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INFLUENCE OF CLIMATIC FACTORS ON HIGH WATER LEVEL OF RIVERS OF THE CENTRAL PART OF THE WEST SIBERIAN PLAIN

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ABSTRACT

The flood time of Siberian Rivers coincides with the spring and summer period and is characterised by intensive water feeding because of intensive snow melting. At all that, the most annual water discharge is formed, the latter, by turn, causes erosion processes. In addition, in years with excessive amount of flood water, the inhabitants suffer economic losses very much: E.g., economic activity areas are flooded, engineering structures are washed away and damaged. A number of factors form high water level such as geomorphologic, biologic (vegetation), climatic ones which, by turn, become stronger, by influence of the anthropogenic factor. Climatic ones influencing high water level by example of the river Ob were analysed. These are air temperature, soil temperature, precipitation, evaporation level, because snow reserves determine volume of high water, air temperature influences snow melting intensity, in addition, soil temperature and isolated permafrost areas occurrence influence high water level respectively. The revealing of hydrological and climatic specialities of the studied area enables to evaluate the environmental changeability and determine a number of the regional patterns of water balance constituents.

Keywords: climatic factors, high water, peat oligotrophic soil, alluvial sod soil, illuvial and ferruginous podzolic soil.

INTRODUCTION

The unique feature of the water regime of the most of rivers of the central part of West Siberian plane is spring high water caused by snow melting and simultaneous rainfall. The flow in this time is 50 - 70% of the annual one. As the water flow rate is increased manifold and causes sizeable flood stage. in years with excessive amount of flood water, the bottomland is flooded; hence, settlements and engineer structures are impounded too. The latter generates economic loss. The main features of spring flood, in the view of E.G. Popov, are as follows: flow volume, maximum flow rate, highest level and their arrival time. The total high water time flow is determined by the three basic factors as follows:

1) Quantity of snow storage in a river basin for winter;

2) Quantity of precipitation for the time of high water formation;

3) Water absorption capacity of the river basin: the former is sizeably changed every year.

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Ceteris paribus, for the high water time, the total flow increases, if there is more snow and precipitation, and, in contrary, decreases, if water absorption capacity of river basins increases [1].

Since the factors of high water are very changeable from year to year, detailed study of the parameters mentioned above is very interesting to develop a correct high water level forecast.

A.M. Vladimirov emphasises four factor groups as follows: climatic, geomorphologic, vegetable, and anthropogenic ones. He also mentions that every group has a few factors, which, by turn, include a few parameters; the latter in different ways influence high water formation. The main such factors groups are climatic sign ones [2]. To study bed erosion processes, T.V. Romashova emphasises such a group [3].

Hydrology of the being researched area is considered to be bad known. The climatic factors forming high water in taiga conditions are today insufficiently studied. No detailed research of hydrological and climatic specialities interrelation influencing flood conditions development. Data of submerged land square do not always totally reflect the real situation. It is required us to be surely informed because the taiga submerged lands were recently increased very much.

The basin of the river Middle Ob is considered to be moderately dangerous on floods. They reiterate once 10 - 12 years; maximum flood plain layers can be up to 0.7 - 1.5 m; submerged lands can be 40-60% of the total area [4]. The natural causes of floods of the being studied region are thought to be as follows: spring and summer melting of snow and ice in drainage basins, heavy rains, ice jams for spring for spring breaking up. Anthropogenic factors can strengthen high water. Such ones are as follows: obstruction of the flow-through area by bed roads and dikes decreasing the bed capacity and raises the water level; abnormalities of the natural water flow and levels because of season regulation of the water flow by upstream reservoirs.

