Using the method of relief plasters to highlight potentially erosion-hazardous areas on agricultural land

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Abstract. With the strong development of soil erosion, land fertility decreases, crops are damaged, ravines turn agricultural land into uncomfortable land and make field cultivation difficult, siltation of rivers and reservoirs occurs. In this regard, issues of land protection from erosion are relevant. The article discusses the issues of identifying potentially erosion-hazardous lands using the method of relief plasters, previously used in landscape science. This method allows to facilitate the identification of destructive processes at an early stage of development and to prevent them in advance. The location of the zones identified by this method (morphoisographs), and their dynamics, characterizes the changes associated with ecological-landscape measures, for example, planting of forest belts, afforestation of ravines and, accordingly, redistribution of surface and underground waters. A morphoisograph, as the line most sensitive to negative phenomena (changes in the chemical, biological, and mechanical composition of soils, soil erosion, etc.) can become the main criterion for identifying potentially unstable zones. The authors highlighted agricultural land that is potentially unstable to erosion. The introduction of a morphoisograph into ecological landscape design expands the possibilities of detailed accounting for the development of erosion processes in the future.

1. Introduction
One of the global challenges of our time is to protect and preserve the environment from natural and man-made impacts. Land resources, which are, as known, not limited, are also part of the problem solving. So, currently on Earth there are about 3.2·10³⁹ ha of potentially suitable land for use, however, about 1.5·10³⁹ ha of land is used in agriculture [1]. The situation is complicated by the fact that 70% of humanity is concentrated on 7% of land. Under these conditions, part of the arable land is disposed annually and on an increasing scale for construction purposes – urban, transport and industrial. In addition, part of the soil is irretrievably lost annually as a result of erosion. According to the Food and Agriculture Organization (FAO, 2014 [2]), there are 196.44 million hectares of eroded land, occupying 15% of agricultural land. In Russia, this ratio is more than 60 million hectares of agricultural land, which exceeds 30%.

2. Problem statement
For Central Black Earth Reserve, one of the main forms of land erosion is water erosion, which results in the growth of a ravine-girder network. With the strong development of soil erosion, land fertility...
decreases, crops are damaged, ravines turn agricultural land into uncomfortable land and make field cultivation difficult, siltation of rivers and reservoirs occurs. Erosion destroys roads, communication lines, power lines and other means of communication.

In the classical form [3, 4, 5], erosion is understood as the process of destruction of rocks and soils by water flow, wind, the movement of destruction products and their redeposition. As a rule, erosion manifests itself in the form of:

- direct mechanical impact of the flow, causing the weighing (and entrainment) of solid particles or their movement along the surface of the bed with a water stream;
- dissolution of rocks by water (corrosion);
- erasing and turning the bed of the stream with water-borne particles (corrosion);
- excitation of electric charges of the opposite sign in the system "water - solids", which contributes to the suspension of small particles.

The erosive ability of the flow is the greater, the greater the flow velocity, and it depends on the nature of the underlying surface (bed).

Erosion is considered one of the main factors in the formation of the relief of the earth's surface or relief formation.

Erosion-hazardous territories refer to lands exposed to a combination of natural-technogenic and anthropogenic impacts leading to degradation of soil fertility to a greater extent than the processes of its natural restoration.

The works of such scientists as Volkov S.N. [6], Lopyrev M.I. [7, 8], Kashtanov A.N. [9], Postolov V.D. [10] and others are devoted to research of methods of erosion protection and organization of territories.

Modern methods of erosion protection of the territory are associated with a change in the existing manifestations of erosion activity and are not designed for the long term, determined by an integrated approach to the development of erosion-hazardous processes. When assessing the prospects for changing soil erosion, one should consider not only the modern rates of erosion, but also the future development of erosion processes.

From our point of view, differentiated accounting of the influence of erosion activity on the verge of a land management decision seems to be technically difficult and economically effective only in the first years, since the general trends of the territory's development are not considered. Therefore, improving the methodology of complex assessments of natural and technogenic impacts when making land management decisions in the conditions of the development of erosion-hazardous processes is a very topical issue.

3. Materials and methods
In accordance with environmental laws, matter and energy are interconnected so that any change in them causes functional and structural changes along hierarchical chains [3]. It is usually impossible to evaluate these changes in a timely manner, since the accumulation of negative phenomena occurs gradually.

It is possible to facilitate the identification of destructive processes at an early stage of development and to prevent them in advance, if the method of relief plasters is used in ecological-landscape design [11, 12].

The essence of this method is that the most pronounced boundaries between the systems of convex and concave relief forms are established along the topographic map horizontals, which is a necessary and completely justified operation of geomorphological analysis.

This method was previously used to highlight on the maps an ordered, genetically substantiated system structure of the earth’s surface and the real structure of the soil cover, soil lithology, as well as geochemical flows, areas of their formation, transit and accumulation [13, 14, 15, 16]. Therefore, the location of the morphoisograph and their dynamics characterizes the changes associated with ecological-landscape measures, for example, planting of forest belts, afforestation of ravines and, accordingly, redistribution of surface and groundwater. A morphoisograph, as the line most sensitive
5. Discussion of the results
Figure 2 shows the erosion-hazardous zones determined by the standard method [10] and similar zones made using relief plasters maps.
Erosion-hazardous lands (IV-V classes) allocated on the territory of an agricultural enterprise allocated according to the existing methodology capture a smaller territory than those allocated by a morphoisograph. The increase in potential erosion-hazardous lands occurred by 5-10%, mainly due to arable land.

These zones, as a rule, have less steepness and the amount of erosion of disturbed lands than the areas identified by the standard method.

Erosion-hazardous territories (IV-V classes) on a cartogram constructed according to the traditional method occupy lands with a slope of 3-5 °, are located on soils of light mechanical composition and the most washed out (Figure 3). In turn, morphoisographs distinguish zones with slopes of 3-5 °, 1-3 °, 1-0 °, but are homogeneous in terms of geomorphological, geological, hydrogeological, soil and other conditions.

![Legend](image)

**Figure 3. Land allocation on slopes**

As practice shows, the magnitude of the slope does not always indicate the danger of using agricultural land. Thus, the spread of natural and technogenic negative manifestations (water erosion) may be due to the properties of the underlying soil, water regime and many other qualities of the territory, which are not always visually determined. In addition, the quantitative characteristics (relative flushing, eroding potential, etc.) inherent in traditional land classes do not apply to these lands.

Negative areas of morphoisographs, defined by us as not tolerant to the aggressiveness of natural and technological phenomena zones, can be identified as potentially erosion-hazardous territories. These territories, as the most hazardous in terms of erosion, should be excluded from intensive agricultural use.

5. Conclusion
The result of the practical work are the following statements:

- taking morphoisograph into account in ecological landscape design allows to identify dynamically potentially erosion-hazardous territories;
- without rejecting the existing methodology of identifying and classifying erosion-hazardous lands, the introduction of a morphoisograph expands the possibilities for more detailed consideration of the development of erosion processes in the future;
- following the existing traditional methods of the anti-erosion organization of the territory on erosion-hazardous lands, the use of the morphoisograph as characteristic special lines corresponds to the middle lines of the unstable equilibrium zone;
the use of morphoisographs as the basis for zoning of erosion-hazardous lands does not previously contradict the used complexes of anti-erosion measures and the organization of the territory.

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