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The Natural Resource Potential of landscapes in the Lechkhumi Region (Tsageri Municipality)

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Abstract

To study a region's natural capital, it is important to classify and describe local landscapes, which, depending on the area they are found in, have different characteristics and vary in terms of natural resources. The mountainous region of Lechkhumi (Tsageri Municipality) has been selected for this purpose. Along with relevant literary sources, the research draws on cartographic material, the landscape maps (1970, 1983) of Georgia and Transcaucasia, and the topographic map (1:50000) as well as on observation records made during the 2022 field expedition in Lechkhumi. Geo-informative system of Lechkhumi landscapes has been created by GIS technology. The large scale (1: 50 000) landscape map of Lechkhumi region has been made, where landscapes are shown on the level of landscape species. The paper describes the region's individual natural assets as well as the natural resources available in selected landscapes. Data on mineral, climate, agroclimatic, soil and forest resources are provided in the tables and diagrams. The synclinical depression in Racha with river terraces (Tskhenistskali, Rioni, Lajanuri) and humus-carbonate soils on the southern slope of the Lechkhumi Ridge (450-750 m above sea level) provide a favourable micro zone for the cultivation of grapevine species (Usakhelauri, Tsolikauri, Orbeli Ojaleshi red and Tskhvediani white) used in the production of the widely known naturally semi sweet Usakhelouri, Tvishi, Ojaleshi red and white wines.

Keywords: Natural resources, Landscape map, Lechkhumi region, Tsageri Municipality

Introduction

Utilization of the environment of a region is related to its natural conditions and resources, as well as the peculiarities of the geographical location of the territory and the historical processes taking place there. Environmental conditions, in turn, impact the material and spiritual culture of the population, traditions, features of nature use and settlement style. All this is clearly reflected in the landscapes, as a single (entire) territorial system, which has a certain characteristic potential, e.g., it has the ability to provide people living in it with heat, water, the possibility of rest (recreation), etc. Meanwhile, for that purpose, it is necessary to reveal the resource potential of landscapes.

Lechkhumi (Tsageri Municipality) is located in the northeastern part of western Georgia on the southern slopes of the Caucasus. The hypsometric levels of the territory vary from 320 m (Tvishi Cliff) to 3170 m (Mount Tsekuri, Egrisi Ridge). In regard to climate, it is located in a subtropical humid sea climate zone and is distinguished by its variety and complexity of natural components and natural-territorial complexes (landscapes) as a whole. The peculiarity of the natural conditions and specificity of the geographical location have determined the peculiar structural characteristics and aspects of nature use of the landscapes of the region.

The landscapes in the region are useful for agriculture, livestock farming, and recreational purposes in accordance with natural conditions.

Methods and Materials

The research was based on the existing published literature and foundation material about the Lechkhumi region. These include Georgia (Saneblidze et al., 1970), the Transcaucasus Medium-Sized Landscape Map (Ukleba et al., 1983), topographic maps (scale: 1: 50 000, 1: 100 000) and statistical data. An important component was the field expedition research conducted in 2022. Based on the

obtained material, the Lechkhumi electronic map was created (ArcGIS) on a cartographic basis and several thematic maps. Lechkhumi region landscapes have natural and socioeconomic environmental influences. Natural conditions and specific geographical locations created the peculiar structural character of the landscape of the region and aspects of natural use.

The Lechkhumi region, represented by the Tsageri Municipality, is a region distinguished by its diverse nature. Tsageri Municipality (1 town and 58 villages) is located in western Georgia on the southeastern slopes of the Caucasus Mountains, in the Tskhenistskali and Rioni River Basins, bordered on the west by Martvili and on the north by Lentekhi municipalities, on the east by Ambrolauri municipality, and on the south by the Tskaltubo and Khoni municipalities. Its area is 756 km2.

The region occupies the southern slopes of the folded mountains of the Caucasus. It is mainly composed of Jurassic and Cretaceous shale, sandstone, and limestone and is built from Palaeogene-Neogene rocks, and the river terraces and the bottoms of the basin are composed of alluvial layers.

