creation of new forest belts and the maintenance of previously created ones ceased. Later on, for various reasons, the annual loss of forest belts was comparable with the rate and scale of their creation in due time.

Results and Discussion

As a result of a comprehensive assessment of the consequences of agrarian and social megaprojects, we have come to the conclusion that the modern appearance of steppe agro-landscapes of Northern Eurasia, the structure and specialization of agriculture, the entire complex of agro-ecological and social problems are essentially a legacy of three consecutive in time, but mutually exclusive megaprojects that remained unfinished. In the European part of the agroecological framework of the Stalin plan the total plowing of perennial grasses and remnants of virgin lands was superimposed; the Zavolzhsko-Uralsky steppe region, where both the Stalin plan and Virgin Land Campaign were actively implemented, the interpenetrating consequences of both of them are the most pronounced; in the eastern part of the steppe zone the virgin megaproject on which the ideology of forest reclamation was superimposed, set by the previous project, was mainly implemented. In general, two Soviet megaprojects, the Stalin plan and Virgin Land Campaign were aimed at displacing steppe vegetation through forestation in the first case and mass plowing in the second, the land reform of the 1990s, albeit against the plan, but contributed to the spontaneous restoration of steppe vegetation in the thrown fields and degrading elements of the forest-reclamation framework.

According to the aggregate of colossal material resources, labor and energy, these megaprojects were in fact an unprecedented stress for the steppe zone, which brought it out of the long-term equilibrium state in the east and created a whole system of new landscape elements in the Zavolzhsko-Uralsky region and to the west of it. It became essentially a unique experiment in activating the dynamics of steppe landscapes and revealing their regenerative potential, which manifested itself in the implementation of land reform: the forest reclamation framework and part of the arable land were left to their fate, thus giving steppe ecosystems a chance for self-recovery. Despite the rigidity of the experiment, it is necessary to note the opportunity to observe a unique combination of interpenetrating effects of megaprojects, the relevance of the study of which only increases.

It should be noted that these dynamic landscape processes take place against the background of the intensified agro-ecological problems and risks of modern steppe land use, including those caused by the modern style of consumption and new materials. We have made an attempt to identify and systematize these risks and develop proposals for their mitigation (Yakovlev, 2019).

Thus, the study made it possible to generalize the consequences of global steppe megaprojects and to identify the main problems of steppe land use, the most important results of which are presented below in the form of conclusions.

1. Modern steppe landscapes are essentially agro-landscapes, the structure and content of which are the result of three steppe megaprojects: The Stalin plan, the Virgin Lands Campaign and the land reform of the 1990s. The interpenetration of the results of all three megaprojects is most pronounced in the Zavolzhsko-Uralsky region, where all of them were actively implemented.
2. Both Soviet megaprojects were transformational in nature and provided for the replacement of natural vegetation, but the Stalin plan seems less destructive to the steppe than Virgin Land Campaign.
3. The main legacy of the Stalin plan is the grandiose forest reclamation framework, which so far has provided an opportunity to study the adaptation of woody shrub vegetation to the steppe zone, and the main legacy of Virgin Land Campaign and land reform is the unprecedented renewal of steppe grasslands.
4. After the completion of the virgin megaproject, self-rehabilitation of steppes seemed unlikely. In the course of the land reform of the 1990s in the Zavolzhsko-Uralsky region and to the east there was a high restoration potential of steppes, which did not reveal itself to the west of it.
5. The possibility of rapid self-recovery of steppe phytocenoses due to high viability and generative activity of titular steppe plants in young grasses, which return to degraded elements of forest-reclamation frames and abandoned fields, was confirmed

6. Until now, two ideologies of steppe land use remain stable: The water-forest-band idea of agroecological framework inherited from the Stalin plan, and the ideology of maximum possible plowing inherited from the Virgin Lands Campaign. The latter makes the consequences of the Virgin Lands Campaign, reversible because of the regenerative potential of the steppes, difficult to reverse for ideological reasons.

7. The combined effects of mega-projects have spread the applicability of V.V. Dokuchaev ideas about the optimal ratio of agricultural lands to the whole steppe zone and gave them paramount importance.

The above results and conclusions allowed us to offer as a fundamental basis for the strategy of development of steppe and Virgin Land Campaign regions of Russia the author's concept of agroecological steppe framework. It is based on relatively large areas of virgin and actively developing secondary steppes as the main nuclei and ribbon steppe elements of the landscape as corridors (Spatial development..., 2018); they also allowed us to approach the understanding of the purpose and main tasks of continuing research in the main agricultural regions.

In order to achieve a positive result on agroecological development of steppe and Virgin Land Campaign regions of Russia, it is necessary to implement the following strategic measures.

