Land conservation as an integral part of the land use planning process

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Abstract. The article addresses the current issue facing the areas with ecological instability of landscapes due to the lands having experienced more than 70% of agricultural development and 50% of plowing. The presented data shows that the ecological stability of the area under study is unstable (0.06), with pronounced instability, and high anthropogenic load on the landscape (3.7). We assessed the results of monitoring the condition and use of lands in the Ivanovo district of the Amurskaya oblast, which showed that 254,811.91 hectares of land are exposed to natural and anthropogenic negative impact. Waterlogging causes the maximum natural negative impact – 171,333.32 hectares, so we propose to carry out the reconstruction of the Klyuchevskaya drainage system in the Ivanovo district on a land plot of 2,106 hectares, allowing for more than 300 hectares of arable land to be used for agricultural purposes. To cope with the identified negative processes, we propose to implement the activities into the land-use planning scheme of the Ivanovo district. This will contribute to the restoration of significant land areas and their inclusion in agriculture. If these measures are introduced, the gross output and net income (28,238 million rubles, including the operating costs) will increase.

1. Introduction

Land is an ecosystem, which acts as a means of production and a means of recreation for people. It represents our basis, the carrier of infrastructure, the repository of natural wealth, and ultimately the provider for all mankind because most food is produced in agriculture. The Russian Federation, and in particular Amurskaya oblast, has significant land resources, however, for a number of reasons over the past two decades the country has been experiencing the exacerbation of issues of preserving and restoring land resource potential associated with the loss of soil fertility, soil degradation, pollution and land disturbance. The society faces a difficult challenge: to organize the use of land resources in such a way as to stop the processes of soil degradation, to carry out their restoration and improvement, and also to increase production efficiency by introducing rational land ownership and land use. Rational use of land is a cost-effective activity of enterprises, organizations and citizens on the impact on land, carried out in compliance with environmental requirements for land protection and in ways that ensure the preservation of land as the main means of production. For a reasonable improvement of the human environment, the impact on a particular component of the landscape, it is necessary to imagine in advance and more precisely, in which direction all other components of the landscape will change. An important role is played by the idea of the interconnected unity of the main natural and
anthropogenic landscape components. This can provide a favorable environmental environment for the population [1-5].

2. Object of research
The purpose of this research is to study the condition and use of land in the Ivanovo district of Amurskaya oblast and to develop the environmental measures.

Ivanovo district is located in the southwest of Amurskaya oblast. The climate is continental with monsoon features. The average annual temperature is +2.4°C, the average annual rainfall is 567 mm, with the maximum occurring in July-August. The district area belongs to the Amur River basin. It is characterized by wet meadow soil and wet waterlogged soil with alluvial sands, sandy loams and loams. Meadow chernozem-like soils are common on the floodplain terraces, and they are most intensively used by humans, which has led to a decrease in their fertility. Over the past 20 years, the humus content has decreased by 11-30%, and its annual loss has comprised 0.45 tons per ha. Along with the loss of humus, the destruction of the soil structure is noted [6].

Ivanovo district is a favorable agricultural region of Amurskaya oblast. Agricultural production accounts for 74% of the region’s economy and is one of the main industries. The largest area is occupied by land of agricultural designation – 233,832 ha, with agricultural land comprising 79.37% (210,750 ha) and non-agricultural land – 20.63% (54,789 ha). Most of the land within the district is in state and municipal ownership – 49.11% (130,399 ha).

3. Methods and results
Ecological instability of landscapes is observed in the Ivanovo region due to the high levels of agricultural development (79.4%) and plowing (47.7%).

Using the method of calculating the degree of ecological stability, we calculated the ecological stability of the Ivanovo region. This degree shows the stability of the landscape, the ratio of agricultural or other lands in the agricultural landscape that have a stabilizing or destabilizing effect on the agricultural landscape [7,8]. Stabilizing lands include areas occupied by constant elements of the landscape (forests, shelterbelt forests, ravine meadows, reserves, nature reserves, natural ponds and marshes, shrubs, pastures, hayfields, arable land under perennial crops). In the Ivanovo district, this area amounted to 7,246 hectares (shelterbelt forests). Destabilizing areas include areas occupied by unstable elements of the landscape (areas under buildings and houses, overgrown and silted bodies of water, mining areas, ravines, arable land under annual crops). In the Ivanovo district this area amounted to 126,850 ha (arable land). Hence, the degree of ecological stability is 0.06; therefore, the environmental stability of the Ivanovo region is low, with pronounced instability.

An assessment of the anthropogenic load on the Ivanovo district land showed a high degree (3.7).

A number of processes negatively affect the quality of land in the Ivanovo district. All of them can be divided into two categories, which include a characteristic set of phenomena leading to a deterioration of the soil and vegetation cover: negative processes of natural origin and negative processes of anthropogenic origin [9].

Among the negative processes of natural origin in the Ivanovo district, the following types were identified:

1. Water erosion – eroded lands that have lost, as a result of erosion, a partially or fully fertile soil layer (according to Industry standard 23 002-97 and OST 23 001-96). This type includes gullies, hollows and ravines.