Results

Lechkhumi is a region with many mountains and a shortage of land. Most of the time, 67. Six percent of its territory is occupied by mountains and foothills. Due to the relief complexity, extreme disintegration and strong inclination (45% of the territory is covered with slopes inclined by 20° and more), the resources of the land for agricultural activities are extremely limited. The agricultural lands occupy 17 146 ha, which is 21% of the whole territory (Government of Georgia, 2023).

Lechkhumi is bordered by the Egrisi and Lechkhumi Ridges in the north, the Askhi Massif in the west and southwest, and the Khvamli Massif in the south. In the east, the valley of the Askhistskali River borders it from the Racha Region. The Lechkhumi Ridge is built of lower Jurassic sediments, shale and sandstones (in the top part of the Lechkhumi Ridge); the Egrisi Ridge and the Jonouli River Basin are built of the Middle Jurassic Bajocian porphyritic suite; the Askhi Massif (northern and eastern slopes) and the western part of the Nakerala Ridge are constructed of lower Cretaceous quartz-arkosic sandstones and dolomitic limestones; the Khvamli and Askhi massifs – with Urgonian facies limestones; and the northern part of the Khvamli Massif, Tvishi Cliff and Lajanuri Cliff – with limestones and marls (Maruashvili, 2020). An important orographic unit is the Tsageri Depression, which represents the western part of the Racha-Lechkhumi Syncline. It is built of Palaeogene and Neogene marls, sandstones, clays and conglomerates. The Tsageri Depression, which is crossed by the Tskhenistskali River, starts from the Muri Cliff and continues south to the Saretskela Cliff. To the south of the Saretskela Cliff, the Tskhenistskali River redistributed again and formed the Zubi Depression in the porphyritic rock. The Tsageri Depression is separated from the Orbeli Depression in the east by the Mid-Lechkhumi Hill. To the east in the Cretaceous limestones, the Rioni River formed the Tvishi cliff. The limestone massifs are characterized by sharp erosive and karst landforms, while landslides are typical of depressions.

In regard to climate, Lechkhumi is located in a subtropical humid sea climate zone. The following climate subtypes are distinguished here: a) damp climate with moderately cold winters and hot and relatively dry summers; b) damp climate with moderately cold winters and long summers (lower belt of mountains); c) damp climate with cold winters and long summers (middle belt of mountains); d) damp climate with cold winters and short summers (1500-2000 m above sea level); and e) damp climate devoid of real summers (the summit zone of the Egrisi and Lechkhumi Ridges and the Askhi Massif).

The average annual air temperature is 11°, the average temperature in January is close to 0°C or is negative, the average temperature in July is 22.5°, and the absolute maximum temperature exceeds 40°. The sum of the active temperatures is 2700-3500°, while the vegetation period lasts for almost 7 months. The annual total precipitation at an altitude of 600-800 m above sea level is equal to 1100-1200 mm. A greater precipitation amount typically occurs in late spring and autumn. The lowest amount occurs in the second half of summer and the beginning of autumn, i.e., when it is most needed for vineyards and fruit. At this time, the humidity coefficient is 0.6-0.8. Therefore, watering is required during this period of the year.

During the active vegetation period, the amount of precipitation varies from 585-780 mm to 970-1298 mm. The annual precipitation is 1300 mm, and the highest precipitation is 122 mm in October. The number of days with snow cover ranges from 54-138. The maximum thickness of snow cover is 103 sm (Tsageri) – 138 sm (Lailashi). In the lower zone, the active vegetation process starts on 4-19 April and ends at the end of the third week of October and the beginning of November. In separate years, when the freezing period is too long or starts in early autumn, the vegetation period may decrease by 1

month (Gobejishvili, 2000; Elizbarashvili et al., 2004; Elizbarashvili & Elizbarashvili, 2021; agroclimatic resources of Georgia, 1978).

Lechkhumi, according to agro-climate zoning, belongs to the moderately humid region of the West Caucasus subdistrict of the West Georgian district (Table 1).

