Justification of measures to protect against the negative impact of water

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Abstract. Significant territories of the Russian Federation are annually negatively affected by water due to floods and underflooding. These phenomena inevitably entail the emergence of economic damage to property objects and sectors of the national economy. Specialists and practitioners are forced to look for solutions and mechanisms to minimize damage and protect the territories and the infrastructure located on it. The article presents material that concerns the current state and prospects of activities based on the concept of land management exposed to the negative impact of water, the choice of protective measures aimed at preventing the negative impact of water, taking into account the economic and social needs of such territories by the example of the Municipality "Omsukhansky city district" of the Magadan region. The practical significance is confirmed by the calculation of the economic efficiency of the proposed measures for the research object.

1. Introduction

Currently, an acute problem for many regions of Russia is the problem associated with the negative impact of water (floods, flooding, flooding of territories from water bodies). Like any other management system, the land management system should have a certain stability, but at the same time adequately and timely respond to events and their consequences associated with negative natural and anthropogenic impacts, the prevention of which is a paramount task at all levels of administrative management. The problem associated with the occurrence of damage as a result of the negative impact of water (floods, floods, flooding, etc.), as well as the development of mechanisms to minimize this damage, is the subject of research by many specialists and scientists [1–3].

In this case, special attention should be paid to modern methods of land protection. Improving the system of state management of land resources exposed to the negative impact of water (NIW) is one of the priority tasks.

One of the goals of this work is the development of proposals for solving problems in land management arising from the impact of water on objects of administrative and territorial administration.

In the course of the work, an analysis of the regulatory and legislative framework was carried out, which ensures the regulation of territories falling into the zones of flooding. The study areas are the districts of the Magadan region.

2. Materials and methods

When developing proposals, an analysis was made of the formation of land plots under capital construction of power transmission lines in the Primorsky Territory, Sakhalin Region, the Republic of
For this, trend analysis methods were used, the balance method was used based on materials obtained from publicly available sources (reports, statistical material). As a result of the application of these methods, the main problems in the formation of land plots under the objects of capital construction of power transmission lines were identified and proposals were given for their solution.

3. Study of the problems arising during the formation of land plots for objects in the Far Eastern Federal District

The problem of land management in the Russian Federation, subject to the negative impact of water, is solved by the state on the basis of the rules for determining the boundaries of flooding zones. They are established by Decree of the Government of the Russian Federation of April 18, 2014 No. 360 "On determining the boundaries of flooding and flooding zones" [4].

Flooding zones are established in relation to:
   a) territories adjacent to unregulated watercourses, flooded during floods of one percent supply (recurrence once every 100 years), taking into account actually flooded areas over the previous 100 years of observation;
   b) territories adjacent to the estuarine sections of watercourses, flooded as a result of surge phenomena of the estimated supply;
   c) territories adjacent to natural reservoirs, flooded at water levels of one percent supply;
   d) territories adjacent to reservoirs, flooded at water levels corresponding to the forced backwater level of the reservoir;
   e) territories adjacent to regulated watercourses in the downstream of hydroelectric complexes, flooded when the hydroelectric systems pass the floods of the calculated supply.

Flooding zones are established in relation to territories adjacent to flooding zones, the rise in the groundwater level of which is caused by the backwater of the groundwater by the high-water levels. Within the boundaries of flooding zones, the following are established: a) areas of severe flooding - with a groundwater depth of less than 0.3 meters; b) areas of moderate flooding - with a depth of groundwater from 0.3 - 0.7 to 1.2 - 2 meters from the surface; c) areas of weak flooding - with a depth of groundwater from 2 to 3 meters.

The main problem of the formation of flooded areas is the lack of reliable cartographic documentation for these territories, as well as information on water bodies and flooded areas in the Unified State Register of Real Estate (USRN) [5].

To date, schedules should be developed for the establishment of flooding zones for all regions of Russia by 15.10.2020, according to the order of Rosvodresurs, and entering this information into the USRN.

Based on the authors' analysis of scientific publications, the regulatory framework for land management, and the assessment of the land resource potential of the object of scientific research, the authors proposed conceptual provisions for management of land resources, which are subject to the negative impact of water.

