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EXOGENOUS GEODYNAMIC PROCESSES OF THE CENTRAL PART WEST SIBERIA

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ABSTRACT

Manifestations of exogenous geodynamic processes in geomorphological objects at this stage is defined as damaging or destroying human life environment, leading to significant changes in the structure of the earth's surface. The term "exogenous geodinamic processes" refers to the concept of EA Likhachev, DA Timofeev "geomorphological danger" by the actions of these processes may be a crisis, disaster or catastrophe for a particular community of people and their economic structure. The factors leading to the expression of exogenous geodynamic processes in key areas of geomorphological objects taiga zone of the West Siberian Plain are: neotectonic movements, lithogenic properties, climatic and hydrological conditions. Spatio-temporal transformation of valley landscapes of the West Siberian Plain under the influence of exogenous geodynamic processes determines the need to systematize the information on the distribution, activation of the facts of the processes in specific situations to assess the risks of natural and technogenic systems.

Erosion and channel processes are subject to a number of common patterns and factors such as the spatial and temporal relations, relations with the natural climatic environment, which have been investigated in key ranges in lowland landscapes middle course Ob. Key polygons match to the tectonic faults, where monitoring of exogenous geodynamic and fluvial processes conducted for 15 years by a fixed terrain of bench marks for ranges; since 2014 used in the study 2 satellite receivers Leica GS10, geodetic measurements are made. Spatial analysis of the territory was performed on the material of information and space technologies Ugra Research Institute of Information Technologies (Khanty-Mansiysk). Data temperature's of the soil, within key polygons fixed by thermochrons type DS1921G-F5 - for depth: 20 cm, 40 cm, 60 cm and 1 m, and type DS1921Z-F5 - depths of 2 m, 3 m, 4 m, 5 m and 6 m. Hydro-meteorological indicators were analyzed according to dates of the Nizhnevartovsk's stream flow measuring station by Tyumen region and Alexander's stream flow measuring station by Tomsk region.

Keywords: exogenous geodynamic processes, geomorphological analysis, natural hazards, exogenous geohazards, Leading exogenous processes, shore deformation, lateral erosion, objects of the oil and gas industry

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INTRODUCTION

The intensive development of oil and gas resources of the central part of the West Siberian Plain is accompanied by multifaceted activation of exogenous processes, often resulting in emergency situations. It determines the need to incorporate exogenous geodynamic phenomena in an integrated monitoring program. To this end, it is important to organize information on the distribution, the facts of activation of exogenous geodynamic processes in specific situations and determining measures their dangers for the natural systems and functioning of technical systems. Designated questions are part of the topical problems of environmentally safe development of oil and gas industry facilities.

The methodical part of the presented work is based on the works of E.A. Likhacheva, V.P. Palienko, I.I. Spasskaya [1], Yu.G. Simonova, S.I. Bolysova [2], Yu.G. Simonova, T.Yu. Simonova [3]. The spatial-temporal transformation of the valley landscapes of the West Siberian Plain is reflected in the identification of exogenous geohazards [4, 5].

Studies are carried out taking into account the landscape structure of the central part of Western Siberia developed by N.N. Moskvina, V.V. Kozin [6], on the theoretical and methodological basis of the study of modern exogenous processes, outlined in the works of A.A. Zemtsov [7], V.B. Vyrkin [8], V.T. Trofimov [9], N.S. Evseeva [10], A. Knighton [11], C. Thorne [12], a tectonic map of the West Siberian Plain (Space image geological Map, 1982)

STUDY AREA

The area of research corresponds to the middle Ob lowland, which occupies the central part of the West Siberian Plain (central part of Western Siberia) within the latitudinal course of the River Ob. The landform of this territory is flat-leveled with the prevailing heights from 40 to 80 m, and on the watersheds from 100 to 120 m above the Baltic Sea level.

