сторону увеличения пространственной и временной детализации климатических прогнозов.

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IMPACTS OF CLIMATE CHANGE ON DRAINAGE RUNOFF IN THE FOUR DECADES

Miseckaitė Otilija
Aleksandras Stulginskis University, Akademija, Kaunas, Lithuania,
otilija.miseckaite@asu.lt

The article presents the influence of fluctuation of the main climatic factors over time on drainage runoff, the analysis of drainage runoff distribution in the course of a year. The seasonal differences of annual temperature amplitude and precipitation quantity decrease. It has a significant impact on the seasonal distribution of drainage runoff. The article analyses the nature of multi-year change of runoff during the last four decades – periodic fluctuations and change trends.

Introduction

Global increase of precipitation is forecasted under changing climatic conditions, however, its extremes will also increase [1]. Drainage of agricultural fields is not only a modern tool for removal of excess water, but also a great component of water balance of open water ponds. The study included watertable strategies subjecting the subsoil to various degrees of water status. The effects on drain outflow, nutrient losses, soil aeration, and nitrogen flow and crop performance were measured [2]. When analyzing the elution of biogenesis from soil through drainage, much research have been carried out [3, 4, 5, 6]. Drainage reduces the time of water in the soil; - the water easily soluble nitrate nitrogen quickly gets into surface water bodies [7]. [8] determined that the highest trend of increase of nitrates in drainage water is in May, and the concentration of nitrates in drainage water was characterized by the lowest increase in October. Climate changes (temperature increase, precipitation decrease) may be related with the environmental pollution. In case of low temperature and low moisture, assimilation of nutrients goes on much worse, therefore, they are leached from the soil with the drainage runoff more intensely [9]. It is important to know, what is the major factor, which leads to the pollution diffused by biogenesis N and P through drainage runoff and how the pollution occurs under various natural and agricultural conditions. The most important is the size of drainage runoff [10, 11].

The objective of research – to evaluate the drainage runoff and its change in loam soils according to the long-term drainage data.

Materials and methods

In order to carry out the analysis of drainage runoff fluctuations and the impact of climatic factors on this process, the test object of Lithuanian Agricultural University in Kazliškės was selected.

Summarize the five long-term drainage systems (No 21, area 0.44 ha, no. 22, area 0.45 ha, no. 23, area 0.44 ha, no. 24, area 0.44 ha, no. 25 area of 0.45 ha) of drainage studies, which began in 1967 and continuing up to now, the data. Drain depth of 0.8, 1.10, 1.40 m, the drainage distance - 12, 18. 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. Research object is located in Lithuania, in the southern part of Kaunas district (Fig. 1).

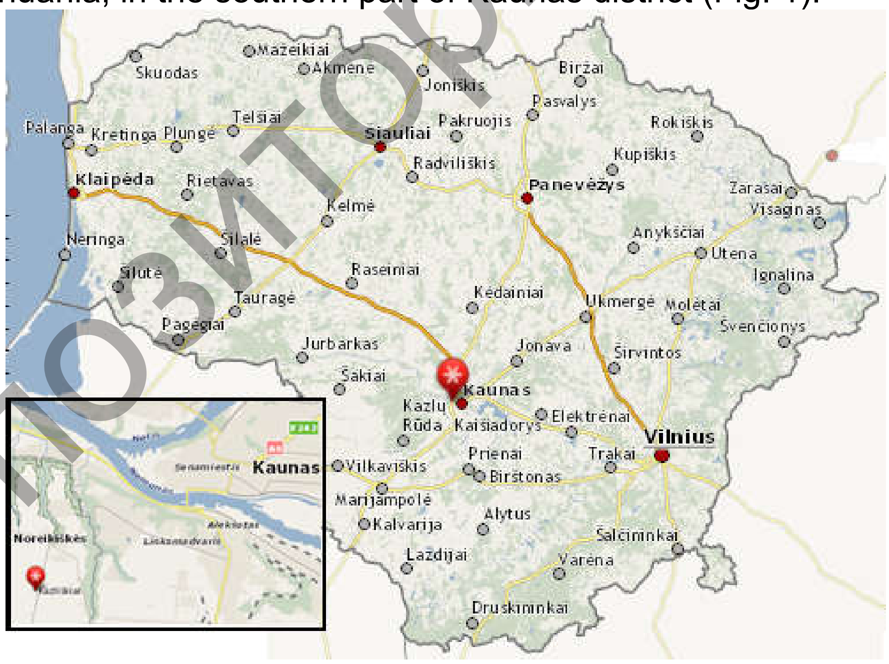

Figure 1 *- Study area location*

The meteorological data of the analyzed period of 1969-2009 were collected from the Kaunas Meteorological Station, which is the nearest to the analyzed object (at the distance of 0.5 km). The relative hydrothermal coefficient (HTK_s) is usually used for assessment of meteorological conditions, since it allows assessment of moisture of not only the entire vegetative period, but also of individual months [12]. It is calculated as follows:

$$HTK_s = \frac{K\sum p}{\sum T} \quad (1)$$

where K – climatic relative zero coefficient, the relative zero is equal to 1; Σp – the total of precipitation of the period under calculation, mm; ΣT – the total of air temperature values of the period under calculation ^{o}C.