Table 1. Agro-climate characteristics of the Lechkhumi Region (Tsageri municipality)

Object	M. above sea level (m)	The sum of active temperatures (10^0>)	Absolute minimum temperature (average) (C^0)	Moisture rate	Annual sum of atmospheric precipitation (mm)	Duration of frost-free days
Tsageri	**760**	**3610**	**-18**	**1.3**	**1000**	**267 -186**
Lailashi	**980**	**2980**	**-22**	**1.5**	**1300**	**216 - 175**

In Lechkhumi, there is a dense network of mountain rivers, and the main rivers are Rioni and Tskhenistskali. The main right tributary of the Rioni is Lajanuri, while its other right tributaries are Utskherisghele, Minatskarosghele and Lakhepisghele. The right tributaries of the Tskhenistskali River are Janouli, Namkashuri, etc. The rivers are characterized by steep slopes and deep, sometimes canyon-like valleys. Mixed nutrients are characteristic of these plants because they are fed by rain, snow and underground waters. Some of the small rivers have karst regimes, and some have torrential characteristics. The flooding of rivers occurs in spring, while that of torrents occurs in summer-autumn. Among the most remarkable lakes are Akhalouri Lake, Mtsvane Lake (green lake), Babushkino Lake and Lajanuri Reservoir.

Here, humus-carbonate soils are common (Tsageri and Orbeli Depressions, eastern part of the Askhi Massif and the Khvamli Massif) and are alluvial (the bottom of the Tsageri Depression); other types of soils are dark gray forest soils (in the basins of the Lajanuri and Jonouli Rivers) and mountain-meadow soils (in the highest part of the Askhi Massif, in the summit zones of the Egrisi and Lechkhumi Ridges). In the mountain-meadow zone, we observe low mountain meadow-peat soils and peat soil, while higher (in the alpine zone) thin primitive mountain meadow soils are observed. Alluvial soils are common on the banks of large rivers. In valleys and on slopes where alluvial and humus-carbonate soils are widespread, there are favourable conditions for viticulture and fruit growing.

In regard to the economy, forest cover is of the greatest importance. It has a great role in soil protection, climate regulation, water regulation, anti-erosion and recreation in healthcare. The forests of the resort area are especially noteworthy. The most distinguished forests are so-called virgin forests that are preserved in their original form and biodiversity (Government of Georgia, 2023; Salukvadze et al., 2021).

Forests also have industrial potential. They provide the possibility to fully satisfy the population's needs for both firewood and timber for industrial purposes. Forests are mainly located on the slopes of the branches of the Main Caucasus Range (Fig. 1). Forests cover 56% of the entire territory of Lechkhumi (Targamadze & Chikhradze, 1973).

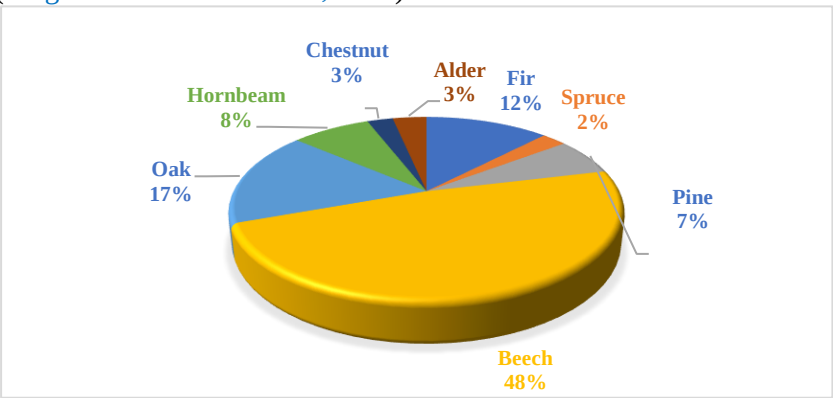

Figure 1. Dominant woody species of Lechkhumi Region

The forests are located at an altitude of 700-2200 m above sea level. Colchian-type forests are observed in the lower part. Here, we describe the relics of the Tertiary flora of Colchis (Pontic