On the territory of the chosen research object, there is a rather dense river network. The largest rivers are the Kolyma and its tributaries. The largest rivers flowing into the Sea of Okhotsk are Taui, Ola, Arman, Yama, Gizhiga.

Of the physical and geological processes in the region, there are flooding of floodplain areas, ice formation, waterlogging, solifluction, thermokarst, thermal erosion, cryogenic heaving.

Let us perform an analysis using the example of the Omsukchan urban district in the Magadan region. The Omsukchan urban district of the Magadan region is rich in various reservoirs. Most of the watercourses, flowing through the territory of the region, flow into the river basin of the Kolyma River (Fig. 1) [6].
Figure 1. Layout of the Omsukchansky city district.

A large river Omchikchan flows through the territory of the Omsukchan urban district. During the summer-autumn period, a number of rain floods are observed on the Omchikchan River; the highest occur mainly in August; the influence of snowmelt is still possible. Spring flood peaks are usually by the order of magnitude lower than rain flood peaks.

The Omchikchan River is highly irregular. In the warm part of the year (May - October), the bulk of the water flows is 94-99%, the share of spring runoff is 60 - 70% of the annual runoff, which is explained by the significant amount of liquid precipitation falling mainly from mid-June to mid-July at the beginning of the recession spring flood. Runoff is negligible in the winter months [7].

The nature of channel deformations of the Omchikchan River along the settlement of Omsukchan is determined by several factors, the main of which are permafrost soils and the geological structure of the floodplain. The main type of channel deformations of the studied streams in the areas under consideration is a wide floodplain, in which the river flows in many branches. During floods, channel deformations are intense and are expressed in the reshaping of banks and channel channels. The main type of channel deformations of the Omchikchan River in the area under consideration is a wide floodplain, in which the river flows in many branches. During floods, channel deformations are intense and are expressed in the reshaping of banks and channels [8]. The scheme of flooding zones of the territory of the settlement of Omsukchan, selected as an example, is shown in Figure 2.
To develop proposals, the authors analyzed the observation materials of the Kolyma UGMS, from the analysis of which the following conclusion was made: the gusty wind, heavy rain and snow, heavy sleet, heavy hail, heavy fog, abnormally cold weather should be attributed to dangerous hydrometeorological phenomena in the village of Omsukchan. Also, a very strong wind with a speed of more than 30 m/s can be observed on the territory. There is significant liquid or mixed precipitation with an amount of at least 50 mm over a period of 12 hours or less, very heavy snow with an amount of precipitation of at least 20 mm over a period of no more than 12 hours. And severe frost is with preservation during the day or more of the air temperature -35 °C. In the period from October to March for 5 days or more, the value of the average daily air temperature is below the climatic norm by 7 °C or lower [9].

Analysis of various documents and, first of all, the concept of spatial development of urban districts of the Magadan region, in which one of the main places is occupied by the problem of protecting territories from the negative impact of water, which is associated with annual damage and risks from floods, which take place of sustainable growth [10].

Proposals for determining the boundaries of flooding zones, taking into account the use of modern software products for statistical analysis and selection of the most representative indicators and GIS technologies for drawing up graphic and cartographic documents for the research object, include the following actions [2]:

- collection, analysis and generalization of observation materials for hydrometeorological, hydrological, geological, hydrogeological and cartographic study of flooded areas using the software "Statistica" v.10.0, JMP Statistic 15 and Minitab 19;

**Figure 2.** The boundaries of the flooded area at a maximum water level of 1% supply
− cartographic study of the flooded territories of settlements of the municipal formation "Omsukchan urban district" using GIS technologies;
− reconnaissance survey of watercourses, including photography;
− morphometric surveys on the watercourse (morpho-structure and longitudinal profile);
− office processing of materials from field topographic works, determination of the calculated hydrological characteristics of watercourses;
− compilation of the climatic characteristics of the engineering survey area;
− preparation of a technical report.

According to the data of the statistical processing, it was revealed that the Industrial stream, which flows into the Omchikchan River, poses a threat to the population living near water bodies, engineering infrastructure and industry. It was determined that it is necessary, first of all, to carry out measures to strengthen the bank of the Industrial stream. And the scheme of the design solution for protection against flood waters is shown in Figure 3, and a fragment of the project for the location of the projected facility is shown in Figure 4.

