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Extreme Flood Situations on the Rivers Of Belgorod Region.

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ABSTRACT

Extreme values of the spring flood levels in the region in 1953 and 1963 were due to the general hydrometeorological conditions such as excessive precipitations (140 - 180% of normal) in the autumn or in the winter-spring period, the abnormally cold winter (1-5°C lower than normal temperature), and soil freezing and snow water reserves 1.5-1.7 and 1.5-1.8 times higher than normal value, respectively. The ongoing climate changes and the increasing withdrawal of groundwater are a sufficient reason to expect lower levels of spring flood in the coming years.

Keywords: hydrological regime, the levels of spring flood, weather conditions, climate changes, anthropogenic load.

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INTRODUCTION

The hydrological regime nature and its elements variability are directly related to the climate and weather conditions in the specific years in the territory of river basins [1, 2]. Spring flood forming conditions change every year [3].

METHODS

The rivers flowing in the Belgorod region are the parts of the Don and the Dnieper rivers basin. The largest rivers of the Don basin, flowing in the Belgorod region, are the river Tihaya Sosna, the river Seversky Donec and its tributaries the river Oskol and the river Nezhegol; and the river Vorskla in the Dnipro basin. The primary elements characterizing the floods and being of greatest interest are the highest level and the maximum flow rate of water [4, 5]. The factors such as water reserves in the snow cover, the amount and intensity of rainfall during the snow melting, soil iciness, the depth of soil freezing, and melting rate are of primary importance in the formation of spring runoff [6]. The surface retention factors play a relatively inessential role, as our area has a well-dissected relief dominating.

MAIN PART

The main feature of the rivers of the Belgorod region is that the spring flood makes a main phase of their water regime. Spring runoff averages 60-70% of annual runoff and 70-80% in wet years. Spring flood level starts rising usually in the first and at the beginning of the second decade of March, lasting the whole April, and sometimes in May. The peak of spring flooding falls within the late March - early April. The water level of most rivers rises in the average by 2.0-2.5 m and in wet years by 5.0-5.5 m of the low water levels. Figure 1 shows the maximum levels of spring flooding on the rivers of the studied region over the last 75 years [7].

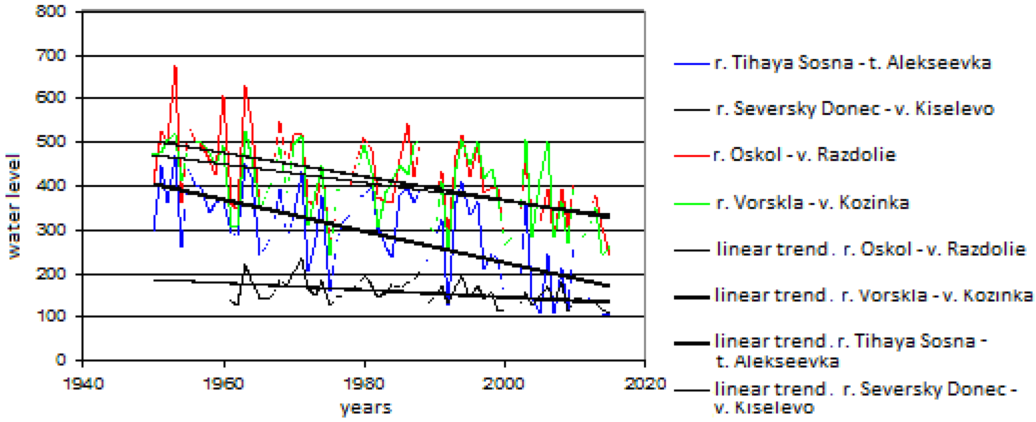

Figure 1: Spring flooding maximum water levels

The trend line shows a steady decline in the maximum water level of spring flooding. The most significant years during 1950-2015 period in terms of formation of high levels and flow rates of water in the rivers of Belgorod region were 1951, 1953, 1955, 1956, 1960, 1963, 1970, 1971, 1980, 1986, 1988, and 1994. The spring flooding of 1953 and 1963 had the highest values of maximum water levels that reached and exceeded the threshold values [7, 8].

Hydrologists have identified the following critical levels of gradation:

H_1 – water overflow, that happens quite often in the average water years;
H_2 – flooding of grasslands and some land, as well as individual buildings; this is a category of unfavorable hydrological phenomena (UHP);
H_3 – flooding of main farmlands and residential areas; a category of dangerous phenomena (DP);
H_4 – complete flooding of farmlands and residential areas; a category of particularly dangerous phenomena (PDP).

