NATURAL POTENTIAL OF KVEMO KARTLI REGION IN SOUTH-EASTERN GEORGIA

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Abstract
Georgia, despite its relatively small territory, has a large number of valuable natural resources. Kvemo Kartli is a region distinguished by the indigenous natural wealth and beauty of Georgia. The province of Kvemo Kartli consists of six rayons or districts. This paper was focused on Bolnisi rayon.
In this article, we also focused on the impact of climate change and land use change on natural potential in Kvemo Kartli Region. For the purposes of this task, a land use scenario was created on the basis of the delimitation criteria, where the extreme land use changes were made. As a result, approximately 90% of the deciduous trees were removed from this scenario and replaced by short grass. The use of water on forested land is generally greater than that of other land-use types, which leads to reduced flows from river basins. Although forests have obvious effects on flood events for small-scale catchments, the effects of forests on floods are likely to be minimal for large-scale catchments. Climate change and land use change will not significantly affect natural potential.

Key words: Recreation, climate change, land use change scenario

Introduction

Georgia, despite relatively small territory, has a number of valuable natural resources. The climate is one of the most important components of recreational resources. Georgian climate is rather comfortable that gives an opportunity to develop the sphere of resorts and tourism. The variety of natural and climatic zones makes it possible to build coastal and mountain climate resorts, balneoclimatic and balneotherapeutic health resorts of which the most promising are resorts located in seaside and mountainous areas (Paresishvili and Mirzaeva, 2015).
Changes in land use may cause land degradation, defined as the temporary or permanent decline in the productive capacity of the land while the soil completely loses its productive capacity (Hlavčová et al., 2019). Agricultural activities on large blocks of land are considered as one of the main anthropogenic factors negatively influencing soil erosion and the landscape ecological stability, which however could be eliminated by effective landscape management activities (Výleta et al., 2019).
Climate change is causing an increased incidence of forest fires and changes in forest communities (Abram et al., 2021; Venäläinen et al., 2020). It is therefore clear that climate change and related land use change have a significant impact on potential natural.
In this paper, we focused on the development of a land use change scenario and soil moisture simulation for estimating potential changes under the changed land use conditions.

Material and methods

Study area
Kvemo Kartli Region is located in eastern Georgia, about 60 km south of Tbilisi. It borders the Republics of Azerbaijan and Armenia. The territory of Kvemo Kartli includes the municipalities of Bolnisi, Dmanisi, Tetritskaro, Tsalka, Marneuli, Gardabani and the city of Rustavi. The population is 424 thousand people. The administrative center of the region is the city of Rustavi. Kartli is spread in semi-desert, arid subtropical and high mountainous alpine zones. The region is rich in rivers. They mainly belong to Ktsia-Khrami and Algeti basins. Their number reaches 2422, the total length is 6980 km (Elizbarashviliet al., 2006).
By the end of the century on the eastern Georgia plains, in particular in Kvemo Kartli, annual precipitation amount will decrease by 50% or more, and will be only 150–200 mm, and the precipitation daily maximum will decrease by about 20 mm and be only 10–15 mm, which naturally intensifies desertification processes of steppe and semi-desert landscapes. In the large parts of eastern Georgia, annual precipitation decreases, decadal trend composes 1–3%. The largest decreasing in rainfall trend is observed in Kvemo Kartli, The same trends are reserved for precipitation in warm and cold periods of the year (Elizbarashvili et. al, 2019).