rhododendron, laurel, holly, box tree, etc.) as well as the vegetation cover characteristics of the dry climate of Eastern Georgia, including oak, oriental hornbeam, hawthorn, cornelian cherry, medlar, juniper, pine, etc. In the lower part of the valleys of the Rioni and Tskhenistskali and alongside their tributaries, we encounter alder trees and Colchian forests with evergreen undergrowth (Salukvadze, Tsitsagi, 2022). In the lower zone of the region, beech and hornbeam trees are dominant, while chestnut, oak and maple trees are also observed. Hazelnut, hawthorn, medlar, Pontic azalea, etc., are among the undergrowths. Among deciduous trees, oak, hornbeam, oriental hornbeam, and beech trees are dominant. For coniferous trees, spruce, fir and pine are present. Beech-oak forests and oak forests are observed in the limestone areas (Fig. 1). On the slopes of the Egrisi and Lechkhumi Ridges, the coniferous forests are followed by subalpine forests and meadows in the higher belt. Alpine meadows occupy only a small area. The massifs of Tsekuri, Sazamtro and Sakeria reach the subnival belt.

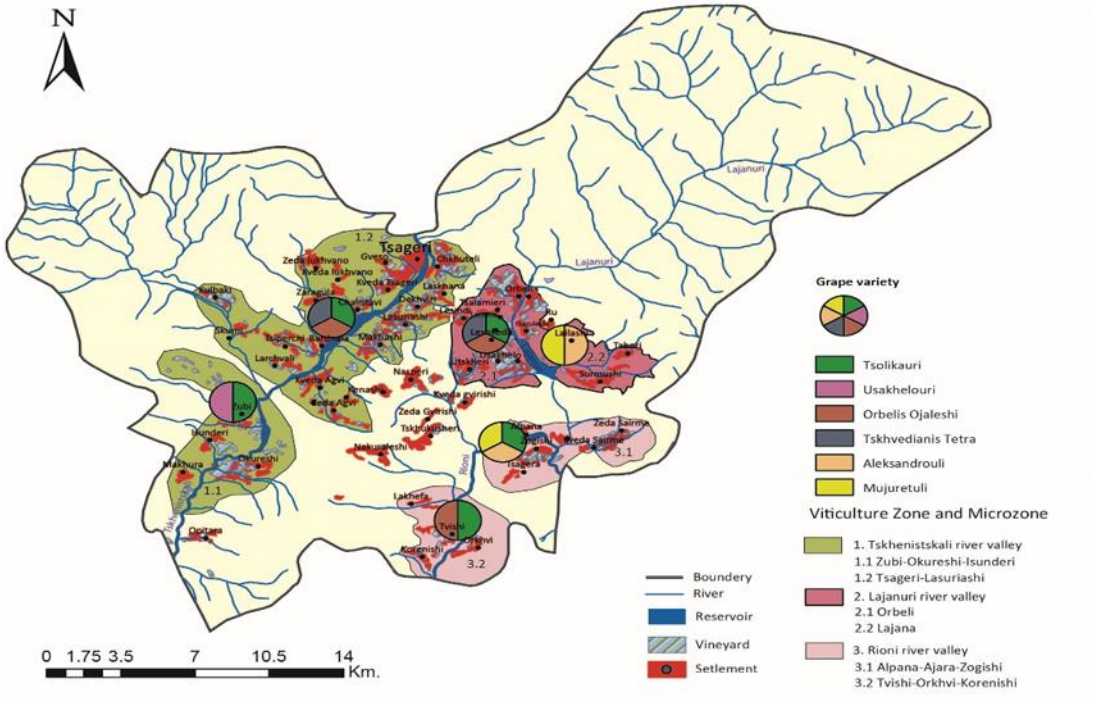

Figure 2. Viticulture Areas of Lechkhumi Region (Tsageri Municipality)

In Tsageri Municipality, the best mineral waters are the healing balneological waters of the Lashichala Resort and the mineral healing water of Dzughuri, which are mainly used for the treatment of diabetic patients. The mineral healing waters of Alpana, Akhalchala, Aghvi-Tsageri, Ladzgveria and Usakhelo are also prominent and are used for preventive arthrological, gastroenterological, gynecological, and neurological treatment. Due to the lack of relevant infrastructure, the potential of mineral water resources is underutilized.