RESEARCH METHODS AND MATERIALS

Researches of active lateral erosion are carried out for 15 years with the help of range line on the locality and from 2014 with the use of 2 satellite receivers Leica GS10 geodetic survey of the studied area. In addition, the decoding of space images for 1982, 1994, 2001, 2014, 2015 and 2016 using the Information and Space Technologies Laboratory of the Yugra Research Institute of Information Technologies (Khanty-Mansiysk) was used in the work. Digitization of the investigated key site located on the right bank of the river Ob was carried out for each satellite image by years based on the reconciliation of GIS technologies. The geological conditions and the soil cover of the study area have their own specifics [13, 14].

For the first time for the territory of the central part of the West Siberian exogenous geodynamic processes are considered in the spectrum of natural hazards, taking into account the classification of exogenous and anthropogenic geodynamic processes peculiar to the areas of oil and gas development. Activation of erosion processes, in connection with changes in natural factors, leads to an increased risk of economic activity and is exacerbated in the zones of tectonic faults, as evidenced by field work. Geomorphological analysis of the most probable places and causes of accidents allows pointwise identification of vulnerabilities and take measures to prevent negative

consequences, as well as to obtain economic benefits from minimizing emergency consequences.

RESULTS AND DISCUSSION

A number of significant natural events within the central part of the West Siberian Plain (the high level of flood waters in 2002, 2007, 2015 and the anomalously warm and shallow summer of 2003, 2012, 2016) of the last time have emphasized the increasing activity of manifestation of exogenous geodynamic processes. In the opinion of F.N. Ryanskiy [15], among the processes that have a significant effect on the functioning of geosystems are natural cycles with a frequency of 12, 36, 108 years. A characteristic feature of such processes is the geophysical complex of a number of natural periodic changes which include sharp fluctuations of dryness-humidity with economically perceptible droughts and floods, earthquakes, development of active erosion, long, severe and snowy winters (for example, the winter period 2014-2015, 2016-2017). Variations in meteorological parameters provoke outbursts of development of the leading class of factors associated with a complex of exo geodynamic processes. The greatest danger is the flooding of valley landscapes, which leads to activation of lateral erosion. A critical level of water uplift in the period of high flood for the river Ob is a 10 meter level above of the schedule zero post. This level is dangerous for the population and for the oil infrastructure. For the Vakh River this level is 7 m. At the Nizhnevartovsk stream flow measuring station "0" of the graph is equal to 29.98 m. In 1979, the maximum level of water lifting was instrumentally fixed to 10.71 m, which led to the flooding of the relief with absolute heights of 40.69 m, in 2002 9.94 m - 39, 92 m in 2007, 10.12 m - 40.1 m, in 2015 it is 10.61 m and this indicator is the maximum for the last 36 years, which led to the flooding of the surface with absolute heights of 40.59 m. In addition, the study uses data on the Aleksandrovsky water-measuring post of the Tomsk region for 1941, where the level reached 12.37 m. An important point is the consideration of the forecast presented on the basis of engineering and geological studies conducted by the Nizhnevartovsk hydrogeological party in 1966-67, in the zone of the projectable Nizhneobskoye reservoir between vv. Verhnemysovaya-Medvedevo. It was supposed that "the backwater of the projected Nizhne-Ob reservoir with an absolute mark of 35 m will reach then the settlement of Nizhnevartovsk and the level will be limited to the banks of the present riverbed of the river Ob and its tributaries. In the period of high floods, the level of the reservoir will rise to absolut data 39-40 m, which will lead to a complete flooding of the floodplain of the river Ob and individual small on the area of depressions I and II of the fluvial terrace above flood-plain in the area of the village of Nizhnevartovskoe and village of Vata, flooding of small riverside areas of the territory and wave destruction of some sections of the coast. Flooding of the territory due to the rise of groundwater as a result of the backwater of their reservoir, will capture extremely small areas of the territory and will not have practical significance. Wave destruction of the shore of the reservoir will have small dimensions, but will affect the most developed areas of the territory. This forecast, in our opinion, did not take into account the geosystem approach. An example of active development of coastal abrasion is the Bratsk Reservoir, where in 1967-1968 was recorded a retreat of the coast by 1.1-1.2 km.