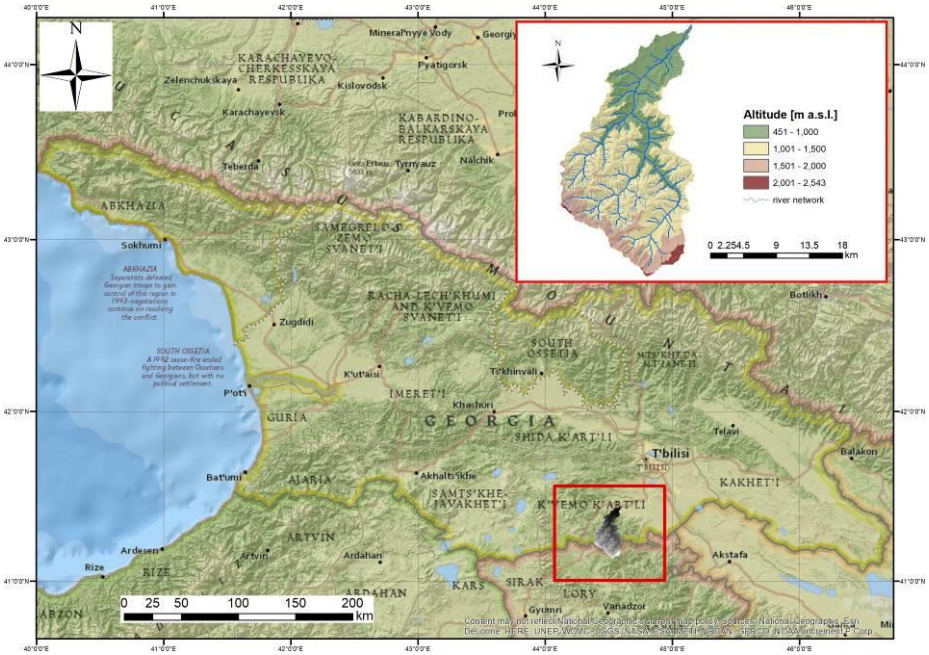
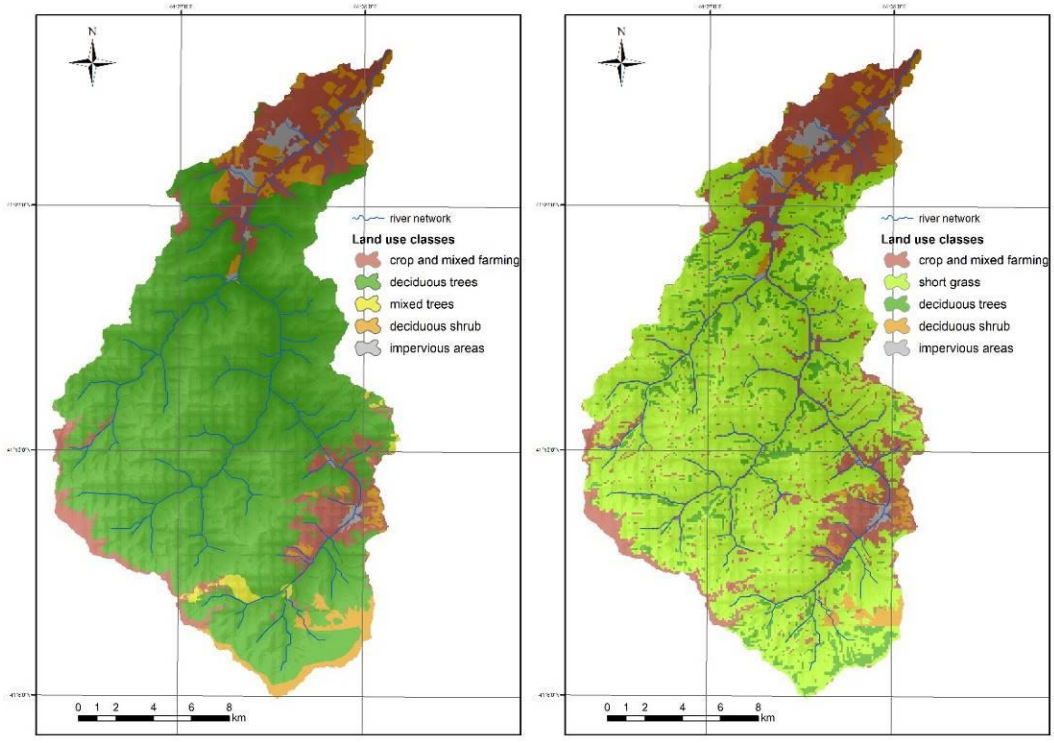


Fig. 1: Location Bolnisistskali River basin in Kvemo Kartli region.

