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CHANGES OF MODERN CENTRAL RUSSIAN UPLAND LANDSCAPES CAUSED BY NATURAL FACTORS (THROUGH THE EXAMPLE THE KURSK REGION)

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Abstract
The influence of climatic parameters changes in the Kursk Region over the past 50 years over the intensification of the process in changing Central Russian Upland landscapes is revealed in the article. Moreover, possible consequences of geochemical elements relocation along the erosional pattern.
Keywords: climate, erosion processes, heavy metals.

The natural and resource potential of Central Russian Upland landscapes determines the peculiarities of sustainable development of Central Chernozem Region (Central Black Earth Region) of the Russian Federation. The landscapes being an emergent product of the geographical environment give people some quality of this environment but at the same time they determine the peculiarities of functional usage of a territory and its sustainable development over the time. The last factor is the factor of time which may bring to more intensive processes of both natural and anthropogenesis landscapes in case of intensive anthropogenic activities.

The key element determining the imminence of landscape geosystems changes is the fact that they have been affected by anthropogenic activities for a long time. As for the Kursk Region which territory may be characterized as typical forest-steppes of the European part of Russia such a factor has been and still is a ploughing, enlarging the number of territories intended for building.

At the same time a whole range of circumstances have contributed into conservation of natural landscapes in the region such as forests, meadow-steppes, floodplain soils and wetlands (creation of the Central Chernozem Nature Reserve named after Prof. V.V. Alekhin).

As a result, nowadays there is a complex mixture of different landscape formations in the region: anthropogenically non-changed lands (nature reserves), anthropogenically slightly-changed lands which still may be regenerated (forests of anthropogenic and non- anthropogenic origin, idle fields, steppes, ettles with a newborn ecosystem), nonreciprocal anthropogenically effected lands (dump embankments, agricultural lands, lands effected by erosion, inhabited lands, and so on).

However, the analysis of ecological problems taken place in the Kursk Region [1], lets us state that all of them are affected directly or indirectly by nature independently on being or absence of anthropogenic regulation and it leads to changes which sometimes can be a catastrophe or even a degradation.

Let's examine the influence of climatic parameters over a half-century period on the character of erosion process and changes of geochemical parameters of soils.

Background response characteristic of forest-steppe of Central Russian Upland is presented in the works by F.N. Milkov [3]. The main factors determining the peculiarity of the landscapes under investigation are the peculiarities of geological construction and the climate of the territory. The derived factors are ground contour, runoff, soils, plants and animals. From the point of view of Geomorphology, Central Russian Upland is not very high (about 300 meters above the sea level). Specific location of the Region on the boarder between the northern and southern parts of the Upland determines its complicated geological formation. Northwards from Kursk its foundation is formed by Devonian limestone. River bottoms are rather narrow with a lot of turns and bank asymmetry. At watershed divides limestone is covered by Yurassic and opoka sandy and clay rock. These deposits are washed off close to the rivers, limestone is on the surface which makes it easy to develop Karst processes. Therefore, spongy soils let clough erosion activity develop. Here goes the second important geomorphologic peculiarity of the territory, it is a thick gill beam system. Its length in the Kursk region is 0,5—1,2 km per km2.

Climatic parameters of the territory under investigation are determined by Baseline Climatic Data of moderate continental climate accompanied with highlands.

Forest-steppe landscapes are characterized by combination of two main types of soils, they are grey forest soils and black soils (podzolized and non-alkalic ones).

Finding grey forest soils proves that this territory was covered with forests in the past. The north-western forth was covered with oak trees. Nowadays they are few, most of them are intrazonal ones. There are aspen and oak forests in Tim-Shchigry upland. The most interesting are mountain cretaceous soil. In the past they formed landscape peculiarity of Central Russian Upland. Nowadays there are found only few mountain cretaceous soils in the Belgorod Region.

Today meadow steppes and stepped meadows are conserved in its origin in Central Russian Upland only in the natural reserves: the Central Chernozem Nature Reserve named after Prof. V.V. Alekhin in the Kursk and Belgorod Regions – Streletskaya, Kazatskaya and Yamskaya steppes, and Mikhailovskaya steppe (Department of the Ukrainian state steppe reserve) in the Sumy Region.