Exogenous geohazards is ranked by us as follows: security; minimal danger; moderate danger, acceptable danger, after which comes into force the emergency category (extreme danger). In addition to this, a point-based system is included in the leading

hazard category for quantitative assessment and territory-geomorphological binding is performed. Geomorphological basis is taken morphogenetic, morphometric and morphodynamic principles, and in the space-time aspect, the territory of valley landscapes with the complex of manifestation of modern exogeodynamic processes is considered. An important role for the dynamic component is obtained by the data of regime observations at field stations. The main method for assessing natural hazards is mapping the territory, creating cartographic models. At the same time, the principle of assessing the territory according to the most dangerous process is realized, and it is also leading in modern physical and geographical conditions. The key site "Ust-Vakhsky" is located on the right bank of the Ob river, in morphodynamic terms this region is wide-floodplain. River bends are free, segmental developed with islands in the ridge-top part (branched-sinuous river channel). The riverbed of the river Ob within the research area is formed under conditions of active development of channel deformations. In 1974, the field station was laid by the Tyumen Integrated geological Exploration Expedition on the right bank channel of the Vartovskaya Ob in the city of Nizhnevartovsk. In 1980, this field station, due to the active development of the coastal zone, was moved to the mouth of the River Vakh and where, until 1994, annual measurements were made. In 2001, observations on this key area were restored by students and employees of the Nizhnevartovsk State Pedagogical Institute (now Nizhnevartovsk State University). The maximum speed of the shore retreat from 2001 to 2016 was recorded in 2004 with an indicator of 17.5 m on the 5th range line. If you take into account the average annual activity, the values obtained vary from 7.8 m / year in 2002 to 0.7 m / year in 2012. Over the years, the average annual retreat of the coast according to the Tyumen Integrated Hydrogeological and Engineering-Geological Regime was: in 1983 - 9.8 m / year; 1984 - 4.9 m / year; 1985 - 2,76 m / year; 1986 - 3.01 m / year; 1987 - 3,9 m / year; 1988 - 10.42 m / year; 1989 - 3.26 m / year; 1990 - 7.72 m / year; 1991 - 1,54 m / year; 1992 - 5.7 m / year; 1993 - 4.84 m / year. The average long-term indicator for 11 years was 5.26 m / year. The displacement speed of the edge of the Ob river bank, taking into account the average annual indicators from 2002 to 2016 were: in 2002 - 7.8 m / year; 2003 - 2.35 m / year; 2004 - 3,46 m / year; 2005 - 2.89 m / year; 2006 - 4,19 m / year; 2007 - 3,25 m / year; 2008 - 1,93 m / year; 2009 - 2.36 m / year; 2010 - 1,57 m/ / year; 2011 - 1.51 m / year; 2012 - 0.68 m / year; 2013 - 2.36 m / year; 2014 - 2.45 m / year; 2015 - 5,0 m / year, in 2016 - 1,69 m / year. The average long-term retreat of the coast, according to observation points, for 15 years is 2.9 m / year. The maximum retreat rate of the edge of the coast was fixed in 2004 and amounted to 17.5 m / year on the fifth range line, which corresponds to informations by maps of the "Morphology and dynamics of the Ob and Irtysh river beds" of the Atlas of the Khanty-Mansiysk Autonomous Okrug-Ugra (volume II, page 75 , 2004). Comparing the two observation periods, the coastal erosion activity from 1983 to 1993 was higher. To verify the obtained values, the method of space images comparison was used. As a result of the comparison, areas of lost land were obtained for three periods: from 1982 to 1994, - 416 200 m2; from 1994 to 2001. - 225,000 m2; from 2001 to 2014 -200 800 m2. Area losses as a result of coastal deformations from 1982 to 2014 amounted to 842 000 m2. Analyzing three periods, the erosion activity of the right bank of the River Ob from 1982 to 1994 was higher, which was confirmed by the values obtained during field observations. To detail the data on modern exogenous processes from 2014 to 2016, a geodetic survey method using GNSS was applied. As a result, the erosion area in 2015 was 29.472 m2 and in 2016 11.403 m2 and the volume of waterworned soil in 2015