In Tsageri, the hydroelectric power station Lajanurhesi has a capacity of 112.5 MW. The power station provides the energy supply for the region. Small hydroelectric plants can be built at different locations on rivers (Jonouli, Akhalouri).

In the 1980s-1990s, the area of arable land considerably decreased due to the following factors: as a result of the partial land reform, due to the privatization of public land, the infertile land was abandoned. Due to the significant steepness of the relief and erosive and landslide processes, certain arable lands have lost their fertility and are currently used for different functions. In particular, favourable agroclimatic conditions in Lechkhumi have promoted the development of viticulture, horticulture, and cereal farming, which have been carried out by the population since ancient times.

Arable lands occupy 1.5 thousand ha, pastures occupy 30.2 thousand ha, meadows occupy 14.8 thousand ha, and perennial crops occupy 0.3 thousand ha (Government of Georgia, 2023).

Lechkhumi is a homeland of nearly 30 species of vine (Devidze, 1961). The endemic vine species “Usakhelouri”, “Orbelis Ojaleshi”, and “Tskhvedianis Tetri” are represented here. From these unique vine species, known wines are produced. The vineyards mainly grow in the lower zone on the slopes along the Tskhenistskali and Rioni Rivers and their tributaries. The whole area of vineyards is approximately 233 ha. The vine species here are characterized by high sugariness and corresponding acidity and are distinctly different from one another in terms of their fragrance, colour and softness. The

following well-known semisweet and table wines are produced: “Usakhelouri”, “Ojaleshi” and “Tvishi” (Table 2.). At different exhibitions, these wines have won several gold and silver medals. According to vertical zoning, industrial vineyards are mainly grown at heights of 400-600 m above sea level. The extreme limit of the vertical distribution is 750-900 m (Fig. 2.)

Table 2. Viticulture Areas of the Lechkhumi Region (Tsageri Municipality)

Viticulture Zone	Microzone	Villages	Grape variety	Type of wine
1. Tskhenistskali river valley	**1_1.** Zubi - Okureshi -Isunderi.	Okureshi,Zubi, Isunderi	Tsolikauri, Usakhelouri	Usakhelouri
	1_2. Tsageri - Lasuriashi	***Right bank of Tskhenistskali river***: Tsageri,Gveso, Bardnala, Tsiperchi, Larchvali	Tsolikauri, Orbelis Ojaleshi, Tskhvedianis Tetra	Tvishi, Ojaleshi
		Left bank of Tskhenistskali river: Chkhuteli, Laskhana, Dekhviri, Lasuriashi, Makhashi, Kvemo Agvi		
2. Lajanuri river valley	**2_1.** Orbeli	Orbeli, Usakhelo	Orbelis Ojaleshi, Tskhvedianis Tetra, Tsolikauri	Usakhelouri, Tvishi, Ojaleshi
	2_2. Lajana	Lajana, Lailashi	Aleksandrouli, Mujuretuli	Quality red wine
3. Rioni river valley	**3_1.** Alpana - Ajara - Zogishi	Alpana, Ajara, Zogishi, Zeda Sairme, Kveda Sairme	Aleksandrouli, Mujuretuli, Tsolikauri	Quality red wine, Tvishi
	3_1. Tvishi - Orkhvi -Korenishi	Tvishi, Korenishi, Orkhvi	Green Tsolikauri, Orbelis Ojaleshi	Tsolikauri of Korenishi Kvevri, Green Tsolikauri of Orkhvi, Tvishi

