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Abstract Among all agrarian-social megaprojects realized in the steppe zone, the Virgin Land [Tselina] (1954-1963) and the Land reform of the 1990s exerted the most considerable influence on the state and properties of current agro-landscapes. It was the projects of opposite orientation which every on its stage set the highest in history pace of the landscape dynamics in the steppe zone. The consistent impact of these megaprojects, one of which practically annihilated steppes, and the other created terms to realize steppe restoration potential, allows considering them in totality as the united experiment of the global scale for revealing and evaluation of steppe self-restoration. Thanks to this experiment in the steppes of Eurasia, new dynamic space – after virgin land was formed. Using new data, including field studies and discovered novel factors, we estimated the Virgin land campaign's consequences and the Land reform. A further fundamental generalization of these megaprojects' effects, landscape, and scientific heritage required developing an adaptation of steppe land use was conducted as a response to climatic and other current challenges.

1. Introduction

The mega-projective approach has historical and geographical preconditions. In Russia, megaprojects' engineering ideas emerged in the XIX century; the realization happened in the Soviet period.

From the point of view of steppe science, we consider agrarian-social megaprojects in the steppe zone among megaprojects from GOERLO (1920-1935) to BAM (1974-1984). Also, we include the post-Soviet Land reform in this row due to touched areas and large-scaled landscape consequences.

The Soviet gigantism and megaprojects as their manifestations are the heritage of the Russian revolutions of the beginning of the XX century when the perception of time and conception of space sharply changed. Historical time was compressed; there was the subjective perception of its acceleration; an urgent want emerged to revise the former value system looking archaic.

Such relation was disseminated inevitably as within the geographical space so in the environment. The hypertrophied desire for changes, the collapse of habitual cliché and patterns, life adaptations gave birth to a sense of "movement of the reality" – an explosive jump from one reality to another. Hence, a principle "the revolution has the start, but does not have the end" emerged. Rephrasing it, we can say that changes have the beginning but do not have the end, implementation of which was the megaprojects [1].

Gigantism and triumph of transformism in the USSR were caused by the largest in the world few-developed, almost unplowed space and resources located within the steppe zone from Trans-Volga to the Ob River. The leader's resolution, possibilities of mobilizing ideology, and mobilization of enormous material and labor resources added historical and geographical preconditions.

Keeping on agricultural expansion to the south-east, riskier than in the XIX century, the USSR as the Russian Empire inevitably faced the problem of gross yield stability and drought impact. The leadership regularly undertook active moves to respond to these challenges. From the point of view of their ideological and transformation positions, their feedback was agrarian-social megaprojects having a nature transformation character. The problem of agriculture stability and drought was not solved; after the leader's change, one megaproject was replaced by another under incompleteness of the former project or its closing.

2. Problem setting

The following peculiarity of agricultural development is typical for forest-steppe and steppe zone: central steppe regions of the European part of Russia, the most favorable for farming, were developed steadily during a long time. But more arid and risky south and east regions of the European part of Russia and virgin lands in the other side of the Ural were plowed very rapidly, mainly in the frame of large projects of the Russian Federation and the USSR. Series of "wheat fever" in the second part of the XIX century, Stolypin's agrarian reform (1906-1931), Salskaya tselina (the 1930s), and Virgin land megaproject (1954-1963) are well-known. These projects, especially the last, had the most agroecological expenses and caused the crisis of landscape-biological diversity in steppes, which was brightly expressed in the second part of the 1980s. They, with particular care, chose and plowed steppe phytocenoses on uplands (plakors) and full-profile soils recognized the most typical – zonal.

Consequently, title biological species found themselves in a critical situation, including threatened and endangered status. The steppe crisis was so deep that the scientific and nature conservation community considered it irreversible. Steppe was mentioned as a lost landscape forever in that period; the last plots of steppe ecosystems were discovered with great difficulty in hard-to-reach places. They received nature conservation status.

In the late Soviet time, the ecological steppe optimization's project with step-by-step conservation of low-productive arable lands did not occur; nevertheless, the steppe received a unique opportunity for restoration, but at the excess of its potential exceptionally.