Changes of climatic parameters over the time we can see taking as an example the Kursk Region. Its climatic peculiarities are explained by its location in moderate continental climate of forest-steppe zone.

The climate of the Kursk region is moderate continental. Sunny long summer is followed by cold winter with steady snow cover. The average yearly temperature varies from 4,6˚ in the north (Ponyri) to 6,1˚ in the south-west (Korenevo). According to the amount of rainfall the Region may be related to the zone of moderate humidity. The yearly quantity of rainfall in the western territories (Dmitriev-Lgov hills, Tim-Shchigry hills) reaches 500—600 mm, but the eastern territories are much drier (400 – 500mm). [8]

The analysis of average yearly temperature parameters in the Kursk Region has revealed their increase in comparison with the parameters over years. Contemporary climatic dynamics is characterized by a range of peculiarities. Firstly, it is because of the temperature increase especially in winter months and humidity increase (fig. 1) [1].

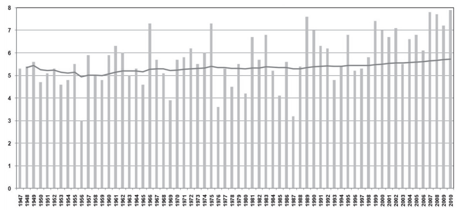


Fig.1. Temperature parameters 1947 - 2011

At the beginning of the forties of the 20th century there was a temperature decrease in winter months. In the fifties it was observed in summer months. In the sixties the temperature started to increase and it is still increasing. In summer 2010 the highest temperature was registered in Kursk, it is 38,8˚C. According to the maximal average yearly temperature was registered in 2000, it was 12,1 ºC, and the minimal one was in 1969, it was 0,3 ºC, the average one was in 1989, it was 7,8 ºC. [1].

During the 20th century the increase of rainfall also has been observed from 1947 to 1968. The amount of rainfall has increased for 22,7 mm/10 years. During 1969 – 2011 the tendency of rainfall change was also positive (fig. 2) [1].

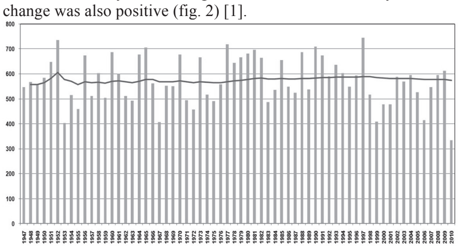
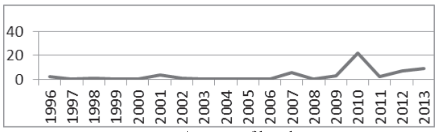


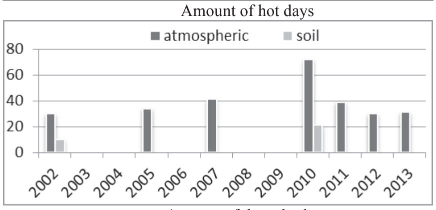
Fig.2. Amount of rainfall 1947- 2010

Maximal amount of rainfall for this period was in 2001 and it was 848mm, and minimal amount was in 1975 and it was 420 mm. [8]. The territory of the Region west and north of the Region is the most humid but east is less humid. At the same time the period 1986 – 2005 was the most humid for the whole Region.

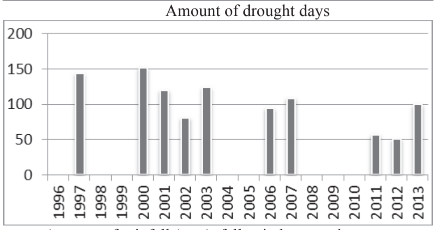
The analysis of climatic data for the last 50 years let us determine the dynamics of microclimatic parameters which influence the condition, tendency of development and steadiness. Among these factors we differentiate anomalies such as anomaly heat, soil and air drought, heavy rainfall and so on (Fig.3).



Amount of hot days



Amount of drought days



Amount of rainfall (mm), fallen in heavy rain

Fig. 3. Amount of days with anomaly events

The analysis of dynamics the parameters of capacity of snow cover for the last years is presented in fig.4 and it characterizes the capacity as rather high in comparison with average yearly parameters: forest – 37 – 30sm; steppe – 27sm; tilled area – 14sm.

