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DROUGHTS AND DESERTIFICATION PROBLEMS ON THE TERRITORY OF GEORGIA

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Abstract. Desertification is well correlated with a climate alteration in Georgia. Therefore, investigation of the climate change process, comprehensive study of droughts and desertification, and elaboration of a long-term strategy and plan of action to combat desertification is one of the most urgent problems for Georgia. In the present article surface and under ground water resources of Georgia is rewired. Some contributing factors of climate cooling on the territory of western Georgia is investigated. Climate warming, droughts and desertification processes in some areas of Eastern Georgia are studded. Some recommendations for reducing the risk of desertification in aired regions of Georgia are given.

Keywords and phrases: Regional climate change, desertification, droughts, modelling.

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Introduction. As it is known desertification is the degradation of land in arid, semi-arid and dry sub-humid areas caused by climatic changes and anthropogenic activities. The process of desertification is accompanied by depletion in surface, sub-surface and ground water resources and reduction of flora and fauna. Frequent relatively long period summer droughts, short-term strong rainfalls, forest fires and strong winds accelerate land degradation, aridity, and desertification process. In such cases desertification is becoming an alarming and visible threat and sustainable management of surface water resources becoming an urgent for serving environment. The last decade of the 20^{th} century was the warmest period in the second millennium, which was characterized a monotonous increasing of temperature and declining of precipitation and in this context, it was seen as an indication of the initial stage of global desertification process. Unfortunately this process is lasting in the first decade of the 21^{th} century accompanied by frequent summer droughts, short-term strong rainfalls, forest fires, strong winds, wood felling.

In Georgia desertification is well correlated with a climate alteration. Climate warming process is a serious threat to the Caucasus glaciers, as it causes melt due to high temperature, low relative humidity and fall in solid atmospheric precipitation. The spread of modern glaciers in the territory of Georgia is due to specific atmospheric processes and peculiarity of relief morphology. The main glaciers are related to the watershed of the Great Caucasus range and the Kazbegi mountain massif. Georgia has 786 glaciers occupying about 559,9 square km.. Warming of the climate over the globe, including the Caucasus, has brought about contraction of glaciers. Namely in 1890-1980 the glaciations area in Georgia decreased by 9.5% [10].

In case these processes take on a systematic character, they will cause an accelerated glacier retreat and obviously lead to serious local climatic change and then regional. Although Georgia does not lie in the immediate proximity to deserts, this process leads desertification of the dry regions of Georgia, namely certain regions located in the eastern part of the country (Gare Kakheti, Kvemo Kartli) may confront a real danger of local desertification. and Caucasus ecological balance is clearly under threat, the more so if the processes become irreversible. Therefore, comprehensive study of droughts and desertification, and elaboration of a long-term strategy and plan of action to combat desertification is one of the most urgent problems forGeorgia.

1. Surface and Under Ground Water Resources of Georgia. Georgia lies along the eastern Black Sea coast, to the south of the Major Caucasian Ridge. The Lesser Caucasus mountains occupy the southern part of Georgia. These two mountain systems are linked by the centrally located Surami mountain range, which bisects the country on the west and east regions. About 85 percent of the Georgian total land area occupies mountain ranges. To the west of the Surami Range the relief becomes much lower, and elevations are generally less than 100 m along the river valleys and the coast of the Black Sea. On the eastern side of the Surami Range, a high plateau known as the Kartli Plain extends along the river Kura. The two largest rivers in Georgia, the Kura and the Rioni, flow in opposite directions: the Kura, which originates in Turkey, runs generally eastward through Georgia and Azerbaijan into the Caspian Sea, while the Rioni runs generally westward through the lower Rioni valley and drains into the Black Sea. An average density of the river network in Georgia is 0.6 km/km^2. The density of the river network is conditioned by the impact of physical-geographical, climatic factors. The quantity of atmospheric precipitation plays a special critical role. Generally the density of the river network in Georgia decreases in parallel with the reduction of atmospheric precipitation from the west to the east. In particular, the density of the river network in Western Georgia is about 1.07 km/km^2, while in Eastern Georgia this figure equals to 0.68 km/km2 and density of the river network in Eastern driest regions of Georgia is very low and it equals to 0.1 km/km^2 [12].There is almost no river network in the eastern driest regions of Georgia, where the annual quantity of atmospheric precipitation is very low and equals to 100-250 mm, and the level of evaporation is extremely high. About 99% of the Georgian rivers are less than 25 km. And only one river, the river Kura, is longer than 500 km. Also there are 43 natural and artificial lakes in Georgia, of which 35 in East Georgia, for irrigation or hydropower generation Surface water and groundwater resources include numerous thermal and mineral springs. Many snow- and glacier-fed rivers are present in the Greater Caucasus. Georgia shows a remarkable diversity of underground waters both in terms of their depth and occurrence form, and their physical and chemical characteristics. Intermountain bands are mostly characterized by artesian aquifers. The Caucasus and the Meskheti-Trialeti folded zones mostly have water-table wells. The karst zone is characterized by subterranean streams and vauclusian springs. Georgia is notable for the number and diversity of its mineral springs - roughly 2000, of which 1700 are natural water-table outcrops. Borjomi, Sairme, Nabeglavi, Zvare, Lugela, Skuri, among others, are well known. Groundwater resources are abundant, especially in the lower slopes of the Greater Caucasus and in the lava plateaus of Javakheti mountains [10,12]. In Georgia, about 1600 water-suppliers provide a total of 620 million m^3 of drinking water per year. From this quantity 90% is consumed by urban population and 10% by rural [9]. Main source of drinking water is groundwater, accounting for about 90% of the total amount of water feeding the centralized water-supply networks. No special treatment of groundwater takes place before it is supplied to the users, the water is chlorinated only. When surface water is used as raw material, this water is specially treated - precipitated and chlorinated.