We carried out comprehensive studies of landscapes in the territory of the region. Each type of distinguished landscape is estimated in terms of its natural conditions and potential possibility of resource usage. In the territory of Tsageri Municipality, we distinguished 23 types of landscapes. We will consider several of these landscapes as long as they have significant resource potentials (Fig. 3):

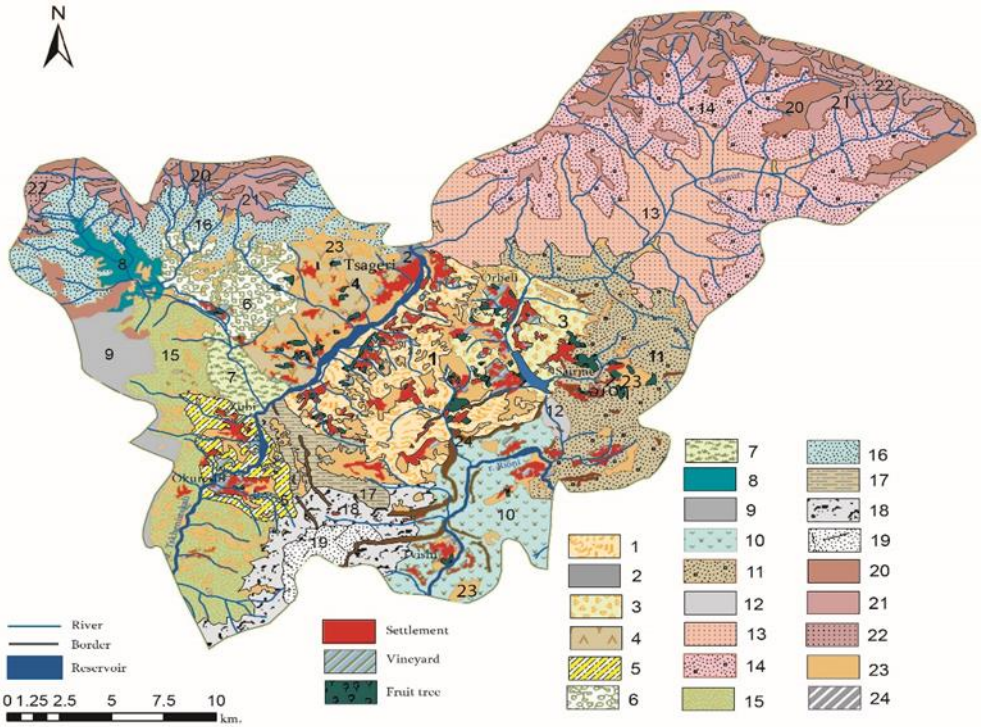

Figure 3. Landscape map of Lechkhumi Region (Tsageri municipality)

The Lechkhumi Landscapes:

1. Lowland erosive depression, with terrace steps, humus carbonate and alluvial soils, with secondary forest shrubs, with landslide processes, rockslides, with river fans, and agro-landscapes (corn fields, vineyards, orchards, and vegetable crops).

The Tsageri erosive depression is located in the western part of the Racha-Lechkhumi Syncline. The depression is presented as a section of the Tskhenistskali Valley between the Muri and Saretskela Cliffs and the basin of the right tributary Kvereshula of the Tskhenistskali River. The bottom of the depression is flat and is located at an altitude of 400-500 meters above sea level. It is distinguished by its typical erosion-accumulation terraces. The Tsageri Depression is composed of Oligocene and Miocene rocks, which are represented by clays, marls, sandstones, etc. Quaternary alluvium, represented by conglomerates and sandstones, is spread on the bottom of the depression. On the right bank of the Tskhenistskali River, the villages of Tsagera, Gveso, Bardnala, Tsiperchi and Larchvali are distinguished for viticulture and wine production. The terrace steps on the left bank of the Tskhenistskali River are flattened and are quite favourable for growing vineyards. On the left bank of Tskhenistskali, the following villages are known for their viticulture: Chkhuteli, Laskhana, Dekhviri, Lasuriashi, Makhashi, and Lower Aghvi. This area is the main viticulture center in the Tskhenistskali Basin, where the naturally sweet wine "Tvishi" is produced. Vineyards located on the right bank of the river produce more wine than those on the left bank. The Tsageri Depression is one of the microzones of Lechkhumi viticulture, where Tsolikauri, Orbelis Ojaleshi and Tskvedianis Tetra, which are promising grape varieties, are grown. Within the landscape, active landslides, erosion processes and rock avalanches are common.