According to observations of the Belgorod Center for Hydrometeorology and Environmental

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Monitoring [8], the incidence of high-water spring floods has reduced in the last 65 years (Table 1):

Table 1

The incidence of maximum water levels classified as DP and UHP						
1951-1960	1961-1970	1971-1980	1981-2000	1991-2000	2001-2010	2011-2015
59	37	32	32	24	9	0

We shall analyze the hydrometeorological characteristics of the high-water spring flooding formation in 1953 and 1963, when the water rises were extreme.

In October 1952, the amount of precipitation was 106-168 mm at the rate of 32-43 mm, which contributed to the soil autumn waterlogging. In winter 1952-1953, a stable snow cover was formed in the most region's area on December 21-25, and in the south-east - on January 6.

An intensive snow accumulation started in February. Snow depth reached 16-28 cm, at a rate of 11-17 cm. The soil froze to the end of February to 60-110 cm, at a rate of 50-60 cm. The water reserves in the snow reached 51-90 mm in this period, at a rate of 35-53 mm. In mid-March, the snow started to melt, with full loss of snow cower on March 25-31.

The air temperature was 1-5°C lower than normal during the winter period. The coolest time was February, when average monthly temperature was 11-12 °C below zero, at a rate of 6.5-7 °C below zero. The cold weather continued in March. The average monthly air temperature was 3-3.5 °C below zero, at a rate of 1-2 °C below zero.

The beginning of spring flooding in 1953 was at the end of the third decade of March that is later than usual (Fig. 2).

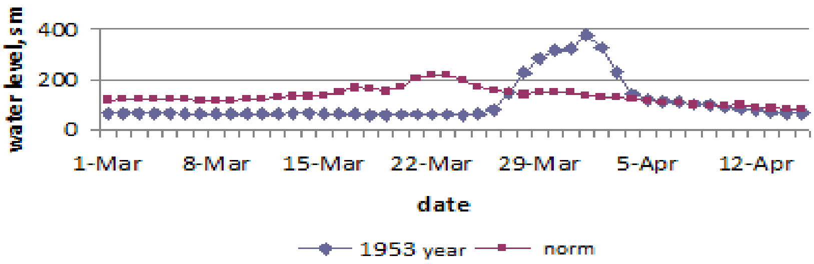

Figure 3: Spring flooding average daily water levels in the river Oskol, the city of Stary Oskol

The spring flooding peak was in the period of March 28 to April 3, at a rate of March 17-28. The maximum water levels at all hydrological stations reached UHP values; further, the levels of DP were observed on the rivers Tihaya Sosna - the city of Alekseevka, the river Nezhegol - the city of Shebekino, the river Oskol - the city of Stary Oskol, and the river Oskol - Razdolie industrial community.

In 1962, the autumn was quite dry. Precipitation in October and November were below normal and reached 30-50%. In late autumn, the meter-deep soil humidity on the river water intakes was 50-70 mm, at a rate of 99-120 mm. In winter 1963, the amount of precipitation was in most cases higher than normal, and in February it reached 130-140% of normal. In March, 44-63 mm of precipitation fell in the most territory of the region (120-190% of normal). The rate of precipitation in April was also 10-50% higher.

The first snowfall was observed on December 6 throughout the region. There was an intensive snow accumulation in January and first two decades of February. The average snow cover deep in late December was 30-33 cm, in the south-east of the region - 11-15 cm, at a rate of 11-16 cm. Throughout March, there was a snow compaction; previous snowfalls increased the snow cover depth up to 46 cm in the western region, at a rate of 15 cm, and up to 28 cm in the rest territory, at a rate of 12 cm.

To the end of February, the soil froze to 75-101 cm, at a rate of 50-60 cm. The water reserves in the snow reached 48-99 mm in this period, at a rate of 35-53 mm. In March, the soil freeze depth increased up to

80-105 cm, at a rate of 49-68 cm. The water reserves reached 60-90 mm in March, at a rate of 4-10 mm, and 4-10 mm in the south-west of the region. Full loss of snow cover in the south-west was on April 10-16, and in the rest territory - on April 17.

The winter period preceding to spring flooding was characterized by low negative air temperatures. The air temperature was below normal virtually the entire period, 6-8 degrees below normal in January and March, and 1-3 degrees below normal during the rest period. The average monthly temperature was 15-17°C below zero, at a rate of 8°C below zero. The average monthly temperature in March was about 6°C below zero, at a rate of 1-2°C below zero.

