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CLIMATE AND DRAINAGE RUNOFF CHANGES IN CENTRAL LITHUANIA

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The change of climatic conditions in Central Lithuania based on the data of Kaunas Meteorological Station is analyzed. The meteorological conditions in 1970-2009 are studied while analyzing the changes in the seasonal distribution of the average air temperature and the precipitation amount in Central Lithuania during the period of four decades (1970–2009), meanwhile each decade has been completely studied. The operation of the drainage and the impact of meteorological conditions on the drainage runoff in different seasons (winter, spring, summer and autumn) are considered.

Keywords: drainage, runoff, precipitation, temperature, climate.

Introduction. Over the past century, the average annual air temperature has increased by 0.6 ^{0}C [1]. Precipitation distribution in a territory and its change within a year has a great impact on hydrological phenomena, soil formation and plant-growing seasons [2]. Climate change impact on flora is given increasing attention around the world [3]. When the climate changes, various environmental phenomena also change, i.e., there is more precipitation the air temperature goes up. It affects the water circulation cycle as well. The size of water resources and the unevenness of distribution in time depend on the climatic and meteorological conditions of a specified territory and change every year – very watery and very dry periods occur [4]. The analysis of distribution and annual course of climate variables (temperature, precipitation, etc., meteorological elements and phenomena) highlights the certain characteristics of its change [5]. The changes of climatic elements, influencing the runoff – temperature and precipitation - have already been recorded in Lithuania [6,7]. An intensive agriculture is impossible in Lithuania without soil drainage - approximately 90% of total agricultural production of the country is grown in drained areas [8]. The size of drainage runoff depends on meteorological conditions of the year, the most important of which are the precipitation amount and the air temperature, however, the interdependence of precipitation quantity and drainage runoff is quite complex. Drainage systems are especially important in spring, during the snow melting period, because the excess of water is removed quickly from the arable layer

of the ground, therefore, the conditions to start spring field works for about two weeks earlier are guaranteed.

Climatic conditions and physical geographic factors determine the fact that in the territory of Lithuania there are 3.4 million hectares of extremely wet land or about 86 percent of total agricultural area, which may be used extensively and productively only after draining [9]. The efficiency of land use also depends on the speed of removal of excess water. The changes of climate (temperature increase, precipitation decrease) can be linked to the environmental pollution. At low temperatures and low moisture, the plants intake nutrients worse, therefore, they are eluted from the soil with drainage runoff more intensively [10]. While analyzing the elution of biogenesis from soil through drainage, much research has been carried out [11]. A. Mališauskas and S.Kutra have determined that the highest trend of increase of nitrates in drainage water is in May, and the concentration of nitrates in drainage water has been characterized by the lowest increase in October. Climate changes (temperature increase, precipitation decrease) may be related with the environmental pollution. The most important is the size of drainage runoff [13]. The measure of reduction of drainage runoff impact on environment is a so called controlled drainage. This drainage is not continuously active, but only at certain times, i.e., it usually operates during the required periods, but when the removal of water from soil is not needed, drainage runoff is intercepted [14].

The object and the research methods. The site under study is located in the southern part of Kaunas district, in the territory of training farm of Aleksandras Stulginskis University, Lithuania. The drain depth of 0.8, 1.10, 1.40 *m*, the drainage distance - 12, 18 *m*. The average test object surface slope - 0.008. The test site soil sod podzolic (the experimental according to FAO: calcar - HypogleyicLuvisol), texture - light loam, dripping down on medium loam. Topsoil layer thickness is 0.2 to 0.25 Arable layer of filtration rate - 1.0 to 2.0 *m/day*, the lower layers of soil - from 0.01 to 0.004 *m / day*. Drainage flow data to 1994 taken from the published edition [15] and subsequent years, data from the Aleksandras Stulginskis University. The meteorological parameters (precipitation and average air temperature) of 1969–2013 are analyzed meanwhile the data are obtained from Kaunas Meteorological Station, which is the nearest to the analyzed site.

Results. One of the key factors in determining the size of runoff is precipitation. In the studied object, the driest year was 2010, the wettest – 1992. The integral curves of average precipitation height deviation from the average show the trends of precipitation height change: the linear trend defining the trend of chronological sequence change is positive (Fig. 1).