Steppe science at the beginning of the XXI century can observe and study massifs of secondary steppe ecosystems, the emergence of which happened due to the Land reform in the 1990s, nearly a counter-project concerning the Virgin Land. Due to scaled dynamic, sometimes spontaneous, processes in agro-landscapes caused by the Land reform with variations of gross yield and the actual structure of lands, this reform is considered in a row of agrarian-social megaprojects. The Virgin Land megaproject and the Land reform together realized the global scale experiment to reveal the potential of steppe self-restoration. This experiment – a succession of mass plowing of tens of millions ha of steppes, maintenance them in the cultivated state "succession coma" during 40 years, and then the same mass and rapid abandonment for fallow lands without phytomelioration can be estimated as a historical and geographical phenomenon. Under any further destiny of steppes, already remained priceless scientific and nature conservation heritage, possibly, is more significant than the heritage of the other agrarian-social megaprojects.

The further destiny of steppe self-restored during this experiment causes anxiety, as a line of neo-virgin land programs and projects to rapidly introduce fallow lands into turnover were realized in Russia and Kazakhstan [2-5]; at present, these processes continue. The post-Soviet agricultural projects can reach a megaproject scale. For example, Kazakhstan offered the ambitious megaproject "Restoration of mobile pasturable livestock," where secondary steppes would be brought as pastures. The project's underlying task is the development and rational use of about 100 million ha of natural steppe and desert pastures, bringing up sheep stock to 100 million by 2050 [6]. Russia has not yet managed to launch the large-scale project of beef farming development. Still, it stimulates the growth

of principal commercial cultures' gross yield, including involvement fallow lands into a turnover. Notably, Orenburzhie plans to re-cultivate from 0.25 to 0.4 million ha of fallow lands in the nearest future. Established secondary steppes with a set of Red Book species unavoidable will occur among them. In the light of the current ambitions, financial and technical facilities, an assessment of landscape-ecological consequences of Virgin Land projects, Land reform, and their total effect have a special significance. Rational steppe land use based on scientific grounds and adapted to the current climatic and other challenges is impossible without the past megaprojects' experience.

3. Materials and Methods

The convergent principle of scientific study, steppe-centric approach, and field studies materials were used in the study. Also, comparative-historical and comparative-typological analysis, answering data, expert assessment methodologies, and the logical method were employed.

4. Results and Discussion

4.1. Virgin Land Campaign [Tselina]

Thus, the half-realized megaproject of agroecological orientation was replaced by the megaproject based on the competed idea – the Virgin land campaign. Famous late-Soviet nature conservation publicists considered this moment a "voluntary breach of the economic traditions" [7]. In the course of the study of this project's historical problems, we concluded that it was voluntary but strategic, having solved the whole complex of the issues and strategic challenges beyond agricultural frames [8]. Moreover, the Virgin land idea did not belong to N. S. Khrushchev, with whom it was associated, but was born by folk wisdom during the resettlement to the other side of the Volga River in the XIX century. Stolypin's reform partly implemented this idea, but considerable reserves of lands suitable for tillage have remained yet in Siberia and Kazakhstan. The Soviet agricultural science in the person of N.I. Vavilov and N. M. Tulaikov paid attention to these land reserves. They rationally supported the development of 11-11.7 million ha of chernozem soils on the east of the steppe zone. T. D. Lysenko opposed them offering to rest upon selecting new, more productive variants but not expanding the cultivated areas [9].

In 1941, the idea of Virgin land had a particular topicality. Due to a temporal loss of the country's principal granary, the government charged the Institute of Geography AS SSSR to found new granary in North Kazakhstan within three months. The expedition under the leadership of the director of the Institute of Geography, A.A. Grigoriev, began field studies in August of 1941. They presented the first report to the government in October of 1941; works lasted until 1943. As a result, the possibility of plowing 13 million ha of virgin lands with the best bioclimatic potential was grounded. Thus, the geographical positions were close to agrarian [10].