STUDY AREA

The study area corresponds to the Middle Ob lowland situated at the central part of the West Siberian plain (the central part of the West Siberia) within the latitude stream between 59° and 63° N and between 75° and 86° E. The area relief is plain with dominant heights of 100 and 120 m above the Baltic Sea level. The main water stream of the study area is the river Ob in its middle course, from the mouth of the channel Svetlaya to the channel Lokosovskaya. Within the Nizhnevartovsky District, the part of the Ob middle course is 134 km length; the bed is from 18 to 20 km width. Middle annual water flow of this part is circa 5634 m^3 [5], [6]. The main second and third order rivers are the ones Vakh, Agan flowing from the mouth of the river Tromyegan up to the source of the Agan. By their water regime, these rivers are ones with spring and summer high water. The latter lasts on average 60-130 days. The river Ob taiga zone sizeably differs from the adjacent forest-steppe one because of, first of all, distinction of their water balance constituents. When precipitation increase sizeably and their evaporation losses decrease, the local surface run-off increases sizeably too [7].

RESEARCH METHODS AND DATA

Water level in the high water time of the river Ob, precipitation and snow depth were studied on the base of our field research data.

To do landscape snow survey to determine the basic parameters of snow cover accumulation we applied the method of route snow survey in different landscape conditions. We measured the snow cover depth applying a mobile snow scale; the snow density and its water stock were determined by a weigh snow sampler. In an area of 10 m^2, there were 10 snow depth measurements per one snow density determination. Cameral calculation of the snow density in every spot of its previous determination is done dividing the snow sample mass by the snow volume. Thus, the snow density is calculated as g = 5m / 50h = m/10h. The meteorological data are taken from the site of the All-Russian Hydrometeorological Information Research Institute – World Data Centre. The route landscape snow survey enabled to find interrelation between parameters of the snow cover and constituents of the water balance. In the network of the given research, by mathematical statistics formulae, the coefficients of standard deviation and variation for precipitation, snow cover height and density, its water stock and equivalent level after melting were calculated.

RESULTS AND DISCUSSION

Climatic factors have special significance regardless of all they acts integrally. They are basic ones determining high water formation. In addition, they cause intensity and geographic pattern of erosion spread (unlike underlying surface features) directly, that is why, these factor are worth to be studied detail. In this work, climatic factors, influencing the water level in high water time, by the example of the river Ob middle course are analysed. They are as follows: air temperature, soil temperature, solid precipitation (snow), and evaporation level. As snow stock determines high water amount, and air temperature influence snow melting intensity, soil temperature and isolated permafrost occurrence influences the flow quantity in high water time.

V.V. Kozin and E.A. Kuznetsova emphasise snow cover evolution phases of snow cover as follows:
I. Temporal snow cover: 20/10-20/11;

II. Intensive snow accumulation: 21/11-20/01;

III. Snow column transformation and compression: 21/01-20/03;

IV. Snow melting: 21/03-21/04;

V. Snow cover dispersion: 22/04-17/05 [8].

To study high water formation phenomenon, one should take the snow melting phase in account, because this stage is notable for maximum snow amount. For the research area, the snow melting phase is from the third ten-day period of March to the third ten-day period of April.

We also analysed late autumn precipitation amount as the key soil wetting factor in this time, because melt water infiltration into the frozen soil is difficult. The sum of positive temperatures for the snow melting phase determines the melting process itself. The more the former is, the sooner high water springs up; hence, its peak springs up sooner too. Such interrelation is reflected in Table 1.

Table 1: Sum of Positive Temperatures a Snow Melting Time by Years

Year	Sum of Positive Temperatures in the Snow Melting Time
2015	72.5
2016	116.0
2017	60.6

Comparing sums of positive temperatures in a snow melting time to high water features, one can clearly see interrelation among temperature records, times of the high water and times of their maximum values. The warmest snow melting phase was in 2016 when the sum of positive temperatures was 116 °C from March to April. In Fig. 1, you see that the earliest high water began in 2016 too and its peak started earlier too (06/06/2016, 868 cm) as against 2015 and 2017.

The obtained data prove: The more the sum of positive temperatures in the snow melting time, the more intensive the snow melts, the time of water rising is shorter and the maximum high water springs up sooner.

As Ye. Kukharchuk, V. Rusnak, Yu. Korman and D. Bratko note, the most important spring flow forming factor is soil moisture in late autumn time. Soil which froze after excessive moisture is little penetrable by melt water and is a natural hydraulic lock enabling more flow to rivers [9]. Ipso facto, late autumn precipitation sum influences surface flow formation [10].