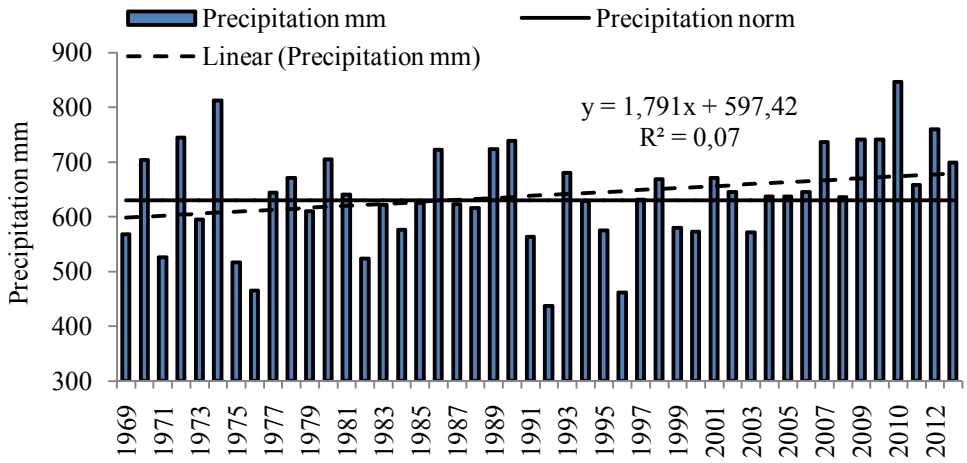

Fig. 1. Dynamics of annual precipitation amount and its linear fluctuation trend

While analyzing the annual air temperature for the period of 1969–2013, it is seen that the highest average temperature was in 2008, and the lowest - in 1993. The linear trend defining the trend of chronological sequence change is positive (Fig. 2).

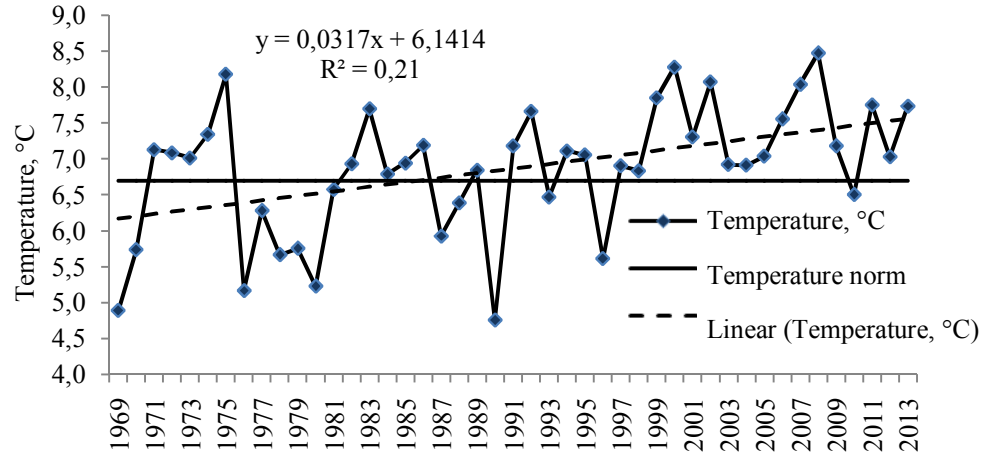

Fig. 2. Annual temperature and its linear fluctuation trend

Meteorological conditions in 1970–2009 have been studied while analyzing the changes in the seasonal distribution of the average air temperature and

precipitation amount in Central Lithuania during the period of four decades (1970–2009), meanwhile a complete study of each ten years has been carried out.

In the recent decade (2000-2009) the average winter air temperature in Kaunas was 0.71 °C warmer in comparison with the average temperature of the four decades (1970–2009), and the amount of precipitation increased only in 0.7 *mm* compared with the average of 40 years' period (Fig. 3).