2. Cliffs intruded into Cretaceous limestones, steep slopes, and outcropped surfaces devoid of soil and vegetation cover. The landscape includes Muri Cliff, north of Tsageri near the border of Svaneti, where the River Tskhenistskali passes from Svaneti to Lechkhumi. The Muri Cliff is a narrow cliff section of the Tskhenistskali valley at the northern end of the Tsageri Depression and intrudes into the Upper Cretaceous limestone layers of the Lechkhumi syncline.

3. Lowland erosive calcareous depression, humus-carbonate soils, intense landslides, altered secondary natural vegetation, agricultural beds, fragments of floodplain forest and shrubbery in some places, reservoirs, and swampy areas in some places.

The landscape includes the Orbeli Depression, Orbeli village and the villages of Lesindi, Spatagora, Usakhelo and Gagulechi located to the south. The Orbeli Depression is located 600-700 m above sea level. The terrain is composed of Oligocene and Miocene clays, sandstones, and marls. The Orbeli Depression has fewer terraces than the Tsageri Depression. Erosive and landslide processes are common. The Lailashi Plateau, which is located in the eastern part of the Orbeli Depression, is a large block landslide. In the southern part of the Orbeli Depression, the Lajanuri River has been blocked, and an artificial reservoir has formed. The natural conditions of the landscape are favourable for the development of viticulture. In this regard, the following grape varieties are common here: Ojaleshi of Orbeli, Tetra of Racha, Aligotte, Shardone, Tsitska, Tsolikauri, Tskhvediani Tetra, etc., and the species of Aleksandrouli and Mujuretuli are found in Lajana village. The Orbeli-Lajana viticulture-winery zone, which is located in the Orbeli Depression, is distinguished by its vineyards of the Ojaleshi variety and the production of the dark red wine "Ojaleshi". The natural landscapes have been heavily transformed and mainly include anthropogenic-cultural landscapes, vineyards, orchards, corn fields, highways, and artificial reservoirs. The primary vegetation cover has greatly changed to secondary sparse forest and forest-shrubbery landscapes.

4. Low-mountain erosive depression, with dark grey forest soils, oak forests, and agricultural fields.

The landscape is spread around Lukhvano village, between the Jonouli River and Tskhenistskali River. It includes the erosive Lukhvano Depression, the basin of the Kvereshula (Lukhvanoskskali) River, and the right tributary of the Tskhenistskali River. It is composed of Oligocene and Miocene rocks. Landslides are common here, and lakes have formed as a result of landslide processes. Here, agricultural landscapes – orchards, corn fields and vineyards – are met.

5. Low-mountain erosive depression, with humus-carbonate soils, scattered pine groves (artificially planted), agricultural fields (mainly vineyards), rockslides, mudflows, and ravines.

The landscape includes the erosional depression of Zubi, which has developed in the outcropped porphyritic rocks formed under the Khvamli and Askhi Massifs. The valley of the Tskhenistskali River widens here. The Zubi Depression is the only way to reach the Askhi Massif from Lechkhumi. The

Zubi-Okureshi viticulture-winery zone is located on both sides of the Tskhenistskali River, south of the Saretskela Cliffs. It has been known for producing high-quality wine since ancient times. In the villages of Zubi and Okureshi, from the naturally sweet grapes of the "Usakhelouri" vine species, the dark red semisweet wine Usakhelouri is made, which is known for its excellent quality. The soil and climatic conditions are favourable for the development of fruit growing. Among natural processes, landslides and rock avalanches are widespread here.

