Landscape and Climatic Assessment of Productivity of Phytocenosis of Mountain Ecosystems of the Makazhoy Basin of the Chechen Republic

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Abstract. The paper presents a landscape and climatic assessment of the productivity of phytocenoses of mountain ecosystems of the Makazhoy basin of the Chechen Republic. The bioclimatic conditions of the territory, soil and vegetation cover are described, as well as calculations of the productivity of phytocenoses of mountain ecosystems are carried out by various methods. The article includes drawings and graphic material, based on the study, conclusions are drawn about the landscape and climatic potential of the Makazhoy basin.

1 Introduction

The climate of any territory is formed under the long-term influence of a number of external factors that characterize their distinctive features based on local natural features. The importance of the problem in the study of climatic features is the identification of the exact distinctive features that create a local picture of the appearance of this landscape. This is especially difficult to do in more cramped conditions, i.e. in mountainous areas. Mountain regions, despite the same geographical latitudes, differ in many ways from each other by their local natural features. Therefore, a local approach to studying the landscape and climatic potential of mountain ecosystems is very relevant.

The purpose of this work is a landscape and climatic assessment of the productivity of phytocenoses on the example of the mountainous zones of the Makazhoy basin of the Chechen Republic on the basis of field and desk research. To do this, the following tasks were defined

1. Collection and processing of information and statistical material: databases of the weather station of the Chechen Republic short-term, medium-term and long-term weather observations;

2. To designate a scientific and methodological approach for determining the methods of determining the productivity of phytocenoses of the mountainous zones of the Makazhoy basin of the Czech Republic;

3. Compare the results of theoretical and methodological approaches with practical research work.

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It is known that the first meteorological observations on the territory of southern Russia, in particular the front Caucasus, appeared in the second half of the 19th in the city of Grozny, etc. Prior to this, the observations were only route descriptions of local climatic features. The research of the mountainous territories was carried out by the Russian naturalist-geographer G.I. Radde (1857-1903) described the vegetation cover of the Shatoi and Itum-Kalinsky basins [1.7]. A special role in the study of the mountain soil and climatic potential belongs to V. V. Dokuchaev (1846-1903). In his route studies in 1899, Grozny-Vedeno-Botlich, most likely, finally proved the regularity of the high-altitude zonality of soils based on the extrapolation method [4]. In 1971, a joint work was published by Ryzhikov V.V., Grebenshchikov P.A., Zoeva S.O., on the geography of CHIASSR, where for the first time a climatic characteristic was given in a separate column [8].

Modern works on the study of landscape and climatic zones of the mountainous regions of the Chechen Republic belong to Gunya A.N., Gayrabekov U.T., Gagaeva Z.Sh., Retrospective analysis of agricultural development of landscapes of the territory of the Argun Historical, Architectural and Natural Museum-Reserve, Grozny, 2021. pp. 131-139., A.N. Gunya., Matsaev S.B. Agro-climatic the potential of cultural landscapes of the mountainous part of the Chechen Republic, in the collection: North Caucasian complex expedition. Proceedings. Editors A.N. Gunya, M.N. Petrushina. Grozny, 2021. pp. 114-124 [2,3.].

