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The role of climatic risks in erosion advancing in the south of Tomsk region

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The aim of our research was the studying of dangerous meteorological phenomena that created situations for an active erosion advancing in the south of Tomsk region in 1967–2012, where there are more than 70% of population of the region, main agricultural lands and industrial sites. The boundaries of the natural seasons in the south of the Tomsk Region were determined by the methodology of Galakhov and Rutkovskaya. The preconditions for the development of water and wind erosion in each phase of the year and five phases with the most active development of erosion were identified. The analysis of climatic conditions of all structural units of the year helped to allocate 39 erosion threatening factors for water erosion and 16 for wind erosion. A model of climate's erosive potential was worked out. It was set that south areas of the Tomsk Region differ in the level of potential risk of erosion. Due to the research it is possible to take measures for protection the soil, which should be local considering seasonal rhythms of climate.

Keywords: natural seasons, weather and climatic risks, water and blowing erosion.

Foreword

Climatic risks are indefiniteness which is connected with a possibility of origin of unfavorable situations and consequences in the future that are influenced by meteorological phenomena.

There are more then 30 types of hazardous natural phenomenona (HNP) in Russia [1], but 50–70% of general damage of all HNP are severed by weather activity [2, 3]. The biggest quantity of hazardous phenomena from all Federal Districts is in Siberian Federal District [4]. There is almost no detailed analyse of HNP – wind, incessant rains, low and high temperatures – in the Tomsk region. In this connection, the research of HNP is actual for the south of the Tomsk region (Tomskiy, Kozhevnikovskiy, Shegarskiy, Bakcharskiy, Asinovskiy, Pervomayskiy disricts), where there are more than 70% of population of the region, main agricultural lands and industrial sites.

Dates and methods of the research

One of the main and the first step of risk management is a monitoring of possible risk events. Therefore, the aim of our research was the studying of dangerous meteorological phenomena that created situations for an active erosion advancing in the south of the Tomsk region in 1967–2012 (Tomskiy, Kozhevnikovskiy, Shegarskiy, Bakcharskiy, Asinovskiy, Pervomayskiy disricts) [5].

The foundation of our research was comprehensive genetic method of climate study of N.N. Galakhov and N.V. Rutkovskaya [6, 7]. The starting of calendar climatic and natural seasons of the year does not coincide (Table 1).

Table 1. Comparison of time fences of astronomical calendar, and natural seasons

The name		The date of season starting		
season of year	phase of year	astronomical	calendar	natural*
Winter	moderate frosty winter	22 December	1 December	2–5 November
	considerably frosty winter	–	–	13–19 December
	prespring	–	–	12–22 March
Spring	snow thawing	21 March	1 March	16–20 March
	postwinter	–	–	14–20 April
	before a summer	–	–	25–30 April
Summer	moderate and tepid summer	22 June	1 June	16–23 May
	moderate and warm summer	–	–	11–13 June
	recession of a summer	–	–	14–22 August
Autumn	formation of an autumn	23 September	1 September	9–15 September
	end of an autumn	–	–	29 September – 2 October
	before a winter	–	–	19–22 October

* It was made by weather station of the south of Tomsk region

The essence of the complex genetic method consists of data mining and analysis of features of chronological daily course of leading climatic factors with simultaneous analysis of the dynamics of phenological occurrences in certain parts of the earth's surface. If a detection of diurnal rhythm does not cause problems seasonal and annual rhythms in its calendar boundaries will not usually coincide with real course of development of natural processes. Accordingly, it is necessary to take into consideration the seasonal rhythmicity for fixation of connection of annual dynamics of erosion process and climate. It will facilitate to study everything in details and to estimate the soil erosion.

We identified the structure of annual cycle that means complex of successive parts of the year. During these parts heat and moisture indexes gradually change. It follows with changing of development of geosystems and it is cyclical. These parts of the year are called structural units and it divides into three degrees (Table 1):

– Structural units of the first degree are cold snow (CSPY) and vegetative parts of a year (VPY);

– The second degree – seasons of a year: winter, spring, summer and autumn. They have different duration every year, and its starting and ending do not coincide with starting and ending of calendar months;

– The third degree – phases. There are 12 phases: 5 – in CSPY, 7 – in VPY [7].

The features were calculated for every structural unit of the year: sums of average daily air temperatures, average air temperatures, sums of precipitation, average amount of precipitation, middle layer of precipitation, amount of days with precipitation; for VPY: quantity of incessant rains, general and average layer of water for incessant rains, average and maximum speed of a wind; for CSPY: average and maximum height of snow cover, average and maximum deep freezing of soil.

Results and discussion, conclusion

The analysis of climatic conditions of all structural units of the year helped to allocate 39 erosion threatening factors for water erosion and 16 for wind erosion. However, there was no simultaneous demonstration of these factors in 1967–2012. The biggest quantity of features for water erosion was in 1995/96 and 2005/2006 and for wind – in 1981 and 2010 [5, 8].

Combination of indicators of dangerous erosion influences on intensity of development of soil erosion. It helps to devise the model of erosional potential of a climate [5]. The reliability of this model was verified in Luchanovo's permanent study area. Our research led to the following conclusions.

The erosion advancing in the south of Tomsk region observes annually. An intensity of erosion relies on thermal and wind mode and moisture security.

There are favorable conditions for developing of water and wind erosion but not in the same time. It is necessary to consider that erosional processes of different genesis closely linked – washed-away soils are more exposed by wind erosion than unwashed-away soils and vice versa.

There are not any soils that are not absolutely influenced by erosion in the south or the Tomsk Region. Moistening of soils is the main climatical factor of erosion advancing.

Preconditions for water and wind erosion advancing are created during the whole year but the most active phases for it are «snow thawing», «postwinter», «before a summer», «moderate and tepid summer», «moderate and warm summer». Moreover, water and wind erosion advancing are made by different combinations of hydrothermaical conditions of these phases.

The most potential of erosional danger is typical for Tomskiy, Asinovskiy, Pervomayskiy; average – for Kozhevnikovskiy and Shegarskiy; the lowest – for Bakcharskiy district of the south of the Tomsk region. In this connection, an activity of protection of soils should be local considering seasonal rhythms of climate.

To sum up, if we know climate changing we can forecast erosion advancing and we can also work out an algorithm of weather and climatic risk management.

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