Land use change scenario

An analysis of the land use in a territory involves the calculation of the individual areas of the land use. We are therefore talking about the percentage of each type of land use utilized in the catchment (Fig. 1). As part of this work, we have been working with the current land use and a land use change scenario. The land use scenario was created on the basis of the combination of the slope characteristics and land use classes (Fig. 2). Zones with slopes of less than 12% and covered with grass were changed to cropland. Areas with a declination (12-20%) covered with cropland were changed to grasses. Areas with over 20% slopes, cropland, and grasses were changed to deciduous trees. The percentages of the various land use types are expressed in relation to the total area of the selected river basin. On the basis of the delimitation criteria, the forested areas (-67%) in the scenario were mostly replaced by short grass (+64%).



a) b)

Fig. 2: a) Map of the current land use; b) Map of the land use change scenario.

To simulate the soil moisture from the basin, the physically-based WetSpa rainfall-runoff model was used. The model uses geospatially referenced data as the input for deriving the model parameters, which include most data types supported by ArcGIS, such as shape files, grids, and ASCII files. Digital maps of the topography, land use, and soil types are the 3 base maps used in the model, while other digital data are optional, depending upon the data availability, the purpose, and the accuracy requirements of the project (Wang et al., 1996).

Results and Discussion

The dynamics of mean daily soil water content in the diagnosed horizon of the soil aeration zone has a cyclical character with a one-year repetition period at study site. In most years of the analyzed period, this cycle can be divided into saturation period and period of discharge. Soil water content is increasing since the autumn with peak in the early spring months (Fig. 3). The beginning of the growing season is manifested by a significant decrease in winter reserves and the availability of soil water is fully influenced by the actual precipitation. This situation may generate conditions for plant water stress.

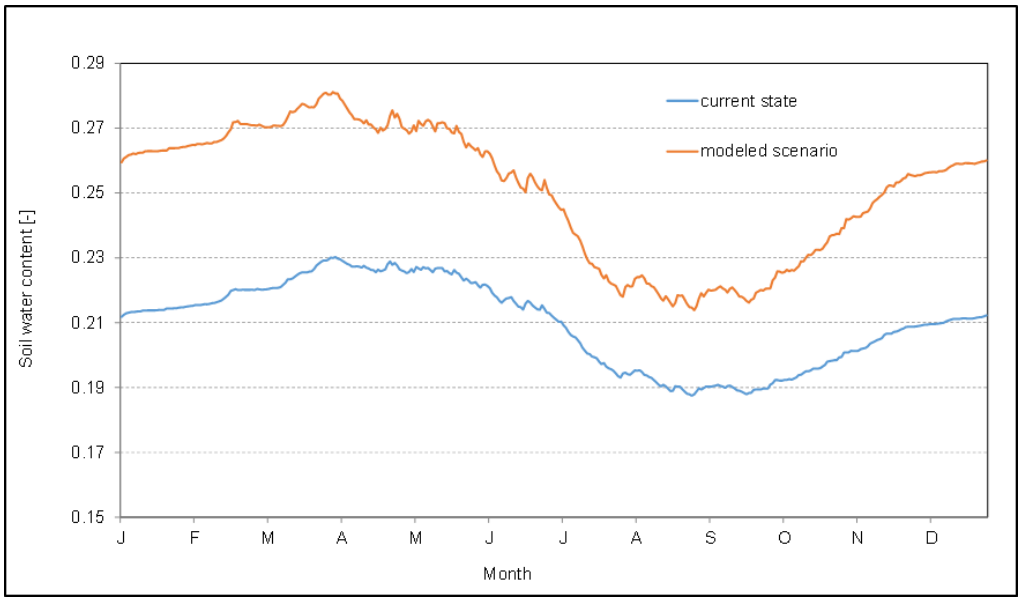


Fig. 3: The cyclical course of mean daily soil water content from period 1971–1985 estimated for 2 land use scenarios

Land use change scenario showed a positive effect on a soil water content at study site, as according to the modeling results, there was a statistically significant increase in the mean annual soil water content within land use change scenario compared to the current state. Such a change in land use, although relatively extreme, will not adversely affect the natural potential in Kvemo Kartli.