with an average height of 4.9 m was 144.412.8 m3, and in 2016, with an average height of the shore in 4.8 m - 54°734 m3. From the data obtained, we arrive at the result that the average shore erosion in the sections at the Ust-Vakhsky key site has the following values in 2014: 2.45 m / year with a maximum of 13.7 m at 10'th range line, in 2015 5.0 m / year with a maximum of 17 m at 10'th range line, in 2016 - 1.69 m / year with the highest value of 4.04 m on the 4th range line, and 2012 is marked by a low erosion rate. due to climatic and hydrological factors. This plot is used for economic purposes as hayfields. in connection with this we can talk about the loss of fodder land. In addition, monitoring of this site will help in drawing up further lateral erosion forecasts for the river.Ob riverbed in the central part of the West Siberian Plain. For the quantitative evaluation of exogenous processes, the intensity of manifestation, estimated by the area or linear coefficient, is applied to the entered scores. When calculating the rates of damage. only those forms of manifestation of the process that are being developed are taken into account. This indicator is an integral value characterizing the actual susceptibility of the territory, and can be used for forecasting. If several genetic species or varieties of exogenous processes are distributed within the area under consideration, the coefficient is determined differentially. The coefficient of damage varies from 0 to 1. The intensity of manifestation of exogenous processes is determined by the leading process. which is characterized by the highest coefficient of damage taking into account others. with less damage. The estimated characteristics of individual classes, types, forms of exogenous processes can be approached in more detail. For example, the fluvial type of exogenous processes is ranked by scores from 0 to 3 and each score corresponds to a quantitative characteristic obtained from calculations of the stability factor, moreover, in each evaluation interval, the value of the averaged rates of erosion (deposition) of the shores (m/year), the length of the zones erosion (%) of the length of the river section, the periodicity of the horizontal deformations in time (development and straightening of the bends, alternating development and dying of the arm of a river), the possible maximum washout rate (m/year) and the average velocity of the river bed relief (m/year). To obtain these indicators, long-term observations of the key site are necessary. At the moment, the surface-water class of exogenous morphogenesis formation is in a linear stable mode, having in its nature an open nonlinear structure. If equilibrium conditions are violated, development turns into a non-linear unstable regime, and when exacerbation of non equilibrium conditions - into an extremely streaming mode of development. In our opinion, it is the surface-water class of exogenous geodynamic processes for the territory under consideration that poses a danger of the development of the natural and technogenic environment.

CONCLUSION

At the moment, the surface-water class of exogenous relief formation is in a linear stable mode. having in its nature an open nonlinear structure. If equilibrium conditions are violated, development turns into a non-linear unstable regime, and when exacerbation of nonequilibrium conditions - into an extremly developing mode of development. In our opinion, it is the surface-water class of exogenous geodynamic processes for the territory under consideration that poses a danger of the development of the natural and technogenic environment. There is an activation of erosion processes in

the zones of tectonic faults, this situation is aggravated, which leads to increased risks for production and economic activities.

Analysis of manifestations of natural hazards associated with exogenous processes makes it possible to identify the boundary conditions of the optimal variant of economic functioning within the geomorphogenesis equilibrium of a territory subject to active economic development, as well as analysis of the most probable places and causes of accidents, allows pointwise identification of vulnerabilities and take preventive measures negative consequences, as well as to reduce economic losses from emergency consequences.

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