![Figure 3](image)

**Figure 3.** Flood protection design scheme: a) morphostvor scheme on PC 15 + 16 of the Industrial stream; b) project proposal; c) design scheme
Figure 4. Fragment of the layout of the designed object and land plots falling into the flooding zone, capital structures

According to the data of the Federal Service for State Registration of Cadastre and Cartography (Rosreestr) and the analysis carried out, within the boundaries of the flooded zone at a maximum water level of 1% of the supply fall the following is observed. There are 12 residential buildings (29 people); boiler room - 1 unit; heating networks - 0.4 km; power transmission line - 3 supports; industrial facilities - 1 unit [11].

The calculation of the volume of the cost of damage from flooding with a provision from 1 percent to 2 percent is given in table 1 [3].

Table 1. Calculation of the volume of the cost of damage from floods with a provision from 1% to 2% of the territory of the village of Omsukchan

| Characteristics of the area exposed to the negative impact of water | Area size, ha | Regulatory specific damage per hectare | K1  | K2  | Damage, RUB million in 2006 prices | Damage, RUB million in 2020 prices |
|---------------------------------------------------------------|---------------|-----------------------------------|-----|-----|-----------------------------------|-----------------------------------|
| Residential buildings, outbuildings, infrastructure and industrial facilities | 0.33          | 65.7                              | 1.85| 0.15| 0.602                             | 0.884                             |

K1 = 1.85 - territorial coefficient, taking into account climatic and local conditions, the risk of flooding, water erosion of territories, for calculating the cost estimate of damage, adopted for the Magadan region (table 2.1) [7];
K2 - coefficient taking into account the anthropogenic load on the catchment area of water bodies when determining the damage from floods, adopted depending on the number of inhabitants per 1 km² of the catchment area (table 2.2) [13].

To calculate direct damage, the deflator index was used in accordance with the Order of the Ministry of Economic Development of October 21, 2019 N 684, \( K_l = 1.47 \).

The amount of direct damage is 0.884 million rubles in 2020 prices. Indirect and unaccounted for damages will amount to 0.884 million rubles, \( x \ 0.25 = 0.221 \) million rubles. Total prevented damage in 2020 prices is 1.105 million rubles [1].

Taking into account the annual negative impact on the study area, with an area of only 0.33 hectares, the impact will be significant with annual capital investments to eliminate the impact of the Industrial stream [14]. The calculated investments for the implementation of protection measures will amount to 1.87 million rubles and will pay off in 3 years, by preventing the negative impact of the Industrial stream as a result of its impact on real estate and land plots falling into the zone of its influence.

4. Conclusion
The paper analyzes the current state and impact of water bodies on the territory of the studied object in the Magadan region, in the Omsuchkan urban district and on the example of a specific object of the Industrialny stream in the Omsukchan settlement [15].

Carrying out works to prevent water damage to land plots and real estate objects that are subject to floods and waterlogging are acute. Millions of damages are borne by the municipalities and citizens of these territories. Carrying out work to prevent the negative impact of water, the concept was adopted at the level of the Russian Federation, the implementation of which requires the latest developments in terms of methodological, technological and organizational.

One of the main tasks in the chain of all solved problems of this problem, as noted in the study, is the relevance of information on flooding zones, its processing, application for design solutions and the subsequent implementation of the project.

The proposed methodological provisions include the following actions.
- collection, analysis and generalization of observations of hydrometeorological, hydrological, geological, hydrogeological and cartographic study of the flooded territories using the software “Statistica” v.10.0, JMP Statistic 15 and Minitab 19;
- processing of materials of cartographic study of the flooded territories of settlements using GIS technologies.

These allow one, in a short time and with maximum reliability and accuracy, to obtain the necessary document used to conduct research in these zones on those indicators that require clarification, or to obtain their new values, processing with the obtained data and forecasting with the obtained indicators of the state in the zone of influence. This can be done taking into account the recommended measures to prevent the negative impact of water on land and real estate.

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