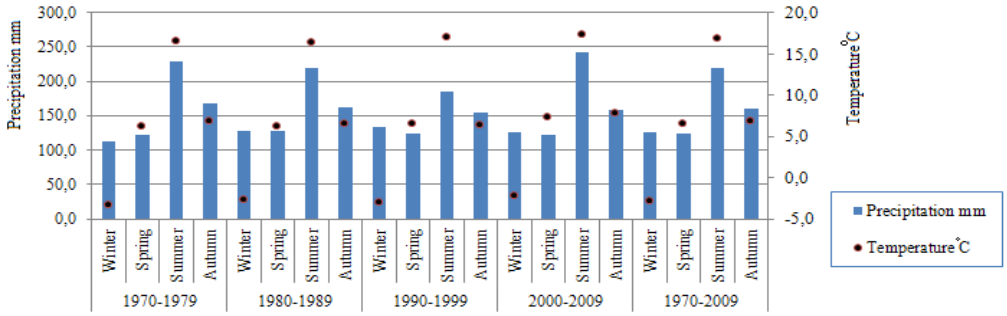

Fig. 3. Perennial (of 1970–2009 period) and four decades (in1970–1979, 1980–1989, 1990-1999 and 2000–2009) average air temperature and precipitation amount in different seasons

At analyzing the temperature in decades, it has been revealed that in spring it was always increasing and during the past decade (2000–2009) was 1.13 ^{o}C warmer in comparison with the average temperature of the years 1970–2009. The average sum of precipitation amount in spring (124.0 *mm*) and winter (125.1 *mm*) is very similar, and during the past decade the average precipitation amount had decreased only in 1 *mm* in comparison with the average precipitation amount of the complete period. The temperature in summer was also increasing, and in 1970-1979, it was insignificantly (0.1 ^{o}C) higher than in 1980-1989, and in the last decade (2000–2009) the summer temperature was in 0.5 ^{o}C higher than the average temperature in 1970-2009 (Fig. 3). The biggest amount of precipitation is in summer months. In the June-August of the last decade, the amount of precipitation increased in 33.3 *mm* in comparison with the average of the complete period, and when comparing with the decade of 1990-1999 – the amount increased even 56.6 *mm*. In the last decade (2000-2009) autumn in the region of Central Lithuania was warmer by 0.9 ^{o}C, although during the analysis of the last four decades, data the decrease in the average temperature was observed (in 1980-1989 and 1990-1999). The autumn season is also characterized by plenty of precipitation, although in the last two decades, insignificant decrease in precipitation amount was observed (in 1990-1999 – 6.2 *mm*, in 2000-2009 – 0.7 *mm*) in comparison with the average precipitation amount of the studied period. The analysis of the air

temperature and the precipitation amount change during the four decades of 1969–2009 has shown that the average air temperature of 2000–2009 was the highest, and the lowest average temperature was observed in 1970–1979 (Fig. 4). The smallest amount of precipitation was in 1990-1999, and the largest amount – in 2000-2009, although it was only 5.2 *mm* more than three decades before (in 1970-1979). During the analysis of the drainage runoff dynamics, it can be seen that the largest runoff was in 1980-1989, and the smallest, the same as in the case of the precipitation amount – in 1990-1999.

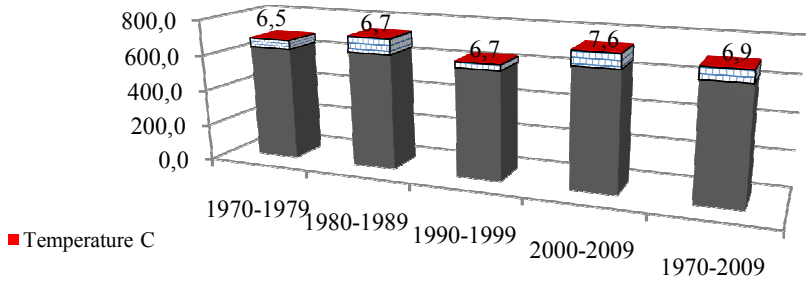

Fig. 4. Perennial (of 1970–2009 period) and four decades (in 1970–1979, 1980–1989, 1990-1999, 2000–2009) average air temperature ^{0}C, amount of precipitation mm and drainage runoff mm and precipitation amount of different seasons

When studying the seasonal distribution of the drainage runoff in decades, the summer season should be distinguished as constantly decreasing, meanwhile the average drainage runoff in other seasons is fluctuating during decades. Although in the last decade the winter season distinguished itself – the average runoff height was 32.4 *mm* (average of the four decades is 17.2 *mm*). When analyzing the data of 1970-2009 in the studied territory, it was determined, that the smallest precipitation amount is in spring (19.7%), in winter – very similarly (19.9%), and the largest precipitation amount is in summer (even 34.8%) and in autumn. Analysing the distribution of the percent amounts of the average precipitation and drainage runoff in 1970–2009 according to the seasons, the highest drainage runoff is namely in spring (48.7%), and the lowest – in summer (4.9%), meanwhile the highest precipitation - in summer (34.8%), and the lowest – in spring and summer (about 20%, Fig. 5).