So, by 1946, when the grain problem was exacerbated, two scientifically-grounded scenarios for a gross yield of grain's increase have already existed: one – the introduction of Dokuchaev-Kostychev-Williams' complex and the other – the Virgin land reclamation according to Vavilov-Tulaikov-Grigoriev on the areas to 13 million ha. Under the difficulty to estimate the cost of possible projects of that time, the plowing of 11-13 million ha of virgin lands with the organization of several hundred new sovkhozes was compared with the formation of 5-6 million ha of woodland belts and organization of 570 afforestation stations in the frame of "Stalin's plan." In 1949, such a plan of the Virgin land development was feasible for the USSR compared with "Stalin's plan" according to costs.

In 1948, the choice was made in favor of the Dokuchaev-Kostychev-Williams system. Due to the government's change, an opposite scenario became dominant in 1954; it was realized with extravagance characteristic for the new leader. In practice, plowing plans were doubled to 30 million ha by the high ground decision. Taking into account the future bare fallows, plowed areas were reached 40 million ha. Also, this plan was overfulfilled at the expense of increased obligations between crew chiefs and even tractor drivers. Thus, the subordinate administration and ordinary

performers' initiative was enough to introduce land into arable turnover, and afterward, the reverse process demanded ministerial permission.

The Virgin Land megaproject (1954-1963) was the most large-scale as according to the areas of plowing: 43 million ha, of which 16 million ha in RSFSR, 25 million ha in KazSSR, so according to execution terms: principal regions, over 36 million ha, were plowed for three years that exceeded three-fold scientific bases [11, 12]. In RSFSR, the largest areas of cultivated lands were in Altaiskiy krai (2.9 million ha) and Orenburgskaya oblast (1.8 million ha) [13], which exceeded two times as minimum the scientifically-based plan. Such scales of new plowing were conditioned by, on the one hand, a strategic necessity. On the other hand, the state's leader principally rejected grassland crop rotation which seemed to him irrational space use. Later, it consolidated in mind as "the Virgin Land syndrome," keeping on at present.

In the light of gigantism, characteristic for that time, adaptive livestock and horse breeding on natural pastures were seemed archaic, retrograde, not corresponding to the space age.

Therefore, we offer to understand the Virgin Land campaign as megaproject efforts to liquidate all-round perennial and steppe grasses aimed to converse soil humus into the grain with actual plowing not only virgin steppes but perennial grasses sowing, pastures of stud farms, voluntary plowing of reserves: Askania-Nova, Naurzumskiy, etc., lands of scientific stations. All efforts were directed to destruct steppe turf and the principle of "long grass" in agriculture.

Naturally, threefold excess of scientifically-based areas of plowing could not help appearing as negative agroecological consequences. The virgin steppe entered into the landscape coma that has lasted for 40 years. All negative processes, first of all agroecological, were caused by not the idea of plowing but threefold excess of the grounded plane.

Potentially low-productive lands were plowed, and they are officially reckoned as arable lands at present; the title steppe landscape was chosen purposefully and plowed entirely. Thus, according to scales and actual purposes, the Virgin Land was the complex strategic megaproject. According to declared aims, it was an agrarian-social project; according to management, it was the state-administrative; according to the staff, it was mainly young.

As the other megaprojects, the Virgin Land campaign, mobilizing scientists, promoted developing fundamental geographical studies in the steppe zone. The problem was that there was only general information on the number of lands suitable for fields. The specifics of the eastern sector of Eurasia are that massifs of full-profiled loamy soils often alternate with their solonetzic and stony complexes. The shortest period is needed to find the most suitable plots and select them in nature. As steppe vegetation is the best indicator of soil cover, the Virgin Land epopee made scientists carefully examine steppes' vegetation cover in the regions of new agricultural development. In short time frames, though in a harry, researchers managed to reveal the principal massifs of lands suitable for tillage. The most important thing is to leave the next generation description of virgin steppes moving to the past.