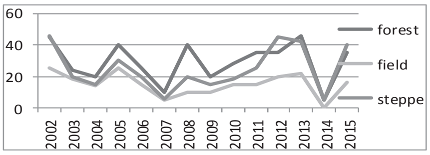


Fig. 4. Changes of capacity of snow cover (2002 – 2015)

At the same time water content of snow was not high. Dynamics of this parameter over the years proves that it is decreasing . (fig. 5)

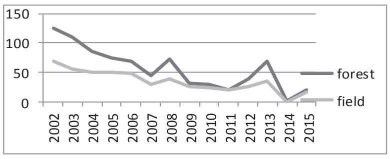


Fig. 5. Dynamics of parameters of water content of snow cover

Therefore, the biggest influence on runoff will be connected not with spring solstice but with summer heavy rainfall.

Let's examine how increase of anomaly events in temperature and rainfall in the case of plain gill beam system will influence the landscapes.

Solar power and humidity of rainfall falling onto the earth surface are redistributed on it due to the earth features. Redistribution of radiant energy is caused by different flanks.

Topographic inequality influencing runoff plays a great role in redistribution of rainfall. Rainfall from the highlands flow along flanks to the bottom and so highland watershed areas usually lose an amount of rainfall but lowlands get additional humidity thanks to runoff from above. Therefore G.N. Vysotskiy has introduced the concept "plakor" which means a highland plain where water stagnation and the influence of groundwater aquifers in soil formation do not happen. [9].

It is important to understand how erosion influences the territory due to the peculiarities of relief structure. According to the data got by V.I. Kirushin convergent (gray - fig. 6) flanks are affected by the processes of linier erosion some times more that divergent (black - fig. 6) ones. This happened due to the fact that convergent flanks are surface formations of flowing systems of surface runoff. There are thousands of micro streams which reach its critical mass when water runoff is able to produce full erosion work.

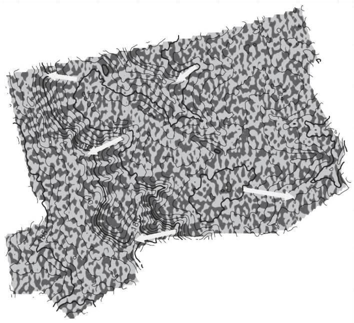


Fig. 6 Planned surface curvature

The energy of water runoff flowing is proportional to mass of flowing water and may be presented as the following $E=m_*v^2/2$ [6]. As an example large cloughs of runoff are marked in the picture. Now they pass through the process of their forming as young erosion forms such as rain channels and further flanks or they have been already formed and are evaluating erosion forms. It is considered by geomorphologists to be a principle of relief self-development when the development vector of form morphology helps its further development at the same direction.

Correlation of climatic processes and relief of the territory plays an important role in migration of hard substance of soils. The process of runoff and corrosion of soils and rock formations by flowing water happens everywhere. As a result of surface runoff of snowmelt and rainfall, runoff and corrosion of upper soils happen and particles of soil are transmitted with water into lower lands where they are accumulated.

The most important factors influencing intensiveness of soil erosion are the following: amount and character of atmospheric precipitation, steepness, length, form and exposition of a flank, condition of surface (plant coverage, micro relief and so on) and features of soil itself (infiltration ability, erosion preventives of structure and others). Intensity of rainfall influences the amount of washed out soil. According to N.I. Makkaveev wash out of dust-clay soils slopping at 9° as a result of two-hour heavy rain while 101,6 mm of rainfall fell down was equal to 179,20 t/ha. Besides, another rain which fell at the same amount but which lasted for 27 hours caused the loss of 20,16 t/ha of soil it means it is 9 times less [7].

In the similar conditions erosion mostly depends on the size of flank. For example, runoff at grey forest soils at the arching flank slopping at 2° is 31mm/ha, slopping at 4°— 41 mm/ha, at slopping 8° — 87 mm/ha. At the direct flank at slopping 2° soil runoff was only 13 mm/ha. It is evident that flanks of the same slopping will be affected by runoff differently depending on climatic conditions, plant diversity, upper soil levels condition, erosion preventives themselves.