A stable transition through "0" degree upward the positive temperature occurred on April 9-10. At the same time, spring flooding of 1963 began (Fig. 3).

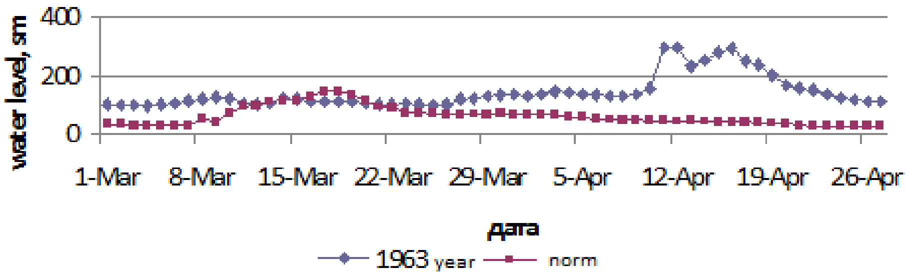

Figure 4: Spring flooding average daily water levels in the river Bolhovets, the city of Belgorod

The spring flooding peak was in the period of April 13-17, instead of usual period of March 17-28; it was observed on April 2 on the river Bolhovets within the boundaries of Belgorod instead of March 17. The maximum water levels that reached the DP criterion were observed at almost all hydrological stations.

CONCLUSION

Thus, the extreme values of the spring flooding levels in 1953 and 1963 were due to the following general factors:

- Excessive precipitation in the autumn (1952), or in the winter-spring period (1963);
- Abnormally cold, long winter (with 1-5°C lower than normal);
- Soil freezing 1.5-1.7 times higher than normal; and
- Water reserves in snow 1.5-1.8 times higher than normal.

Modern climate trends (Figure 4-7) have led to a reduction of moisture reserves in the meter-deep soil level, despite the increasing amount of precipitation in both cold and warm months [1, 9, 10].

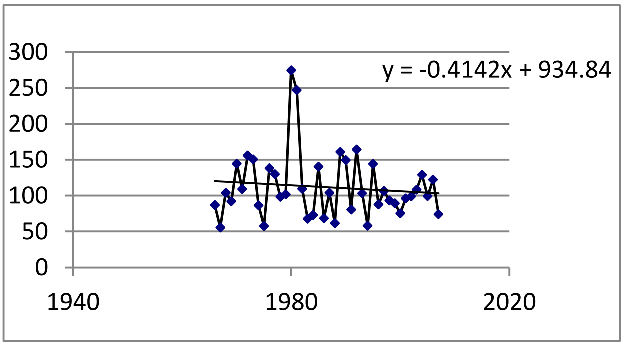

Figure 4: Average regional moisture reserves in the meter-deep soil level in the autumn, mm

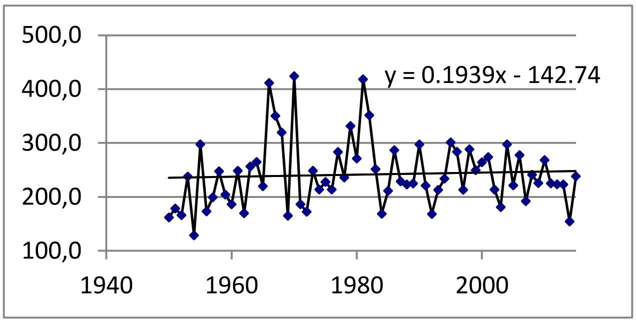

Figure 5: Average regional precipitation amount during the cold period, mm

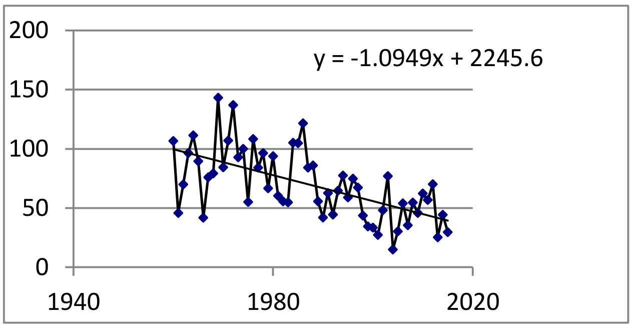

Figure 6: Average regional maximum deep of soil freezing, cm

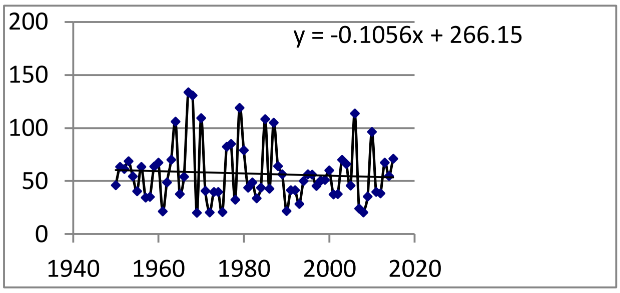

Figure 7: Average regional maximum moisture reserves in the snow cover, mm

The temperature rise during the winter period has led to the reduced depth of soil freezing. The interchanging cold and warm weather periods has led to the reduced moisture reserves in the snow cover.