Tens of scientific field teams were formed to act in the Special complex expedition for new agricultural land development AS SSSR (1954-1955). Essentially, the scientific exploit was performed (sometimes, a botanist was working in front of a plowing tractor). MSU organized the Kostanayskaya expedition that became the Complex virgin land expedition of MSU afterward. Undoubtedly, domestic steppe science was enriched by new knowledge about the Eurasian steppe zone's eastern sector. Numerous scientific publication was edited, including series of geographical atlases as a separate steppe region so the virgin land space on the whole that allowed to create one of the most considerable steppe science's generalizations of landscapes in Asian steppes that were caught in a pure state in the last moment [14, 15]. The convergence principle worked: different scientific branches' efforts created fundamental programs and methodologies for bio complex steppe research [16].

Negative consequences of the Virgin Land megaproject emerged practically at once after its finish, and even the initiator of the project recognized them.

In the New York Times of 02.23.1964, N. S. Khrushchev confessed that a part of the former virgin lands that suffered erosion would be allocated for pastures, and state efforts would be directed to other regions more favorable for agriculture [17]. It was the intention and a turn to realize to the end

interrupted "Stalin's plan," but at this moment, the government's change happened again in the country. As a result, instead of principal correction of the Virgin Land megaproject consequences, a period of its inertia began. By the middle part of the 1970s, more than 5 million ha of chestnut soils were plowed with simultaneous Renaissance of "Stalin's plan" components without principal priority of fodder grass cultivation for steppes and conservation of low-productive arable lands.

The state response at the post-virgin land challenge was mainly soil-protecting measures. Series of state resolutions on immediate measures to protect soils from wind and water erosion, on prospects of lands melioration and redistribution of river's flow was approved from 1966 to 1970. Again plans of the large-scale field-protecting forestation, regulation, and accumulation of the water runoff developing ideas of "Stalin's plan" were set. Soil-protecting agricultural systems were introduced; views of transfer rivers from Siberia to Central Asia were revived. The Soviet period entered its last twenty years that was characterized by megaprojects.

4.2. Land reform

Social orders for market land turnover were formed in the USSR by the end of the 1980s. Possibilities to achieve high efficiency of agriculture, to conserve and restore soils and the most suffered ecosystems, first of all, steppe, were connected with them. However, a necessity in social justice with strong opposition to private land ownership was kept on.

In 1992, the priority was given to justice privatization understanding as non-repayable equal distribution of agricultural lands between rural residents. The mechanism of such distribution became the Russian diversity of land ownership – a land share represented itself a right to legalize a land part of some Soviet agricultural enterprises for private ownership.

A complicated way from the right to actual ownership was exacerbated in the course of the reform, and, in such a way, a share became virtual in the final. Thus, in reality, it was privatized with no lands but the structure of farmlands. Rural residents became owners of a part of the farmlands system and possessed the hard realized right to be land proprietors.

The land share conserved the late-Soviet structure of agricultural holding since a change of proportion of farmlands of a different kind inevitably infringed upon share' holders interests. Even insignificant reduction of cultivated fields in agricultural holdings could provoke a sequence of court actions. It generated the following characteristics of lands:

1. Extremely difficult change of type of farming lands' use and turnover. 2. Lack of demand: plowed field's abandonment without preliminary phytomelioration. 3. Spontaneous self-conservation of cultivated fields and steppe self-restoration.

There is the impression that an attempt of justice privatization of agricultural holdings (to what extent the privatization of agricultural lands is possible in Russia in principle) turned into the privatization of the late-Soviet structure of farmlands. Such privatization did not correspond to proclaimed market priorities as the late-Soviet structure sometimes answered neither bioclimatic nor agroecological parameters. It was not optimal from the point of view of population placing and technological facilities. Moreover, not all rural residents saw themselves in the role of landholders, especially successful. The attempt to privatize and build market turnover of the official land structure instead of the lands itself looked like nonsense. Even from the point of view of management and administration, it was simpler to control hectares than income and profits.

Moreover, this structure was imposed on all rural inhabitants. Therefore, in the post-virgin land space with the least agroecological potential, particular risk of dry farming, and climate change, as a land share itself so the entire structure became a burden for owners, complicated the land market construction, and hampered the steppe land-use optimization. However, it played an exceptionally significant role for steppe ecosystems, promoted them to realize their restoration potential.