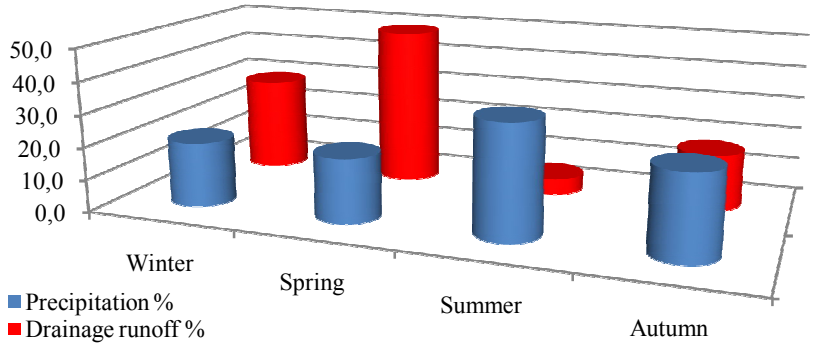

Fig. 5. Distribution of the percent amounts of the average precipitation and drainage runoff

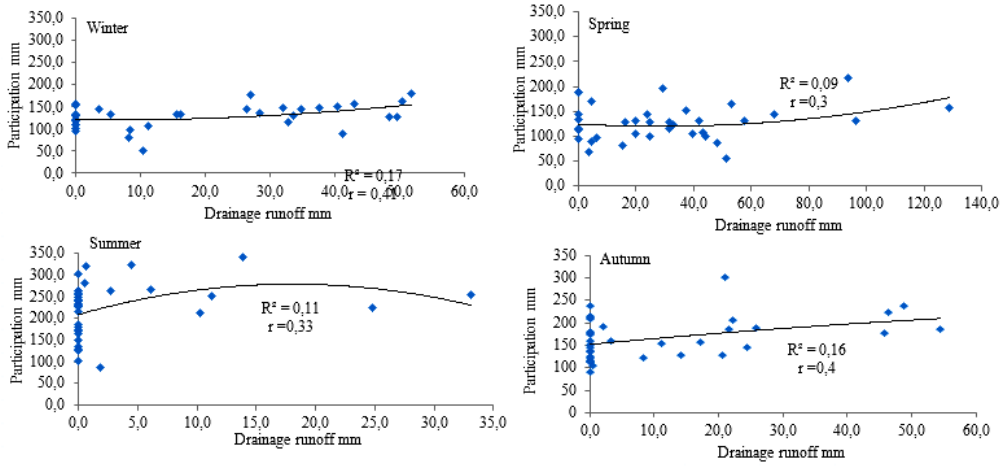

Fig. 6. Dependence of the monthly drainage runoff on the average precipitation amount in different seasons of the period 1970–2009

After carrying out a correlation-regression analysis of the investigation data, it was revealed that the relation between the drainage runoff and precipitation amount during different seasons was weak (in spring (r=0.3) and in summer (r=0.33) or average (in winter (r= 0.41) and in autumn (r=0.40, Fig. 6).

When studying relations between the drainage runoff and the average air temperature in different seasons it has been determined that in winter there was an average link (r=0.55), and in other seasons – the inter-relation was very weak (in spring (r=0.17), in summer (r=0.17) and in autumn (r=0.14, Fig. 7).