According to HTK_s, the conditions of location moisture are grouped as follows: when $HTK_s \geq 1.2$ – moist period, when in the range of 0.8 – 1.2 – the period of average moisture, when $HTK_s \leq 0.8$ – droughty period [12]. Following the research object data, the relations, which would allow determination of temperature and precipitation quantity on the quantity of drainage runoff and its seasonality, were sought during data systematization. Interdependence of the individual factors was analyzed, using binomial correlation method: the determined correlation and reliability of the data was checked by autocorrelation analysis. Descriptive statistics and correlation methods have been used for data analysis. For the analysis of runoff change the Mann-Kendall test, which determines positive and negative trends of analyzed characteristic and significant positive or negative trends (5% significance level) was used [13].

Results and discussion

The analysis of climatic conditions of forty years (1969-2009) shows that the air temperature and precipitation quantity was very different during the mentioned years. The relative hydrothermal coefficient of individual years was changing significantly (Fig. 2).

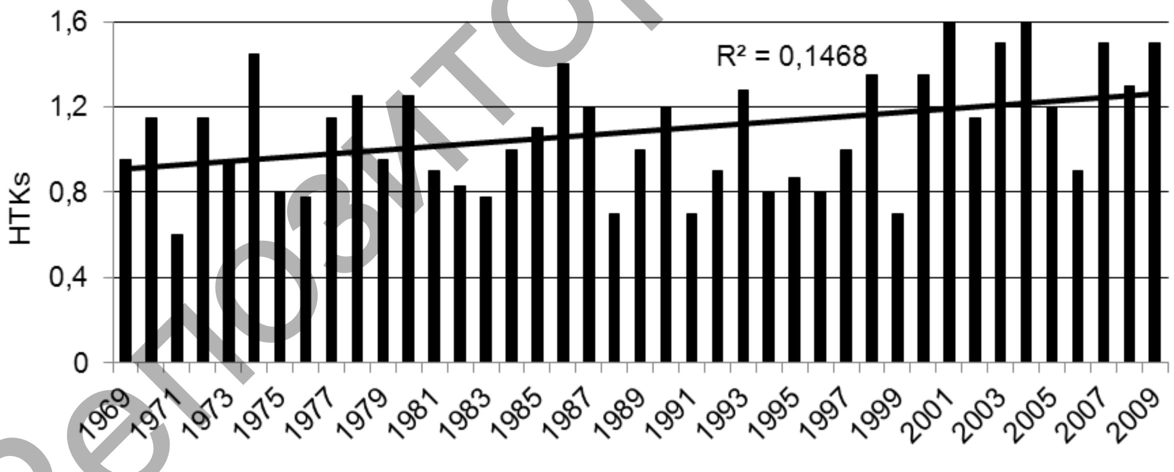

***Figure 2** - Relative hydrothermal coefficient (HTK_s) dynamics in the object at 1969-2009*

One of the key factors in determining the size of runoff is precipitation. The analysis of average annual precipitation quantities shows that precipitation quantity was 639 mm, or 1.5% higher than the standard during the mentioned period (Fig. 3). In the researched object the doughtiest year was 1992, the moistest – 1969 (1.31 times higher than standard).