Conclusion

This paper describes the possible impact of land use change on the component of water balance. Soil moisture is important in many hydrological processes. Therefore, it is important to know their behaviour in the change conditions, especially how the land use change affect soil moisture. The soil moisture changes were evaluated by comparing the simulated average soil moisture for the current state and the land use change scenario. Land use change scenario showed a positive effect on a soil water content at study site, as according to the modeling results. The created scenario was also used to analyse the ability of the Wetspa model to simulate changes in land use. The WetSpa model demonstrated sufficient ability to simulate soil moisture under changing land use conditions.

One more aspect of the issue under consideration is environmental safety assurance. Along with the growth in demand for natural resources, anthropogenic impact on the environment grows as well; economic activities considerably damage flora and fauna of the country. Rational nature management, introduction of resources-saving technologies, waste recycling, water purification, land recultivation and some other arrangements will reduce negative impact on the environment.

References
Abram, N. J., Henley, B. J., Sen Gupta, A., Lippmann, T. J., Clarke, H., Dowdy, A. J., Boer, M. M. (2021). Connections of climate change and variability to large and extreme forest fires in southeast Australia. Communications Earth & Environment, 2(1), 1-17.
Elizbarashvili, E. S., Chavchanidze, Z. B., Elizbarashvili, M. E., Maglakelidze, R. V., Sulkhanishvili, N. G., Elizbarashvili, S. E. (2006). Soil-climatic zoning of Georgia. Eurasian Soil Science, 39(10), 1062-1065.
Elizbarashvili, M., Elizbarashvili, E., Tatishvili, M., Elizbarashvili, S., Meskhia, R., Kutaladze, N., Khardziani, T. (2017). Georgian climate change under global warming conditions. Annals of Agrarian Science, 15(1), 17-25.
Hlavčová, K., Danáčová, M., Kohnová, S., Szolgay, J., Valent, P., Výleta, R. (2019). Estimating the effectiveness of crop management on reducing flood risk and sediment transport on hilly agricultural land–A Myjava case study, Slovakia. Catena, 172, 678-690.
Paresishvili, O. I., & Mirzaeva, V. A. (2015). Natural recreation potential of Georgia and prospects for its realization. Annals of agrarian science, 13(4), 111-116.
Venäläinen, A., Lehtonen, I., Laapas, M., Ruosteenoja, K., Tikkanen, O. P., Viiri, H., ... & Peltola, H. (2020). Climate change induces multiple risks to boreal forests and forestry in Finland: A literature review. Global change biology, 26(8), 4178-4196.
Vyleta, R., Valent, P., Nemetova, Z., Hlavcova, K. (2019). An Assessment of Changes in Ecological Stability and Landscape Management Practices over the Last Centuries: A Case Study from Vrbovce, Slovakia. In IOP Conference Series: Materials Science and Engineering (Vol. 603, No. 2, p. 022083).
Wang Z., Batellan O., De Smedt F. (1996). A distributed model for water and energy transfer between soil, plants and atmosphere (Wetspa), Phys. Chem. Earth, 21: 189-193.

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Souhrn
V tomto článku jsme se zaměřili na vývoj scénáře změny využití půdy a simulaci půdní vlhkosti pro odhad potenciálních změn v podmínkách změněného využití půdy. Na základě dosažených výsledků lze konstatovat, že změna využití půdy nebude mít negativní vliv na přírodní potenciál. Hodnoty půdní vlhkosti se zvýší, čímž se sníží riziko půdního sucha. Na druhou stranu může změna klimatu způsobit zvýšení počtu lesních požárů a změny ve složení lesů. V tomto výzkumu byl vytvořený scénář použit také k analýze schopnosti modelu Wetspa simulovat změny ve využití půdy. Model WetSpa prokázal dostatečnou schopnost simulovat vlhkost půdy v podmínkách měnícího se využití půdy.
Region Kvemo Kartli má rozhodně bohatý přírodní potenciál, ke kterému je třeba přistupovat zodpovědně. Důležitá je také snaha o využití jeho potenciálu, avšak na rozumné a udržitelné úrovni.

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