Table 2. Climatic Factors Records Forming High Water

Years	Late Autumn Precipitation Sum	Snow Cover Depth	Snow Density	Snow Cover Water Equivalent	Water Level
2015	179	89,3	0,032	28,6	1061
2016	114	70,4	0,026	18,6	868
2017	105	78,3	0,025	19,3	878
2018	116	67,7	0,020	13,5	

Table 2 represents climatic factors records forming high water. You can see that, in 2015, the late autumn precipitation sum was 179 mm; it is highest from 2015 to 2018. In 2015, the other parameters were higher and caused the maximum water level rise in recent 36 years. To prove interrelation among the climatic records, the polynomial approximation was plotted; R^2 value is very close to 1. The latter proves a good coincidence between the experimental and theoretical curves. Thereby, it proves interrelation of high water forming climatic factors and their influence on a high water level. Fluctuation of meteorological parameters causes leading factors development bursts connected with a number of exogeodynamic processes. The most dangerous one is valley landscapes flood; it activates lateral erosion. The critical mark in a high water time is 10 m over the datum level [11].

Within the Middle Ob lowland, there is isolated and rare permafrost areas occurrence. They are in low-lying lacustrine-alluvial plains where there are hummock-ridge bogs and peat depressions like valleys. The permafrost temperature is not lower than -1 °. The season frozen layer within melted landscapes increases consistently: 0.5-0.8 m in the peat and 0.8-1.1 m in different type bogs: from 1.4-1.7 m to more than 2 m in loam soils depending on the reforested plains drainage degree; from 1.4 m to more than 2 m in sands, in addition, in compliance with landscapes hydromorphism [12]. Thanks to the field research, depths of frost penetration distributed by soils in the key area of the Middle Ob lowland were determined (see Table 3). The obtained results on the frost penetration differ from ones, which are indicated by the special literature. In addition, the difference is generated by soil types.

Table 3. Soil Frost Penetration Since 2015 to 2018, cm

Measurement Date	Peat Oligotrofic	Alluvial Turf	Peat Podzol	Podzol Illuvial-ferrugenous
13/03/2015	3	5	20	41
22/03/2016	16	13	15	26
14/03/2017	20	22	28	30
16/03/2018	21	20	17	67

Type variety of soils in the southeast part of the Middle Ob lowland lacustrine-ingressional terrace, in the estuarine part of the river Vakh, at the confluence into the river Ob, is determined by the smoothed relief having light inclination towards rivers, bottomland regime, and light granulometric composition of the lacustrine-alluvial rocks in the form of dust loamy sand. All that is generated by

the area evolution speciality in the Holocene. Developed complexes of hummock-ridge bog are mainly represented by hydrophilic vegetation. The species composition, besides widespread mosses (Sphagnum L.), is as follows: waxy-leaved andromeda (Andromeda polifolia L.), bog myrtle (Chamaedaphne calyculata (L.) Moench), European cranberry (Oxycoccus palustris Pers.), marsh tea (Ledum palustre L.), bog bilberry (Vaccinium uliginosum L.), Arctic birch (Betula nana L.), vaginal cotton grass (Eriophorum vaginatum L.), spherical rasp-grass (Carex globularis L.), vesicular rasp-grass (Carex vesicaria L.), cloudberry (Rubus chamaemorus L.), Scotch pine (Pinus sylvestris L.), and Siberian pine (Pinus sibirica Rupr. Mayer) [13]. Specialities of vascular plants favour peat oligotrophic soils formation, peat thickness of 2 m. The maximum peat layer water saturation (1400%) is in May; by August, the peat humidity is 400%.

The oligotrophic bogs are drained by rivers (at the being studied area, the biggest one is the Bolshoy Yogan). In the area near their beds, alfehumus soils are formed as follows: podzolised brown, podzolised, peat-podzolised gley illuvial-ferrocious (in hummock-ridge bog ecotones) ones. Mineral horizons of illuvial-ferrocious podzolised soil with gleying indications and peat horizon of 40 cm are formed on light sandy-loam deposits at recurrent wash water regime on slope positions among mineral islands, where there are moss, pines and shrub. In August, the peat horizon humidity is circa 200-300%, BF one is 47%.