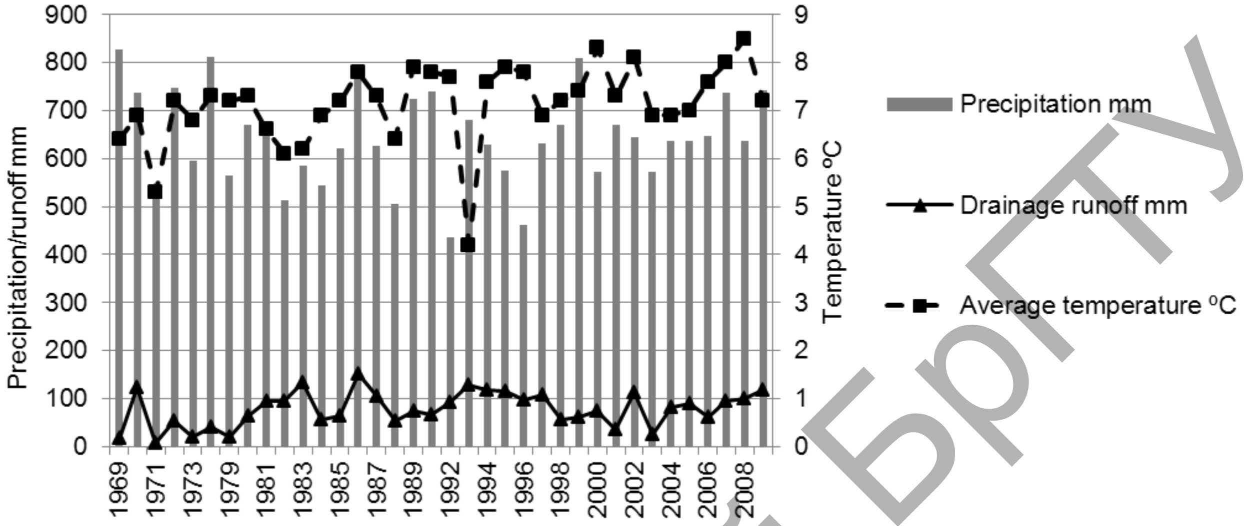

Figure 3 *- Variation of precipitation, drainage runoff and temperature*

The integral curves of average annual drainage height deviation from the average show the trends of runoff height change: the linear trend, defining the trend of chronological sequence change, is positive (Fig. 4).

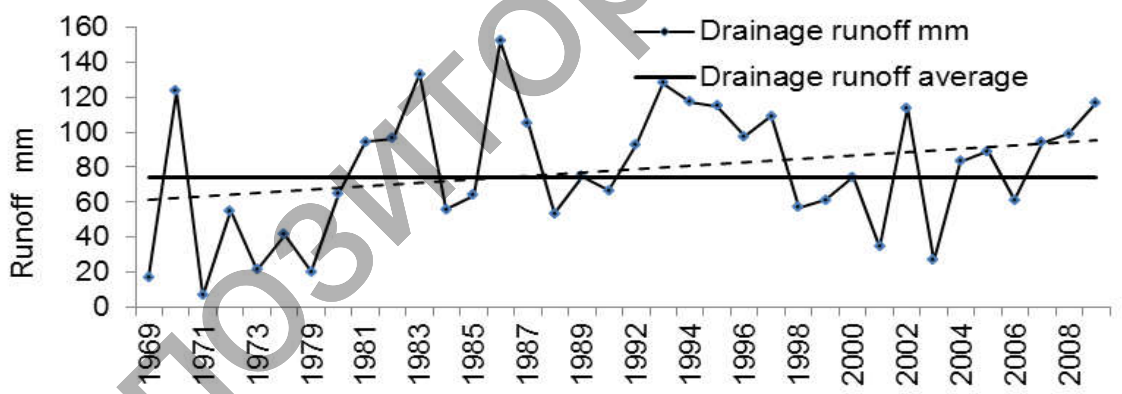

Figure 4 *- Chronological succession of drainage run-off and their linear fluctuation trend*

The analysis of runoff observations' data shows that the seasonality, typical for runoff change, remains: during spring – March and April – the average runoff is the highest, it is the lowest in summer season – July and August, while in May, June and August – almost the same (1.9 – 2.2 day/mm). Precipitation – the main feeding source of drainage runoff, therefore, this factor has a significant impact on runoff characteristics.

When relating the changes of runoff with periods of seasonal fluctuation (Fig. 5), it becomes obvious that the drainage runoff has significantly increased during the winter season over the last four decades. It is likely that the maximum runoff values, which were under very different meteorological conditions, are determined by the conditions of global climate change - warmer winters, and thus earlier snow melting, smaller water supplies in snow cover, etc.