2. Waterlogging is the state of soils when their moisture content exceeds 85% of the maximum field moisture capacity (according to OST 23.001-96). The process is localized in the hollows, and the bottoms of the draws, on the low banks.

3. Groundwater flooding – a rise in the groundwater level to the ground surface caused by natural or anthropogenic factors and leading to soil water saturation, changes in the physical and physico-chemical properties of groundwater, transformation of soil, types, structure and productivity of vegetation cover, transformation of animal habitats (according to OST 23 001-96).
4. Bog formation – a change in water regime, expressed in an increase in periods of prolonged waterlogging, groundwater flooding and flooding of soils (according to OST 23 001-97). The bog formation process is invariably accompanied by a change in the type of vegetation; bog formation is a landscape process associated with flooding and groundwater flooding.

5. Flooding – the formation of a free surface of water on a site as a result of an increase in the level of a watercourse or groundwater (according to OST 23 001-96). The main criterion to determine this type of negative process is the presence of a water surface.

The category of negative processes of anthropogenic origin comprises:

1. Land construction, including sections of linear construction – power lines, railways and roads, industrial construction and urban planning.

2. Hydrotechnical construction, including the construction of bridges and dams, the construction of storage reservoirs.

3. The development of the mining industry, the development and operation of deposits, including the development and operation of solid mineral deposits, the development and operation of oil and gas fields, the development and operation of deposits by surface and underground mining.

4. Agricultural development, including the land reclamation construction, agricultural construction.

5. Warehousing and burial of industrial waste, land pollution, including production and consumption waste pollution, pollution of land with oil and oil products, industrial waste.

Negative processes of natural and anthropogenic origin affect 254,811.91 hectares of land in the Ivanovo district. The largest areas are impacted by the processes of waterlogging, which are spread in lowlands and on soddy-cryptopodzolic and soddy-gleyous soils – 171,333.32 hectares of land have been identified (64.52% of the total area of this region). Large areas are affected by the processes of groundwater flooding and flooding, especially in areas of anthropogenic development near watercourses and in floodplain areas. They account for 62,736.74 ha or 23.63% of the total land area. Relatively large areas are impacted by bog formation – 11,467.48 hectares of land (4.32%) are identified. Water erosion is spread over an area of 207.34 ha, with each erosion scar being relatively small and in total this negative process being spread over 0.08% of the area.

Negative processes of anthropogenic origin can be called significant, they are spread over an area of 9,067.03 hectares.

In order to manage the negative processes encountered in the Ivanovo district and to improve the state of the soil and vegetation cover, a number of recommendations were made.

It would be advisable to implement the following measures in the areas with natural and anthropogenic negative processes:

1. Water erosion: monitoring the dynamics of erosion processes (speed and volume of dropped eroded material), preserving the natural vegetation cover, restoring disturbed vegetation cover along the slopes of the erosion pattern, restoring tree and shrub vegetation in areas adjacent to erosive slopes and watersheds, soil-protecting crop rotation (alternation of row crops and perennial forage crops), hydrotechnical measures (delaying runoff on a gully forest belt, providing water discharge into a ravine without channel erosion, structures to strengthen the peaks, bottom and slopes of the ravine against erosion).

2. Waterlogging and groundwater flooding: the creation of drainage ditches, the elimination of objects or landforms that prevent the outflow of water. The method of draining waterlogged lands is to be established depending on the type of water supply to the land. In areas with atmospheric water supply, methods of increasing surface runoff are effective; while for areas with groundwater supply, lowering the level of groundwater and increasing internal runoff are more productive. With slope water supply, interception of slope surface runoff is helpful. Measures to eliminate the consequences of waterlogging should primarily be carried out on agricultural lands, residential areas, industrial areas, and transport infrastructure areas.

3. Bog formation: land reclamation measures are necessary (creating drainage or maintaining the existing land reclamation system in working condition). In order to improve soil fertility, liming can be used. Reclamation measures for wet meadow soil are especially effective.
4. Flooding: it is necessary to undertake engineering and technical measures: to increase the capacity of the channels and to create detention basins. In the event of the possible flooding in Central Amur Lowland, the most effective measures would be to construct protective dams to prevent the penetration of flood waters to residential areas, industrial and transport facilities. Also, it is possible to implement adaptation measures (removal of residential and farm buildings from the flood zone, transformation of agricultural land) and landscape measures (planting forest areas along the banks, creating forest areas, digging retention ponds). In flooded wet meadows, in order to increase productivity, it is necessary to create a network of reclamation drainage canals to prevent severe waterlogging and bog formation. In the areas affected by the negative processes of anthropogenic origin, the following measures can be taken to improve the condition of the land and restore the soil and vegetation cover:

1. Ground-based construction: a set of remediation measures is required in the areas affected by the construction – removal of construction waste, adjustment of the terrain (backfilling of pits, trenches, ditches, leveling off the ground), restoration of the soil and vegetation cover (soil supply, planting of trees, shrubs and grass plants), aesthetic improvement.