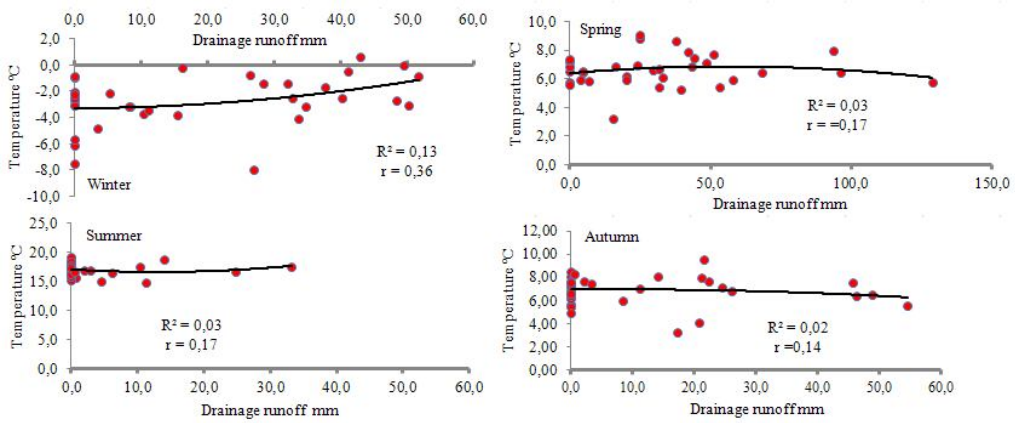

Fig. 7. Dependence of the monthly drainage runoff on the average air temperature in different seasons of the period 1970–2009

Conclusions

1. The integral curves of annual precipitation and temperature height deviation from the average show the linear trend defining the trend of chronological sequence change is positive.
2. When analyzing the data of four decades in the studied territory, it has been determined that the smallest precipitation amount was in spring (19.7%) and winter (19.9%), and the biggest amount of precipitance was in summer (34.8%) and autumn (25.6%). The drainage runoff according to the data of 1970-2009 reached the highest point namely in spring (48.7%), and the smallest drainage runoff is in summer (4.9%).
3. After analyzing the annual drainage runoff change during the period of 1969-2009, the significant one-trend change was not determined; however, the insignificant statistical linear trend is noticed. An important factor for runoff formation is the precipitation intensity and duration, since intensive short rain forms a larger surface runoff, while the rain of lower intensity and longer duration infiltrates into soil and evaporates from the ground surface better.
4. After correlation-regression analysis of the study data it has been revealed that the relation between the drainage runoff and the precipitation amount during different seasons was weak (in spring and in summer), and average in winter and autumn.
5. When studying relations between the drainage runoff and the average air temperature in different seasons, it was determined that in winter there was an average link, and in other seasons – the inter-relation was very weak.

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ԿԼԻՄԱՅԻ ԵՎ ԴՐԵՆԱԺԱՅԻՆ ՀՈՍՔԻ ՓՈՓՈԽՈՒԹՅՈՒՆՆԵՐԸ ԿԵՆՏՐՈՆԱԿԱՆ ԼԻՏՎԱՅՈՒՄ

Օ.Վ. Միսեցկայտե

Վերլուծվում են բնակլիմայական պայմանների փոփոխությունները Կենտրոնական Լիտվայում՝ ըստ Կաունաս քաղաքի օդերևութաբանական կայանի տվյալների: Ուսումնասիրվել են օդերևութաբանական պայմանները՝ Կենտրոնական Լիտվայում չորս տասնամյակի ընթացքում (1970-2009թթ.) օդի միջին ջերմաստիճանի և տեղումների քանակի փոփոխությունների վերլուծության միջոցով: Առանձին իրականացվել են յուրաքանչյուր տասնամյակի ընթացքում տեղումների քանակի մանրամասն ուսումնասիրություններ: Ուսումնասիրվել են դրենաժի գործառությունը և տարվա տարբեր եղանակներին մթնոլորտային պայմանների ազդեցությունը դրենաժային հոսքի վրա:

Առանցքային բառեր. դրենաժ, հոսք, տեղումներ, ջերմաստիճան, կլիմա:

ИЗМЕНЕНИЕ КЛИМАТА И ДРЕНАЖНОГО СТОКА В ЦЕНТРАЛЬНОЙ ЛИТВЕ

О.В. Мисецкайте

Анализируется изменение климатических условий в Центральной Литве на основе данных метеорологической станции г. Каунаса. Изучены метеорологические условия путем анализа изменений в сезонном распределении средней температуры воздуха и количества осадков в Центральной Литве в течение четырех десятилетий (1970-2009 гг.). В отдельности проведено детальное изучение количества осадков в течение каждого десятилетия. Рассмотрены вопросы функционирования дренажа и воздействия метеорологических условий на сток дренажа в течение разных сезонов.

Ключевые слова: дренаж, сток, осадки, температура, климат.