THE PROCESS OF DESERTIFICATION CAUSED BY CLIMATE CHANGE AND THEIR IMPACT ON GEORGIA'S BIODIVERSITY

Tea Mchedluri
Doctor of biological sciences, professor,
Iakob Gogebashvili Telavi State University, Georgia
E-mail: t.mchedluri@yahoo.com

Elene Petriashvili
Doctor of Biology. Assistant professor Sokhumi State University.Georgia

Tinatin khokhobashvili
Doctor of Biology. Director, Education LLC

Abstract:
Different regions of Georgia respond uniquely to ongoing climate change, leading to varying levels of vulnerability. The country features a diverse natural landscape that has evolved over time. By the end of this century, climate change will remain a significant ecological and socio-economic challenge. It is a major driver of biodiversity loss. The projected increase in temperature and decrease in precipitation in Georgia are especially damaging to transitional ecosystems, altering the distribution of their flora and fauna.

The landscapes of eastern Georgia are more vulnerable to modern climate change than those of western Georgia's humid subtropics. In southeastern Georgia, a semi-desert area of about 3,000 km² is constantly affected by drought and wind erosion and is experiencing degradation or desertification. Both natural and human activities contribute to desertification. Areas in the Kakheti region (Dedoplistskaro, Sighnaghi, Sagarejo) are especially at risk of desertification (Fourth National Environmental Protection Program of Georgia for 2022-2026) Fighting desertification is crucial for protecting existing biological and landscape diversity.

The arid and semi-arid areas of Georgia are especially prone to desertification. Both natural and human causes drive this process. The southeastern part of the country, including the Dedoplistskaro, Sighnaghi, Sagarejo, and Shida Kartli districts, is particularly at risk.

Due to the urgency of the issue, focus is on the processes of desertification and the ecological challenges caused by soil degradation in the Alazani Valley, particularly in the municipalities of Dedoplistskaro and Sighnaghi. These processes adversely impact local ecosystems, crops, and biodiversity, posing a serious threat to regional environmental sustainability. It is important to develop effective strategies to mitigate or adapt to the negative effects of desertification, ensuring both ecological and socio-economic stability.

Keywords: biodiversity, climate change, desertification.

Introduction:

Georgia, as a country with an economy in transition, is listed in Annex B of the United Nations Framework Convention on Climate Change (UNFCCC), which obligates the country to specific commitments under the Convention. To promote sustainable development, it is essential to reduce the adverse effects of climate change and develop suitable adaptation strategies. It is important to highlight the collaborative efforts of the Government of Georgia, the Global Environment Facility (GEF), and the United Nations Development Programme (UNDP), which enabled the submission of Georgia's (first-fifth) notifications to the United Nations Framework Convention on Climate Change (UNFCCC). (Fourth National Environmental Protection Program of Georgia for 2022-2026)

Different regions of Georgia respond differently to ongoing climate change, which directly affects their vulnerability. The areas most at risk from climate change in the country include the Black Sea coastal zone, Dedoplistskaro, and Lower Svaneti.

In the Black Sea coastal zone, the study indicated a rise in sea level, an increase in the frequency and intensity of storm surges, the accumulation of solid sediment in river deltas, and changes in sea surface temperature. Consequently, the following climate vulnerability indicators have been identified for the Black Sea coastal zone: sea level, storm surge rates, river solid sediment, and sea surface temperature (Georgia's Fifth National Communication to the United Nations Framework Convention on Climate Change. Tbilisi 2024).

Based on similar studies, the indicators used to assess climate change vulnerability in Lower Svaneti include heavy rainfall, flood frequency (Tskhenisi River), landslides, drought duration, and demographic factors.

The analysis of climate change vulnerability in Dedoplistskaro identifies both natural and human-made factors. Natural factors include more frequent and more prolonged droughts and stronger wind events. Human-made factors involve the removal of windbreaks, damage to irrigation systems, and incorrect land use, which lead to decreased soil fertility and the expansion of abandoned lands (Elizbarashvili & Tatishvili 2013).

Prof. E. Elizbarashvili's research (Elizbarashvili, 2005) confirms that the landscapes of Eastern Georgia are especially vulnerable to global warming. Under these conditions, more frequent droughts lead to changes in natural landscapes. It is important to note that the leading cause of desertification in Georgia is not temperature rise itself, but the increased frequency of droughts, which is further worsened by human activities such as overgrazing, deforestation, and clearing of pastureland.

Discussion of the research results:

The goal of our study was to assess how climate-driven desertification affects Georgia's biodiversity. Based on data from the conducted studies (Fourth National Communication of

Georgia to the UNFCCC, 2021), hotspots of intense warming in eastern Georgia include the Gudamakari and Kharuli ranges, the southern part of the Kakheti range, and the Javakheti plateau, where temperatures are rising by more than 0.1 °C every 10 years, according to the increase in average annual air temperature. Areas experiencing moderate warming (0.06–0.10 °C every 10 years) are found in the central Likhi range, the southeastern Gombori range, the central Iori plateau, and some parts of the Kakheti and Kharuli ranges (Climate Change, 2007). In western Georgia, moderate warming is observed in most areas of the Svaneti, Lechkhumi, and Egrisi ranges. Weak warming zones (0.02–0.06 °C per 10 years) include the Svaneti, Lechkhumi and Egrisi ranges, as well as the central part of the Kolkheti plains. These temperature changes are statistically significant in eastern Georgia at the 95–99% confidence level, and in the western regions at the 90–95% confidence level (Georgia's Third National Communication to the UNFCCC. 2015)

Thus, under global warming, the landscapes of Eastern regions warm faster than the humid landscapes of Western regions, where much of the heat is used for evaporation, causing them to warm less or even cool. (Elizbarashvili & Tatishvili, 2013). Changes in atmospheric precipitation with global warming showed similar patterns. Annual precipitation totals over most of Eastern Georgia decreased by 1-3% every 10 years. The highest rates of decrease are seen in Kvemo Kartli, exceeding 5% per 10 years.