2. Hydrotechnical construction: measures are required to minimize the impact on the water body and adjacent area. Reclamation measures in the adjacent areas are also necessary: removal of construction waste and soil, leveling the territory, restoration of soil and vegetation cover. When creating artificial reservoirs, shore protection measures are required in areas subject to erosion, planting trees and shrubs in the coastal strip, and the creation of water-conservation areas. When there are signs of intensification of waterlogging, bog formation, or water erosion, a set of measures is required to minimize their effects.

3. Development of the mining industry: remedial measures are needed – backfilling of excavations, restoration of soil and vegetation cover, and construction of recreational zones in place of flooded quarries. In the process of exploitation of a deposit (quarry) operation, natural negative processes might occur – water erosion, flooding, waterlogging, bog formation, so a set of measures is needed to reduce their impact.

4. Agricultural development. It is localized in relatively small areas, so the negative effect of agricultural development is negligible. With areas of agricultural development, it is necessary to determine the type of negative impact. Agricultural objects can be sources of pollution of soil, groundwater and surface water (pollution by runoff from farms, chemical pollution in warehouses with fertilizers, pollution by oil products from tractor depots). When identifying the type of pollution and its source, it is necessary to take a set of measures to eliminate it and to reclaim the contaminated area. Remediation measures (dismantling of unused buildings, removal of garbage and unused equipment, restoration of damaged tree-shrub cover and soil fertility) are required at unused agricultural development sites [10].

5. Warehousing and burial of industrial waste, land pollution. In areas with localization of pollution sources, it is necessary to determine the type of pollution (organic substances, oil products, chemical fertilizers, radioactive elements), and, if possible, eliminate the source of pollution or minimize its impact, take measures to remove pollution (removal of the contaminated soil layer, cleaning water bodies), as well as carry out remediation measures (importation of new soil, fertilizer application, planting of trees and shrubs).

In the Ivanovo district a large area of land is subject to waterlogging, therefore, drainage reclamation measures are necessary to preserve and restore agricultural land. There are 14 reclamation drainage systems in the district, of which 13 are not functioning at the moment. In this regard, we propose a reconstruction of the existing Klyuchevskaya drainage-irrigation system. The reconstruction site is located on the grounds of the Luch collective farm, with its central estate located in a village of Ivanovka, Ivanovo district, Amurskaya oblast. The area to be used for the reconstruction of the Klyuchevskaya drainage-irrigation system will be used for its intended purpose – agricultural land. The total area of the drainage system is 2,106 ha, and it is currently used as an arable land and for the purpose of haymaking. The arable land houses legumes and corn. This system, just
like others, is in a state of degradation: most of the channels are silted up, shallow, overgrown with dense grass and tree-shrub vegetation. A number of canals show insufficient operational carrying capacity, while other canals have their operational carrying capacity at the limit. Due to the deterioration of parameters, the maximum flow rate in canals is skipped during the maximum filling. In case of overgrowing of shrubby and aquatic vegetation or clogging of the canal, water may enter the adjacent territory. Canals have an uneven profile.

The project provides for the following activities:
- restoration of the operational carrying capacity of an open drainage network;
- removal of wood and shrubbery vegetation, bringing the profile of the canals to design specifications, cutting the edge of the channel strip to ensure unhindered discharge of surface water;
- reduction to an acceptable limit of the level of excessive soil waterlogging during the growing season of plants in the second half of summer and in the fall during the field work;
- ensuring the unrestricted passage of agricultural machinery to the fields and the passage of vehicles to transport the crop products out of the field;
- restoration of the roadbed, followed by a coating it with sand and gravel;
- reconstruction, taking into account the experience of operating systems, hydraulic structures, ensuring the interconnection of roads with canals;
- installation of irrigation system on an area of 300 hectares.

The current total estimated cost of water management system is 315.9 million rubles, including the survey and design work of 18 million rubles.

The economic activity indicator provides for an increase in arable land and hayfields: before the reconstruction, the area of hayfields amounted to 1,437 ha, after the reconstruction – 1,754 ha; arable land amounted to 300 hectares. After the proposed measures are implemented, the gross output will increase, which will entail an increase in net income to 28,238 million rubles, taking into account operating costs. The main economic indicator of the project effectiveness is its profitability, which according to our estimates will be at 56.8%. The project payback period will be 11 years and 1 month.

4. Conclusion
Since the district has the most waterlogged land, we proposed the reconstruction of the existing Klyuchevskaya drainage system in the Ivanovsky district on a land plot with a total area of 2106 hectares, which will allow the introduction of an additional 300 hectares of arable land into agricultural circulation. Overall, in order to cope with the waterlogging, we propose to include the measures presented above into the land-use planning scheme of the Ivanovo district of Amurskaya oblast. This will contribute to the restoration of significant areas of land subject to waterlogging and inclusion in the turnover of land not used in agriculture, due to this negative process.

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