The being drained mineral islands are, as a rule, roundish, have clear boundaries and flat tops, are higher than hummock-ridge bog complexes. There are moss, pines and shrub on podzolised illuvial- ferruginous soils formed on horizontally stratified dusty sandy loam, where the groundwater line is 5.5 m. The marked drainage is expressed by hydrological regime of the soils very good. The maximum humidity is in spring-and-autumn time in forest floor upper layer AO - 80%. In June, humidity of the podzolised illuvial-ferruginous soil horizons is as follows: AO - 34 %, E - 10 %, BF - 6 %, BC - 9

%. In September, the mineral horizons humidity is as follows: E - 10 %, BF - 6 %, BC - 8 %.

The river Bolshoy Yogan is the second order one for the Ob, falls into it from its right; its mouth area has the good formed bed; its herbaceous vegetation is developed good. These are as follows: sharp edged sedge (Carex acuta L.), caespitose sedge (Carex cespitosa L.), long-leaved veronica (Veronica longifolia L.), golden loosestrife(Lysimachia vulgaris L.), cowberry (Comarum palustre L.), bottle brush (Equisetum arvense L.). The alluvial turfy gleyed soil with quite thick light humic horizon (20 cm) is represented by light brown loamy soil which is penetrated by roots of herbaceous vegetation and mother rock; the latter is blue-grey gleyed cloddy loamy soil. In August, the soil humidity for horizon AY is 43%, and for horizon CG is 25%.

CONCLUSIONS

The flood time of Siberian Rivers coincides with the spring, summer period and is characterised by intensive water feeding because of intensive snow melting. At all that, the most annual water discharge is formed, the latter, by turn, causes erosion processes. In addition, in years with excessive amount of floodwater, the inhabitants suffer economic losses very much: E.g., economic activity areas are flooded, engineering structures are washed away and damaged.

The obtained data proves that the more the sum of positive temperatures for snow melting time is the more intensive snow melting is and the peak of high water springs up sooner. Snow stock determines high water amount, and air temperature influences snow melting intensity; precipitation quantity in late autumn time is the key factor to form surface flow. Sum of positive temperatures a snow melting time by years: 2015 - 72.5; 2016 - 116.0; 2017 - 60.6.

The warmest snow melting phase was in 2016 when the sum of positive temperatures was 116 °C from March to April, you see that the earliest high water began in 2016 too and its peak started earlier too (06/06/2016, 868 cm) as against 2015 and 2017. Climatic factors records forming high water: late autumn precipitation sum (2015-179; 2016-114; 2017-105; 2018 -116); snow cover depth (2015-89.3; 2016-70.4; 2017-78.3; 2018 - 67.7); snow density (2015-0.032; 2016-0.026; 2017-0.025; 2018 -0.020); snow cover water equivalent (2015-28.6; 2016-18.6; 2017-19.3; 2018 -13.5).

In the being studied area, there is isolated and rare permafrost; it favours the melt water to flow. The records of the soil frost penetration within the key area showed specialities of 2015. In spring-and-autumn time of 2014-2015, the maximum soil humidity favoured high level of the high water. Type soil variety influence season frozen layer thickness and interaction with the groundwater. Soil frost penetration since: peat oligotrofic (2015 - 3 cm, 2016 - 16 cm, 2017 - 20 cm, 2018 - 21 cm); alluvial turf (2015 - 5 cm, 2016 - 13 cm, 2017 - 22 cm, 2018 - 20 cm); peat podzol (2015 - 20 cm, 2016 - 15 cm, 2017 - 28 cm, 2018 - 17 cm); podzol illuvial- ferrugenous (2015 - 41 cm, 2016 - 26 cm, 2017 - 30 cm, 2018 - 67 cm). The obtained results prove influence of a number of climatic factors on high water formation.

But once you note that in connection with a larger variety of the parameters influencing formation and volume of a flood during the spring-year period, and with the minimum quantity of stations of supervisory network, prediction of level and the course of a flood is at a loss. The main can be considered nevertheless climatic group of factors, though from this group not all parameters work every year

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