The privatized structure of farmlands came into conflict with economic conditions and therefore was broken. The decline of arable lands became not right away after introducing the share system but after the two most substantial droughts in 1996 and 1998, which left without seeds and other resources numerous farms in the steppe zone. Mass reduction of arable lands in Russia happened in the border of

millenniums. According to our estimates, the cultivated area decreased to 35-40 million ha compared with Virgin Land's area developed in the 1950s; and the minimum in twice of virgin lend developed in RSFSR. In Orenburzhie, the reduction of arable lands to 3 million ha was noticed in 1999. Then, due to the realization of a row of national agricultural projects, the fallow area was sharply reduced. According to different estimates, only in Russia, fallow lands occupied from 16 to 35 million ha, including in Orenburgskaya oblast about 0.8 million ha.

As far as the privatized structure of farmlands did not attractive for the rural residents, the feature of land non-demand passed socially painless. For steppe science and agroecology, the fundamental question is: how much unclaimed land is an excessive plowing of the Virgin Land project? How many areas of fallow lands coincide with the regions of the least bioclimatic biopotential and the least productive lands? Is not the characteristic of the lack of demand and self-conservation objectively determined by a factor of automatic optimization of post-Soviet agrolandscapes?

Without receiving the answer, we ascertain that all post-Soviet states' governments, as though justifying themselves for dramatic reduction of arable lands, make efforts to return it into the turnover. In some cases, these efforts are justified by economic reasonability: Russia and Kazakhstan became leaders on the global grain market, but simultaneously, millions of hectares of fallows have remained under the threat of repeated re-development; it is potentially low-productive lands where secondary steppe ecosystems have already formed and principal resources of title steppe species, first of all, rare and economically valuable have self-restored.

Landscape consequences of the Virgin Land megaproject were reversible only under the counter-project realization in the same areas.

Privatization of Soviet farmlands – the Land reform of the 1990s played the role of such a counter-project.

Under mass and one-time arable lands' abandonment without phytomelioration, many seats to open potential of steppe self-restoration studied by us have emerged even under the little possibility of coincidence of a line of required terms. The uniqueness of succession of the Virgin Land project and the Land reform on an unprecedented scale is a speed of both projects' fulfillment and spatial coincidence. The totality of consequences of these megaprojects allows us to consider them as the united mega-experiment according to an assessment of the potential for steppe self-restoration.

Such mega-experiment is unique; therefore, it is difficult to interpret it. We notice some outwardly resembling "back to nature," but due to low historical irreversibility, "back to nature" is impossible. It can be only as a consequence of degradation, in this case, of the Soviet agro-landscape. However, in this case, the new steppe will not be a virgin. Also, it is impossible to interpret the observed phenomena as "forward to nature"; a lack of conscious efforts in this direction does not allow it [18]. Indeed, agriculture degradation as a condition of "back to nature" took place. In this case, the degradation of one nature-anthropogenic system promoted the self-development of the new natural-anthropogenic complex that was principally closer to the steppe. We assume this process's fundamental interpretation as "labor of nature" from destructed agro-landscape to secondary steppes or neo-steppes. Development of this scenario "together with nature," in our opinion, is a condition of stable growth in post-virgin land space.

We should separately note that the lack of demand for plowed fields unavoidably spread to field-protecting woodland belts that could not affect their states. In our opinion, the mass collapse of woodland belts can be considered as the agroecological challenge though scales of their loss compared with the first years of "Stalin's plan" closing up. Simultaneously, we should mention that in some cases, steppe vegetation self-restores rapidly, including the Red Book species within destroyed woodland belts. So, it will be an original agroecological, juridical and moral challenge since, in these cases, woodland belts restoration will be conjugated with the destruction of the Red Book steppe species' habitats. Moreover, the consequences of lack of demand impacted artificial water bodies; most of the small reservoirs were drained, their bottoms are overgrown with arboreal-shrubby and suffrutescent vegetation.