Various natural territorial complexes—landscapes—have developed across Georgia. As a predominantly mountainous country, the distribution of natural features by altitude is clearly visible, resulting in landscapes characterized by altitudinal zonation and a full spectrum of landscape zones. The landscapes of Eastern Georgia, compared with the humid subtropics of the West, are susceptible to modern climate change, as reflected in a significant rise in temperature and a slight decrease in atmospheric precipitation in recent years. Therefore, special attention should be given to the study of ongoing desertification processes in Eastern Georgia.

Therefore, it is imperative to pay special attention to the problems caused by desertification in the southeastern part of Georgia - Dedoplistskaro and Sighnaghi, which in turn leads to land degradation, which seriously harms both agricultural development and local biodiversity (Mchedluri & Vepkhvadze, 2017).

The desertification trend is expressed in relatively large areas of the ecosystem of the arid and semi-arid territory: in the Chachuni steppe, in the foothills of the southern slope of the Kotsakhura ridge, in the Iori steppe, in the Eldari lowland, in the Taribana depression, in Natbeuri, in the Chatmi depression, on the terraces of the Iori river (below the Dali reservoir), in the foothills of the western part of the Kotsakhura ridge (between the oil well and the Chachuna steppe), etc. The desertification trend is evident in small fragments and in the

Sakmlishkhiani light forest complex. Even in floodplain forests, desert elements are observed (Mchedluri & Vepkhvadze 2017)

A large part of the arid and semi-arid ecosystems themselves represent rare biotopes in Georgia (arid light forests, semi-deserts, and desert elements), which is why particular species are found only here, e.g., gyurza, duraj, striped aftari, gazelle. Of the insects common in the region, 24 species were included in the Red Book of the Soviet Union, including: Papilio machaon, P. alexanor orientalis, Inphichlides podalirius, Utethesia pulchera, Arctia caja, Coenonimpha saadi, and others. Among the rare vertebrate species, the following species from the Red Book of Georgia are worth mentioning: Pelobates syriacus, Eryx jaculus, Eumeces scheineri, Elaphe longissima, Haliaeetus albicilla, Aythya nycora, Perdix perdix, Mesocricetus brandti, Suncus etruscus, Nyctalus leisleri, Lutra lutra, Hyaena hyaena, Lynx lynx, Gazella subgutturosa, and Cervus elaphus. Among small mammals, rare and endangered species include Sorex volnuchini, Crocidura leucodon, Allactaga elater, Cricetulus migratorius, Allactaga williamsi, and others. Some bird and small-mammal species are also globally rare and are listed on the Red List of the International Union for Conservation of Nature (IUCN). For example: Phalacrocorax pygmeus– LR; Aegypius monach– LR; Haliaeetus albicilla – LR; Aquila heliaca – VU; (Tetrax tetrax) – LR; (Aythya nyroca) – VU; Rhinolophus ferrumequinum – LR. Cd Rhinolophus hipposideros – VU.A 2c; Barbastella barbastellus – VU.A2c; Driomys nitedula – LR.nt, etc. (Mchedluri & Vepkhvadze 2017)

The indicators of desertification in arid and semi-arid areas include plant impoverishment, reduced floristic composition, and degradation of plant communities. Expansion of plant species typical of semi-deserts and deserts (Salsola spp., Artemisia fragans, Gamantus pilosus, etc.) and associated plant communities (Artemisietum, Artemisieto-salsoletum, Botrichloeto-artemisietum, etc.); animal – disappearance of some insectivores and rodents, such as Crocidura leucodon, Microtus socialis, Sorex volnuchini, and Alactaga spp., which are characteristic of desert landscapes; edaphic – destruction of the upper soil layers, soil salinization, and sodification (Climate Change 2007).

The arid and semi-arid regions of Georgia are highly vulnerable to desertification. A combination of natural and human-made factors drives this process. Key natural influences include climate, hydrogeology, landform dynamics, and soil conditions. These regions, particularly in southeastern Georgia—including Dedoplistskaro, Sighnaghi, Sagarejo, and Shida Kartli—are especially prone to desertification.

Conclusion

Based on the research results, it is clear that climate change is significantly impacting the arid and semi-arid landscapes of Georgia. A notable trend of temperature increase was observed in Eastern Georgia, often exceeding the average rate of global warming. Additionally, the

trend of decreasing annual precipitation, especially in Kvemo Kartli, has increased the risk of hydrological resource depletion. Under such conditions, desertification processes are sharply accelerating, placing substantial pressure on local biodiversity.

Arid and semi-arid ecosystems are already rare and ecologically sensitive habitats in Georgia, requiring special protection. However, ongoing climate change-driven degradation—such as soil salinization, reduced vegetation cover, and the expansion of semi-desert species—makes these areas even more vulnerable. As a result, many local and endemic species face increasing danger.

Therefore, in the context of climate change, desertification processes are already among the main threats to Georgia's biodiversity. To stop this process, it is necessary to implement evidence-based management, improve ecosystem monitoring, and quickly adopt measures to restore the natural environment. Only an integrated approach will ensure the preservation of biodiversity and enhance ecosystem resilience.

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