1. State recognition of priorities for solving agro-ecological problems of steppe regions, primarily in the Virgin Land Campaign area with the development of a national project aimed at addressing them. Optimization of the spatial distribution of agriculture and its specialization in all natural zones of the Russian Federation with the priorities of the restoration of arable land in the forest zone, the development of Arctic meadow farming in the tundra, adaptive meat cattle breeding in the Virgin Land Campaign steppe area.

2. To promote adaptation of dry-land cultivation to modern trends in climate change by shifting it from the most problematic areas of the steppe southeast towards the historical center of Russia, where there is a steady increase in bioclimatic potential.

3. By analogy with forest management to conduct a steppe zoning with the allocation of groups of areas of priority steppe land use. The first is the "meat belt", the priority of development of adaptive animal husbandry, carbon sequestration and preservation of ecological reserves of populations of tundra steppes. This group should include the areas of the highest agricultural risk, which we regard as the Virgin Land Campaign area. Elements of the agroecological framework in these areas should get the status similar to that of the first group of forests. The third one is the priority and support of intensive agriculture on the lands that combine adaptability and the highest bioclimatic potential for the steppe zone. The second is the transitional (or variable) combination and varying land use between the first and the third depending on climatic changes and market conditions.

4. Development of land relations with transformation of land relations with transformation not carried out in temporarily managed by the state with the purpose of their modern ecological and economic reassessment with the subsequent transfer of the most productive arable lands on the right of lease to effective owners ready to apply intensive technologies. From low-productive arable lands to form a fund for stabilization and restoration of soil fertility, and use it for the development of adaptive animal husbandry.

5. Initiation of new and updating of previously developed regional projects on agro-ecological optimization of agricultural land structure with identification of low-productive arable lands and their conservation.

6. Legislate the priority of optimizing the structure of steppe land use in the construction of territorial planning schemes. To develop legal mechanisms for inclusion of the steppe framework in these schemes, primarily for the Virgin Land Campaign area.

7. At the state level, to recognize the export of products of extensive agriculture as soil trade. Only farms that successfully apply intensive, including natural-like, agro-technologies, approaching or exceeding the biopotential yield, should be allowed to export agricultural products.

8. Replacement of untied hectare support (in the framework of the WTO) by state support for a unit of output.

9. Introduction of digital technologies in monitoring the condition of land resources and landscape and biological diversity of steppes, and in the main types of steppe land use, primarily in field production.

10. Overcoming the soil-cost ratio of steppe farming, including support for the introduction of technologies to compensate for humus losses, including large-scale breeding of Russian breeds of the California worm.

11. Initiating new and updating existing programs for the development of beef cattle breeding with priority given to the breeding of adaptive livestock breeds and new agricultural species (bison, Siberian red deer).

12. Management and use of locust bioresources through the development and implementation of locust harvesting and processing technologies during outbreaks.

13. Recognition at the national and international levels of the special role of steppes in carbon storage and, accordingly, of the special Russia and Customs Union countries in its implementation. Recognition of the special economic value of the ecological steppe framework nuclei, including as carbon-depositing plantations.

14. Intensification of research on the processing of steppe vegetation into technical fiber, which is in demand in the world markets, and other non-traditional use of steppe plant products

15. Development of steppe rewilding in the form of a system of centers for breeding steppe animals, primarily using the nuclei of the steppe frame.

16. Overcoming prejudices and prejudices towards the steppes. Supporting the development of the steppe component in the "nature garden" style. Spreading the centers with semi-free ways of keeping of steppe animals for the demonstration purposes. Development of steppe agro- and ecotourism.

The fundamental foundations of the strategy and measures are based on the principles of promoting the processes of self-recovery of steppe ecosystems within the framework of targeted management in order to support the most productive stages of development of steppe phytocenoses.

Conclusion

In conclusion, it should be noted that in general, three scenarios of development of the steppe zone in the near future are possible. The first scenario is a neo-virgin land, the restoration of the late Soviet scale of arable land with the suppression of all self-recovery processes. The second is the stagnation one, which is a conservation of the current situation. The third is the adaptation-optimization one, which is being implemented when solving complex steppe problems at the level of a priority national project. In the case of a non-targeted scenario, it is quite possible to activate forest reclamation, but with a more pronounced landscape adaptation of forest crops. For the other two scenarios, we have developed a concept of steppe agroecological framework, primarily for the Virgin Land Campaign territory of the Zavoizhsko-Uralsky region, with the allocation and justification of its main elements and the use of natural technologies in their management. We believe that the most effective means of refining and implementing

the agroecological framework of steppes would be the consistent implementation of the steppe research megaproject and the national project "Steppes of Russia". The latter would serve as a logical continuation of the three previous social and agrarian megaprojects in the direction of creating more productive and sustainable steppe agro-landscapes that preserve the ecological reserve of populations of titular steppe species in a state of high generative activity. In our opinion, the guiding principle of such a project may be to promote the maximum possible and expedient expansion of steppe phytocoenoses into modern agro-landscapes with their rational use as pastures, including for the development of rewilding.

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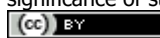
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