5. Conclusion

The Virgin Land megaproject had three variants. According to Vavilov and Tulaikov, the first agrarian-rational project was suggested at the beginning of the 1930s and assumed plowing of 11-12 million ha in 1930. The second, according to Grigoriev, the geographical-rational plan was developed in 1941-1943 and assumed the plowing of 13-15 million ha. According to Khrushchev, the third was the mobilizing project in 1954 to plow 40 million ha, and it was overfulfilled to 43 million ha.

The view of current steppe agro-landscapes in North Eurasia, structure, specialization, and agriculture problems, the whole complex of agroecological problems and rehabilitation successes are the heritage of agrarian-social megaprojects, first of all, the Virgin Land (1954-1963). Ones defined modern agrolandscapes; the others created the scientific potential for their study. Steppe landscapes in Eurasia turned into agrolandscapes due to agrarian-social megaprojects.

The inter-penetrating influence of megaprojects, to the most degree, became apparent in the Trans-Volga-Ural region, including the Orenburgskaya oblast that is the most typical for it and the steppe zone on the whole.

The Land Reform of the 1990s promoted spontaneous self-restoration of steppe vegetation on fallows and critical components of the forest reclamation framework.

In the totality of involved material resources, labor, and energy, the considered megaprojects were unprecedented stress for the steppe zone, took it out a long-term stable state in the east, and created the whole new system landscape components in the Trans-Volga-Ural region and to west from it. It was a unique experiment to activate steppe landscapes' dynamics and reveal their restoration potential represented itself under the land reform's implementation.

The global experiment of steppe self-restoration showed that landscape consequences of the Virgin Land megaproject were reversible, but only in the case of realization of the same large-scale counter-project. Privatization of agricultural lands – the Land reform of the 1990s was such a counter-project. Mass and one-time arable lands' abandonment without phytomelioration promoted to form many seats opening potential of steppe self-restoration [19].

Ideology in steppe land use has not experienced "de-virgin land process" neither the eve of the Land reform nor by the present. Even the initiator of the Virgin land project confessed a necessity to correct it principally.

Assessments of agrarian-social-megaprojects, to the most degree the Virgin Land and the Land reform, remain disputable and high politicized; their contribution in the development of fundamental science, first of all, geography, is underestimated, the same as consequences of the global experiment for self-restoration of steppe ecosystems. However, for geography, such projects are the only real experimental basis allowing to foresee consequences of the future nature conservation decisions. Outcomes of such experiments should be studied in positive and negative details, including the dynamics [20]. The study of dynamic processes in landscapes after removal from the agricultural and industrial load has particular significance; these processes can be exposed within areas compared with landscape zones. On the whole, these processes manifest themselves in post-industrial countries where are accompanied by the activation of the research on landscape planning [21].

We consider that our approach to assessing the consequences of the principal agrarian-social megaprojects helps to study a problem concerning the optimization of steppe agrolandscapes, to estimate such enormous work which nature made itself to rehabilitate steppe ecosystems. In our opinion, geography's role is how to organize and adapt steppe space turned it from the arena of politically motivated megaprojects into a model for biosphere natural-anthropogenic zone stable in social-economic development.

In conclusion, we note that national projects in agriculture and ecology are realized in Russia at present. Taking into account the significance of the problem and specific importance of the steppe zone for food security, carbon sequestration, restoration of title steppe biological species, and adaptation of steppe land use to climate change and other challenges, we offered to initiate a specialized steppe national project or principally intensify steppe component of the operating projects. We expect a range of steppe problems to come to a national projective level, and Orenburzhie will be

one of the pilot regions of a new steppe megaproject. The success of realizing such kinds of projects is required to adopt the best advances of the preceded agrarian-social megaprojects, consider all their failures and errors, and study more carefully their heritage to make the most effective decisions. An assessment of lessons and consequences of megaprojects from the point of view of steppe science will promote to transfer from neo-virgin land and transformism ideas and strategies to the agroecological and social adaptation of land use to climate changes and other challenges of modernity.

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