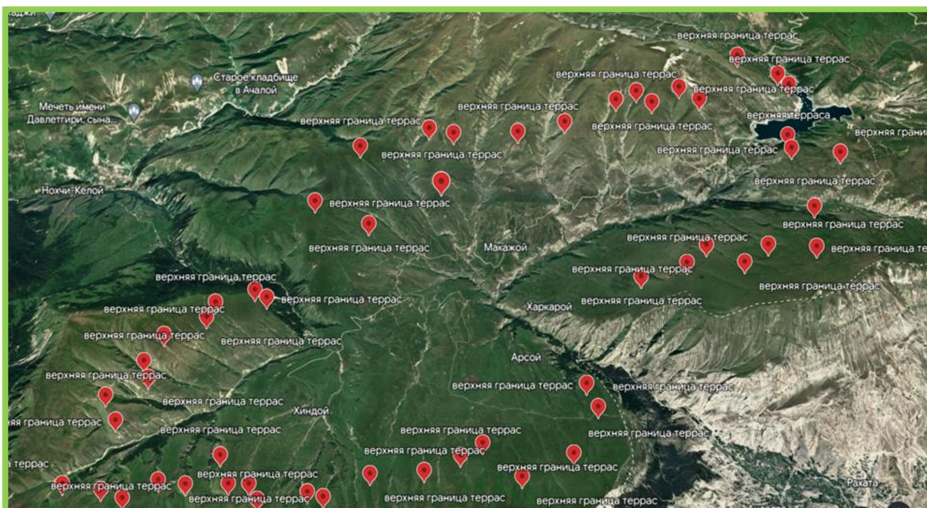

Fig. 1. Makazhoy basin of the Chechen Republic. Source: Google Earth.

2 Research Methodology

The research materials are landscape and climatic zones of pasture and hayfields of the Makazhoy basin of the Chechen Republic (see Fig.1.). Data from the weather station of the Chechen Republic for long-term meteorological observations and short-term observations from 2021 to 20223 of the carbon landfill weather station of the Chechen State University named after A.A. Kadyrov. Archival, periodical and book materials were used to describe research scientists in different periods, the end and beginning of the 19th and 20th centuries of Tsarist Russia, the Soviet Union and modern Russia.

Methods of studying the landscape and climatic potential of the productivity of phytocenoses of mountain ecosystems are the collection and processing of information and statistical material of meteorological parameters operating at the Carbon Landfill of the

Chechen State University since 2021, Vedeno, Shatoy, Itum-Kali, as well as data from portable meteorological devices, including smartphones, where weather station applications are connected.

3 Results and Discussions

Temperature, humidity, pressure, wind direction and speed are determined by arithmetic mean calculations [6]. Precipitation is accumulated by decades, months and per year. The moisture coefficient is calculated by the formula:

$$KU = R/E \quad (1),$$

where, R is the sum of precipitation;

E- evaporation, calculated by the formula:

$$E=0.0018\times (25+t)2 \times (100-a) \quad (2),$$

where, 0.0018 is the coefficient of transition of water to steam;
25-average high temperature during the growing season;
t-average monthly temperature;
100-absolute humidity;
a is the average relative humidity of the air.

To determine the natural productivity of phytocenoses, we apply the methods of productivity calculations according to Isachenko A.G. [5], according to the formula:

$$Epr= 0.000035 \times \sum t{>}10^{\circ} \times Cu \times Q \quad (3)$$

where, Epr is the natural productivity of phytocenosis t/ha;
0.000035 -coefficient of dependence between phytocenosis and climate;
Ku - coefficient of humidification;
$\sum t>10°$ is the sum of active temperatures during the growing season;
Q is the number of days of the active vegetation period.

For practical calculations, we apply the author's development according to the certificate of the computer program No. 2023610731 "Web application methodology for calculating the zonal productivity of plants (phytomass) ecosystems (landscapes)" [9].

$$Zpr= \Sigma t/\Sigma r \times Sg \times Cu \quad (4),$$

where, Zpr is the zonal productivity of plants;
Σt - the sum of active temperatures for the growing season;
Σr - the amount of precipitation in mm per year;
Sg - humus content;
Ku is the coefficient of humidification, the ratio of precipitation to evaporation.

Results and discussions the territory of the Makazhoy basin of the Chechen Republic has a paradoxical external picture in landscape terms, i.e., a relatively homogeneous surface, but at the same time a complex structural natural alignment.

The climate of the territory is formed by the orographic factor. in general, it is temperate sharply continental. The climatic conditions here depend on the exposure and the direction of the slopes. The northeastern slope is relatively wet (Iharoy-Lam) in winter, snow is more stable. The average daily temperature for the growing season is 12.25 0C. The absolute amplitude of the average annual temperatures ranges from – 17, in rare cases it can drop to -20 0C in winter (January-February) and +25 +30 0C in the hottest period (July-August). The average annual temperature is +5.2 0C. The sum of temperatures for the growing season averaged above 2000° was $\sum t>10° = 2250°$, the number of days with temperatures above 10 °C 105 days, for 2021-22.