Geomorphological structure and relief morphology are leading factors of erosion development. Flat plains are characterized by minimal intensity of runoff (0—0,5 t/ha a year). Runoff dramatically increases at dissected highlands such as Central Russian Upland which is under investigation and increase gets up to (20—30 t/ha a year). In spite of soil runoff linier erosion such as gullying is found.

Intensity of erosion depends not only on relief but it increases as a result of destruction of natural coverage and poor cultivation of earth. General amount of yearly runoff from plowed fields in Russia is estimated as 560 mln. t. According to the data of the forecast for coming a hundred of years the amount of plowed fields under erosion in the European part of Russia will increase for 5—6% [6].

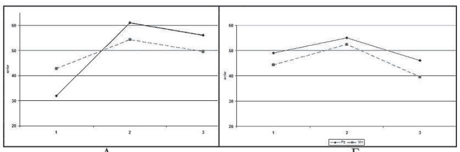
The role of relief in migration of soluble productions of eolation and soil formation means the following. Migration of soluble productions of eolation and soil formation is connected with redistribution of moisture along the elements of relief. Upper watershed areas with deeply lying groundwater aquifers get moisture only from atmosphere. Lower elements of relief which are characterized by additional flow of productions of eolation and soil formation with upper runoff may be also found with close deposits of groundwater aquifers. The last ones influence soils because different substances flow alongside, the substances which have been washed out from the soil and upper ground of watersheds. In such conditions of relief it is possible a great number of saving chemical elements in soil mostly able to quick migration in the presented climatic and landscapes environment.

The least favorable element in substance migration may be called heavy metals. As there deposits in the certain elements of relief can lead to the further increase of there content in plants and moreover in animals even in domestic. And agricultural territories are usually situated at watersheds and happen to be the first stage of erosion. Anthropogenic objects provide products of dusting and further different dusters including originated from heavy metals at the territory of the Kursk Region.

The character of spreading of heavy metals in soil coverage in lands of different agricultural usage and of different flanks is not the same. Te carrying out happens from the plowed fields affected by erosion, and washing out of heavy metals is also noticed. These processes are now of great interest among Russian researchers such as Litvin L.Y., Lisetskiy F.N., Golosov V.N., Kosinova I.I., Goneev I.A. and others.

At the clough at winddown and windup flanks which is under the investigation some soil samples have been taken. The samples have been chosen at three morphostructural elements: 1) in the zone of intensive flat erosion, 2) at the flank in the zone of primary flattening and primary accumulation; 3) at the bottom of the cough in the zone of accumulation. At the bottom of the cough the samples have been chosen from the soil with lighter grain size content that influenced the results of the analysis.

On the basis of these samples there were drawn the diagrams showing the content of all studied metals at the territories affected by erosion. (fig. 6). In the diagrams there is content of lead and manganese in the soil coverage. Vertically, the content of metals in mg/kg of soil is presented. Horizontally, the numbers of points of choice are presented. 1 – the zone of intensive erosion, 2 – the zone of primary accumulation, 3 – the zone of accumulation in the conditions of washing of snowmelt and rainfall.



А Б

Fig. 6. Content of lead and manganese at flanks in the points of different range of erosion (А -windup, Б-windown flank).

The analysis of the data let us state that minimal concentration of heavy metals is typical for the flanks affected by flat erosion. In the zone of the location of geochemical barrier the accumulation of erosion material and increase of concentration of heavy metals happen on the surface of flanks presented by terracing and in the middle part of the flanks covered with grass and bushes. At the bottom of the cough in the zone of transition, flowing and flow of tide the concentration is higher than at the water-shed but lower than in the central territory [2].

Therefore, reinforcement of continental climate, increase of time intervals with heat and drought accompanied with rainfall in condition of flank relief of the territory. The last one reinforces the intensification of the processes of flowing out potting soil. Thus, the process of flowing out in condition of increasing rainfall can lead to the process of soil relocation not only through erosion net but of different non-favorable substances migration too. Besides, at one side, this process is even good for the fields with primary erosion as pollutants are washed out, but at the flanks or in the zone of accumulation of substance such process is dangerous because accumulation of pollutants will be found in soil and as a result risk of its getting into agricultural products and human organisms will increase correspondingly.

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