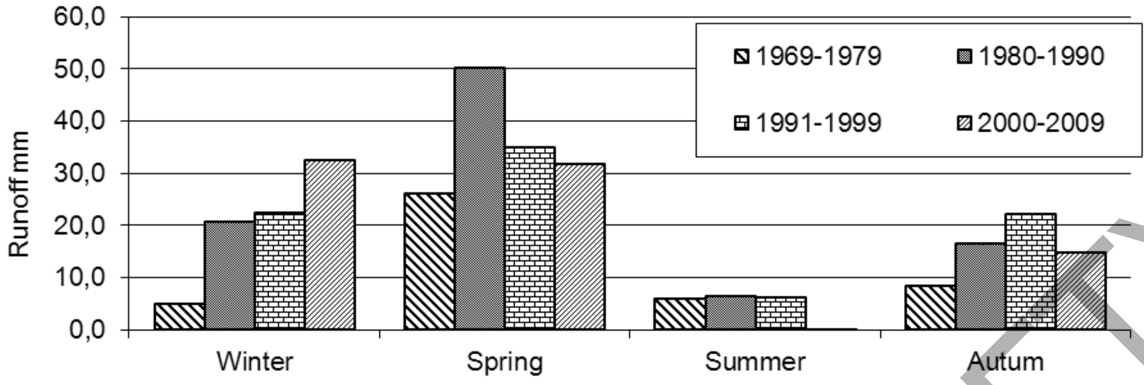

Figure 5 *- Variation of seasonal differences of runoff amount*

Analysing the heights of the drainage runoff during winter period (1969-2009) by decades, it is possible to see that the drainage runoff has increased (Fig. 6). It is seen that in spring, summer and autumn (1969-2009) negative trends were defined, i.e. the decrease of runoff, whereas in winter time the runoff increased (29% in the last decade) and the change of total annual runoff was positive.

Looking for the relationship between the runoff and meteorological parameters (monthly precipitation, temperature) the following correlation coefficients were defined: runoff/precipitation – 0.70; runoff/temperature – 0.64, runoff/evaporation – 0.50. The above results confirm the fact that the main source of the runoff formation is precipitation, to be more exact – the relation of the precipitation with the temperature regime of the locality. The hydrothermal coefficient evaluates this process best of all.

Table 1 *- presents the aggregate statistics of significant trends (5% significance level) of researched runoff characteristics. Mann-Kendall test for all research time of significant trends shows that runoff in winter increase.*

Month	Sum of year	MK-Stat	p-value
1	29	2.89	0.01
2	29	3.59	0.01
3	29	2.66	0.01
4	29	-0.36	0.72
5	29	0.21	0.84
6	29	-1.53	0.13
7	29	-1.13	0.26
8	29	-0.06	0.95
9	29	1.39	0.17
10	29	1.10	0.27
11	29	1.18	0.24
12	29	2.17	0.03

Table 1. Mann-Kendall test for all research time (1969–2009)

The sequences of multi-year air temperatures have already shown the increase of temperature of year and all seasons, except autumn [14]. The depth, duration and temperature of frozen ground of soil depends on winter duration and air temperature, thickness of snow layer, vegetation layer, thermal characteristics and humidity, texture of soil, depth of ground water. Since the middle of twentieth century the duration of frozen ground has shortened by approximately two weeks, moreover, the probability of its total thaw and repeated freezing has increased. An increased incidence of thaw of frozen ground demonstrates that water infiltration conditions of cold season must have changed. Water, present in thinner capillaries of clay and loam soil, freezes at lower temperature. On the other hand, wet soil freezes less, since during water freezing heat of water crystallization is released, which slows down the further drop of soil temperature. Snow layer and vegetation also protect soil from deep freeze. The depth of frozen ground more depends on physical conditions of location than its formation and thawing dates [15].

Conclusions

1. After performing the analysis of 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. It corresponds to global increase of precipitation, forecasted under changing climatic conditions. An important factor for runoff formation is precipitation intensity and duration, since intensive short rain forms a larger surface runoff, while the rain of lower intensity and longer duration better infiltrates into soil and evaporates from ground surface.
2. The analysis of runoff observation data revealed that seasonality, typical for run-off change, remains, however, the drainage runoff during winter season has increased significantly over the past four decades. Mann-Kendall test showed a significant increase of winter runoff during research period. It was confirmed by results of Sperman test. It was also influenced by growth of multi-year temperatures of all seasons, except autumn: the frozen soil is characterized by low water permeability, irrespective of its content. Water, present in thinner capillaries of clay and loam soil, freezes at lower temperature. An increased incidence of thaw of frozen ground demonstrates that water infiltration conditions of cold season must have changed.
3. Significant decrease of drainage runoff is observed in July and August. It is related with redistribution of precipitation amount, which increased in winter and decreased in summer, and it corresponds to aridity, which is forecasted by other scientists to increase significantly in the second half of summer and in the beginning of autumn in Lithuania.

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ЭКОЛОГИЧЕСКАЯ КУЛЬТУРА ПРЕДПРИНИМАТЕЛЬСКОЙ ДЕЯТЕЛЬНОСТИ: ЗНАЧЕНИЕ И РОЛЬ В РАЗВИТИИ ПРЕДПРИЯТИЙ

Новикова Т.В.
Омский государственный технический университет, г. Омск, Россия
notaci@yandex.ru

This article discusses the environmental culture of entrepreneurs, its impact on the economic efficiency of the business entities. Given the author's definition of environmental culture. The mechanism of the implementation of environmental management in the enterprise, articulated the benefits of its successful functioning.