Figure 2 shows the average daily temperature parameters for the last 2021-22 years of the Makazhoy basin. The first negative air temperatures here may be at the end of September, and stable frosts occur only at night, the end of October and the beginning of November come. In general, in autumn, more stable weather is established here, the number of sunny days is greater than in other seasons of the year. During the day, the temperature can rise above +15 0C, and at night it can drop below zero degrees.

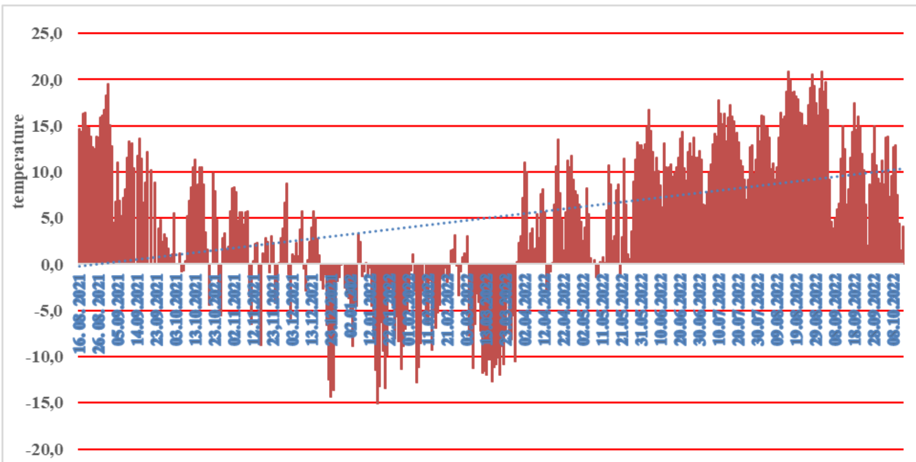

Fig. 2. Average daily temperatures of the Makazhoy basin. Source: Data from the carbon landfill weather station of the Kadyrov Chechen State University (2021-22)

The average relative humidity is 69.4%. Precipitation for the year falls within 654mm. More precipitation falls from April to early June. In winter, precipitation is negligible. The humidification coefficient is 0.75-0.8, according to the calculation method: E=0,0018×(25+12,3)2 × (100-66) = 0,0018×1391×34; CU= 654/85=7.69, the indicators are calculated on the basis of precipitation and temperature data for 2021-22 at the weather station of the carbon landfill of the ChSU in the village of Makazhoy.

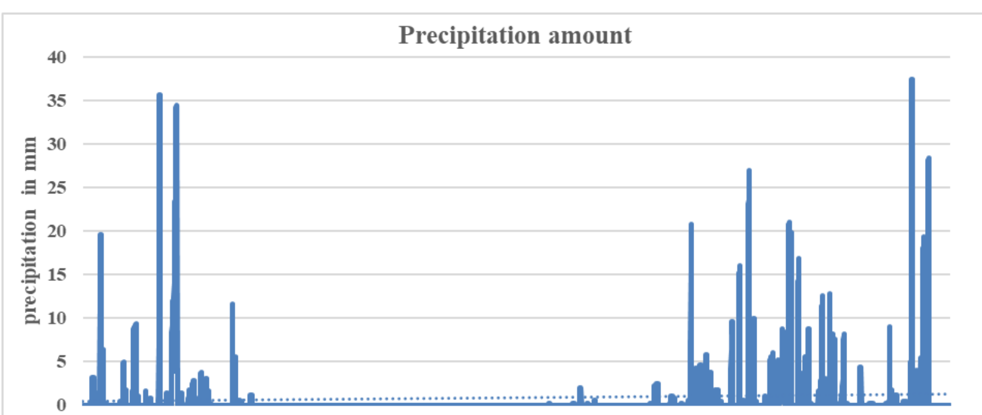

Fig. 3. Annual precipitation of the Makazhoy basin. Source data from the carbon landfill weather station of the A.A. Kadyrov Chechen State University (2021-22)