2. Some Contributing Factors of Climate Cooling on the Territory of Western Georgia. Against the background of global climate change, climate change of Georgia is characterized with strongly expressed regional peculiarities. There are observed as warming as well cooling processes on the territory of Georgia. Namely statistical treatment of data of average climate temperature of 1905-1995 years has shown simultaneously sharp process of warming in the Eastern Georgia and climate cooling in the Western Georgia. There are also exposed the micro regions, where the average climate temperature does not change according to time. The mentioned changeability of the climate on the whole territory of Georgia corresponds to the picture of climate change on the territory of Georgia obtained by the observations conducted according to the program of the global climate investigation and model calculations of global climate [8]. Among many atmospheric circular processes, which take place in the Western Georgia, only the circulation of the monsoon type is caused by the irregular warming of the territory of Black Sea and Kolchi lowland during the year. This circulation (which can not exist in the Eastern Georgia), must be caused by the action of constantly acting two heating mechanisms, in which the Kolchi lowland plays the role of heating and the Black Sea - the role of refrigerator during the summer, but in winter - conversely: Kolchi lowland is a refrigerator and the Black Sea - heating. It is natural, that this alternation of the sources gives rise to the changes of temperature by the annual period. To the existence of the monsoon circulations in Georgia point the investigations [5,7]. Since the reality of the existence of sources generating the monsoon circulation in the Western Georgia has no alternative and analogously are daily and nightly sources of breeze and valleys and mountains circulation, we assume as a priori the compulsory existence of the circulation of such type in the Western Georgia, the real exposition and detailed description of which must be the actual subject of the future research. The monsoon circulation, which is the most large-scaled among the daily and nightly breeze and valley and mountains' circulations existing in the Western Georgia, easily can comprise all the territory of the Western Georgia till Surami Range. This circulation, which in winter generates the monsoon circulation rotating clockwise and the up flow stream in the Black Sea sufficiently far from the shore, is characterized by the down flow streams at Surami Range[7]. In summer, the circulation has the opposite direction of rotating and at Surami Range the up flow streams change by down flow ones in the Black Sea. The distance of up flow and down flow streams from the shore and the spatial scales of generated circulations depend on the contrast (intensity) of summer and winter seasons during a year [2,3,5].

3. Climate Warming, Droughts and Desertification in Some Areas of Georgia. The problem of the forthcoming climate change resulting from natural and growing anthropogenic factors acquires a particular importance for Georgia. As we have mentioned above Georgia's climate oscillates from subtropical conditions on the