SUMMARY

The climate changes [11-12] ongoing on the background of increasing anthropogenic load, expressed in active water withdrawal from underground aquifers [13-14], form the conditions unconducive to critical water level rise (up to DP or PDP) in the rivers of the region during spring snowmelt.

REFERENCES

[1] Petin A.N., Lebedeva M.G., Krymskaya O.V, Chendev Y.G., Kornilov A G., Lupo A. 2014. Regional Manifestations of Changes in Atmospheric Circulation in the Central Black Earth Region (By the Example of Belgorod Region). Advances in Environmennal Biology, 8 (10) June, pp.544-547

[2] Petin A.N., Petina M.A., Novikova Iu.I. 2014. Seversky Donec: hydrological regime and ecological status. Belgorod: Publishing house "Belgorod" SRU “BelSU”, p. 184.

[3] Lebedeva M.G., Drozdova E.A., Kornilov A.G. 2013. Natural and anthropogenic factors determining the elements of the water balance in the Belgorod region. Problems of environmental management and the ecological situation in the European part of Russia and neighboring countries: Proceedings of the V Int. Research. Conf., p. 90-93.

[4] Manual for hydrometeorological stations and posts: Ed. 2 Part 2. Hydrological observations at the posts. 1975. L., Gidrometeoizdat, p. 264.

[5] Manual for hydrometeorological stations and posts: Ed. 6 Part 1. Hydrological observations and works on the large and medium-sized rivers. 1978. L., Gidrometeoizdat, p. 384.

[6] Manual for estimated hydrological characteristics determination. 1984. L., Gidrometeoizdat, p. 448.

[7] Library materials of Belgorod Center for Hydrometeorology and Environmental Monitoring for 1940-2015.

[8] GD 52.04.563 – 2002. Guidance Document. Instructions. The criteria for hazardous hydrometeorological phenomena and the storm warning procedure. p. 28.

[9] M.A. Petina, M.G. Lebedeva, J.I. Novicova. 2014. Hydro-ecological characteristics of the transboundary rivers of the Belgorod region in conditions of exstrime antropogenic load and climate change. Technische Univtrsity Bergakademie Freiberg, Germany: Scientific Peports on Resourse Issues. Volume 1, pp.46-53.

[10] Chendev Yu.G., Petin A.N.,.Lupo A.R. 2012. Soils as indicators of climatic changes. Geggraphy, Enviroment, Sustainability, 1, pp. 4-17.

[11] A.N. Petin, V.K. Tokhtar, V.I. Petina. 2014. Geo-Ecological Problems of Kursk Magnetic Anomaly in the Russian Federation, Ways And Means for Their Remedy. Research Journal of Pharmaceutical, Biological and Chemical Sciences September-October, JPBCS, 5(5), pp. 1603-1606

[12] Yury G. Chendev, Guillermo Herandez- Ramirez, Aleksandr N. Petin, Richard B. Hall, Larisa L. Novykh and Evgeny A. Zazdravnykh. 2013. Soil organic carbon dynamics beneath tree windbreaks in the Russian Stepe and U.S. Great Plfins. Water, food, energy and innovation for a sustainable world. ASA, CSSA, SSSA International Annual Meetings, Nov. 3-6 Tampa, Florida.

ISSN: 0975-8585

[13] Furmanova T.N., Petin A.N., M.A. Petina. 2014. Technique of the complex geological evaluation of state of natural environment under the influence of open mining of the common minerals. Technische Univtrsity Bergakademie Freiberg, Germany: Scientific Peports on Resourse Issues, Volume 1, pp.. 355-360

[14] Petin A.N., Ukolova E.V. 2013. Environtal problems of mintpal resources development in the regions of Kursk Magnetic Anomaly (KMA). Technische Univtrsity Bergakademie Freiberg, Germany: Scientific Peports on Resourse Issues. Volume 1, Part 1, pp. 260 - 265.