Here, of course, in the process of forming landscape and climatic zones of mountain meadows, a special role was played by the factor of high-altitude zoning, in particular exposure and the steepness of the slope. The territory of the Makazhoy basin has a bowl-shaped shape elongated from the northeast to the southwest with a small depression in the center (see Fig. 1.). According to the landscape-geomorphological structure, it can be divided into the following belts: subalpine (valley-floodplain, belt of dark coniferous, including (petrophytes-rocky coniferous shrubs) and mixed undergrowth consisting of Caucasian fir and pine, aspen, fluffy birch and tall grass meadows 1400-2100 meters), lower Alpine meadows 2100-2300 meters, Middle Alpine meadows 2100-2650 meters and Upper Alpine 2500-3300 meters above sea level. The highest point here is Mount Kashker-Lam 2806m.

The landscape appearance of the basin has, as it were, a side feature due to the exposure and the direction of the slopes in relation to the Sun. Therefore, the north-eastern slope is wetter in contrast to the south-western relatively arid, the mountain-dry-steppe factor is clearly traced here, and on the contrary, the north-eastern slope (Iharoy-Lam) of the mountain-meadow-steppe is relatively wet, therefore the herbage is more stable for the entire growing season. The soil cover is represented in the undergrowth zone by meadow-forest mountain-meadow and sod-brown soils with a small thickness of the humus horizon from 10-15cm.

In the belt of high-grass meadows, chernozem-shaped mountain-meadow soils with a large humus horizon of 25-35 cm prevail, vegetation is mainly represented by cereals and leguminous species: hogweed (Heraslum), aconite (Aconitum orientale), roadworms (Doronicum macrophyllum), comfrey (Symphytum asperum) and goat (Galeda orientalis), as well as varieties of meadow clover and others. The Alpine belt (lower, middle) can be divided into two landscape subtypes, where dense sod-grass and sedge grasslands predominate.

The lower belt of sod-alpine meadows can be divided into the same type and mixed. Typical sedge plant species predominate here, especially this is clearly traced on the north-western slope of Kashker-Lam, oatmeal (Helictotrichon adzharicum) or in common people they call wild fescue, barley.

Natural productivity of phytocenoses (ecological potential of landscapes) according to calculations (Isachenko A.G., 2004), $Epr= 0.000035 \times \sum t>10° \times Cu \times Q$; $Epr=0,000035 \times 2250 \times 0,7,69 \times 105 = 6367$ kg/ha; Next, we will carry out calculations according to the author's method of zonal productivity of phytocenoses, taking into account field collections of phytomass from 1m2, according to the formula:

$$Zpr = \Sigma t / \Sigma r \times Sg \times Ku; \quad Zpr=2250/654 \times 3 \times 0.77=7,947 \text{kg/ha}$$

4 Conclusions

Thus, based on the conducted research, the following results are indicated: 1. The sum of temperatures for the growing season and the amount of precipitation show that the year 2021-22 is sufficiently warm and moisture-rich, therefore productive in terms of phytomass; 2. The natural productivity of aboveground phytomass according to the method (Isachenko A.G., 2004) is high equal to about 6.4 t/ha 3. The zonal productivity of the author's work is slightly higher, since for the entire growing season 1 hectare of area can reproduce about 8 (7,947 kg) tons of green mass.

With good indicators of heat and moisture availability in this area, the natural and ecological productivity potential of phytocenoses (NM) can be high (productive), for example, 2021-22 was saturated with both warm and moisture, according to the author's calculations, and in some years and due to dryness, the indicators can drop below 5 tons of aboveground phytomass (NFM) by 1 a hectare of area.

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