Black Sea coast to continental conditions, with cold winters and hot summers, in the extreme east, with dry lands. Activity of anthropogenic factors resulted in the considerable change of the area of underlying surface in Georgia. Namely there are observed decreasing of the following units owing to increasing of the production and building: mowing; arable; unused lands; shrubs and forests. Transformation of one type structural unit into another one, naturally, results in local climate change. The process of desertification due to both natural and anthropogenic factors. The most important among natural factors are those related to climate, hydro-geology, morpho-dynamics and soils. Georgia's arid and semiarid regions are especially sensitive to desertification. These include the south-eastern part of Georgia - the districts of Dedoplistskaro, Sighnaghi, Sagarejo, Shida Kartli. However, it is important to emphasise the need to look into the impact of desertification processes in Akhaltsikhe, i.e. in the Meskheti trough, and to identify and study all areas vulnerable to desertification. Droughts in Georgia is characterized by special extra conditions of the weather, with high temperature, low humidity and absence of atmospheric precipitations for a long period of time, i. e. when a daily norm of atmospheric precipitations are less than 1 mm. Genesis of droughts is determined by numerous natural phenomenon, but on the territory of Georgia atmosphere currents play an great importance. Namely when air currents are invading from the east, or south-east regions, they bring dry air masses on the territory of Georgia. Namely during the influence of the Asia Depression, the currents of summer thermal cyclone are extending from the south-east and as a result dry and hot air masses are formed over the territory of Georgia. Minimum temperature of the lowland dos not fall below +20° C , and a daily maximum exceeds +38° C. Recurrence of the influence is the highs in July (25,1%). During the development of various influences in Georgia change of air temperature regime takes place. Invasion of hot and dry air masses on the territory of Georgia is very dangerous for the development of draughts. For example on the steppe valley of Gardabani region lock of rain. (dry weather period) are observed 3-4 times in year, when the ground is demanded watering, while at the Black Sea coast arias only one time in 10 years. In the dry regions of eastern Georgia 15-20 days with dry weather is observed 5-6 times in year and some times dry weather period exceed 80-100 days. Reiteration of the eases the amount of atmospheric precipitations is less then 150 mm. For example in Shiraci it is equal 19% and in Gardabani area 44%. That is way there is observed desertification processes in Gardabani and Shiraci regions [11]. It is known that in Georgia the most drought regions are lower Kartli and lowland of Eldary, where possibility of the severe drought is about 40%, in Shiraki Valley- 20-40% and in the vest regions of arid East Georgia probability of the severe droughts is 10-20%. Also investigations have shown that during XX century in every ten years annual average temperature has increased in average about 0.02-0.07° C, which is closed to the velocity of global average annual temperature rise [4]. Investigations have shown that in lower Kartli and Shiraki Valley from the middle of XIX century to the beginning of XX century average annual temperature has increased only significantly. Namely in every ten years from 1920 to 1940 value of the temperature increased on 0.3-0.4° C, from 1940 to 1955 the value of the temperature decreased in average on 0.25-0.29° C, from 1955 to 1960 increased on 0.21-0.34° C, from 1960 to 1980 the temperature decreased about 0.26-0.30° C, and then from 1975 to nowadays value of the temperature speedy increased with the velocity 0.32-0.4° C in every 10 years [4]. desertification occurrence depends on complex interactions among a large number of factors. Namely a decrease in the total amount of rainfall in arid and semi-arid areas could increase the total area of dry lands, and thus the total amount of land potentially at risk from desertification. Many dry land areas face increasingly low and erratic rainfalls, coupled with soil erosion by wind and the drying up of water resources through increased regional temperatures. In addition such areas also suffer from land degradation due to over-cultivation, overgrazing, deforestation and poor irrigation practices. The analysis of perennial regional research material and the data of regime observation in the territory of Georgia showed that there exists very close dynamic connection between activation from the perennial norms. When the precipitation amount is about 700 mm mean perennial index, then activation of desertification processes remains at the general background level. When atmospheric precipitation is about 500 mm the tendency of activation of desertification processes is registered above mean level, but when precipitation less than 200 mm then there begins catastrophic development of desertification processes. It is not yet possible, using computer models, to identify with an acceptable degree of reliability those parts of the Earth where desertification will occur. But below we are going to use new simply physical-mathematical model of desertification for the purpose of to study, one of the main characteristics of desertification process, soil upper layer's temperature's temporary and spatial variations by analytical solution.

4. Conclusions. The challenges facing the science community include better understanding the soil surface and meteorological processes that lead to desertification and determining how new technology and techniques might be applied to reduce the risk of desertification. Solution of these challenges usually supposes composition of drought hazard zone maps and then attempt to predict probabilities of droughts and associated consequences. To help with this scientists can take advantage of advances in satellite remote sensing and other data sets in the development of landslide susceptibility maps based on satellite-based digital elevation maps, satellite land cover information, soil characteristics and high time resolution multi-satellite precipitation analyses with sufficient accuracy and availability to be useful for detecting rare rainfall events that provoke droughts. The combination of these products potentially provides information on the "where" (susceptibility) and "when" (rain events) of desertification process occurs and the potential to detect or forecast drought areas. Method of dripping irrigation needs 3 times less water compared with surface natural irrigation, giving up to 67% irrigation water economy, and thus resulting in much more rational irrigation water consumption. Therefore, the introduction of indicated method in the basins of rivers with irrigation water deficiency may be considered to be as an important anti-drought measure [1,6].

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