6. Low mountains with brown forest soils, with oak, and with Colkhian broad-leaved forest.

The landscape is spread in the upper part of the valley of the Jonouli River (the right tributary of the Tskhenistskali River) near the Akhalchala Resort. It is represented as a relief form of troughs, cirques, moraines, and large erratic boulders formed by old glaciers. The slopes of the Jonouly Valley are covered with mixed fir-spruce-beech forests and beech forests. Resort Akhalchala is located 1900 m above sea level, where mineral springs containing carbonic acid and iron are present.

7. Low-mountain flat-bottomed valley, with alluvial boulders, humus-carbonate and alluvial soils, broad-leaved forest with evergreen undergrowth, intensive landslides, terraced right and steep, terraced left slopes.

The landscape is spread across the valley of the Jonouli River above the Akhalchala Resort in the Akhalouri River valley, which collects water from the slopes of high mountain massifs of Tsekuri, Sazamtro, and Tsalmagi of the Egrisi Ridge. Glacial troughs are observed at a height of 2300 m. The lower parts of the slopes are covered with erratic boulders. This proves that in the past, the glaciers descended even further.

8. A low-mountain flat-bottomed valley with alluvial boulders, brown forest and dark gray podzolic soils, beech forest, spruce, and fir-beech forest with recreational resources.

The landscape is spread in the middle reaches of the Jonouli River (the right tributary of the Tskhenistskali River). This part of the valley is characterized by a wide and flat bottom that is significantly inclined in the direction of the river. Here, above the village of Kulbaki, limestone boulders are scattered and were brought down by a powerful landslide that moved from the northern edge of the Askhi Massif. The southern part of the Jonouli Valley is bounded by a slope of the limestone Askhi Massif, and the karst plateau is covered with karst funnels.

9. Steep slopes of the limestone massif, devoid of soil and vegetation. The landscape is presented as the eastern part of the Askhi Massif, the peripheral part of the Plateaus of Maidani and Sachikvano. In the north and east, it is bounded by a high limestone cliff, which stretches like a wall along the right side of the upper basin of the Jonouli River and the right bank of the Tskenistskali River. The cliff is extremely high. Its crest is several hundred meters above the base. The plateaus and ridges are dotted with karst funnels, karst wells and fissures.

10. low mountain karst limestone, valleys with steep and rocky slopes, oak forest, and oak-pine forest. The landscape presents the valley of the Rioni River (within Lechkhumi), which has formed in Cretaceous and Tertiary sedimentary layers. The narrowest and deepest part of the valley is the Cliff of Tvishi, which intruded into the Cretaceous limestones of the southern part of the Racha-Lechkhumi syncline. In its walls, at a great height above the level of the Rioni River, there are karst caves – the Verdzistava Cave on the right side and the Orkhvi Cave – on the left side. It is spread on the right bank of the Rioni Valley up to an altitude of approximately 600-700 m and is characterized by moderately cold, short winters and hot long summers. The annual amount of precipitation is 1000-1300 mm. Due to favourable climatic conditions, viticulture and fruit growing have developed since ancient times. It is the Usakhelouri-Tvishi viticulture microzone, where two types of semisweet wines, "Tvishi" and "Usakhelouri", are produced. On the right bank of the Rioni River, the landscape includes the villages of Alpana and Tvishi, while on the left side of the Rioni River, the villages of Orkhvi, Zogishi and Tsagera are located.

11. Low-mountain erosive depression, built with sands, clays, limestones, brown forest soils, oaks, oak-hornbeam forests, secondary meadows, and agrolandscapes.

The landscape is spread across the villages of Lailashi, Gagulechi, Tabori and Surmushi. Vineyards, fruit orchards and cereal crops (maize) are grown in the territory. The flora consists of oak and oak-hornbeam forests. Here, landslide phenomena are widely observed, among which the "Lailashi Landslide" is well known.

12. Erosive depressions with steep slopes, oak and pine forests, strongly transformed by anthropogenic factors, and cliffs intruded into Cretaceous limestone sediments.

The landscape covers the areas of the lower and upper sairme villages and includes the valley of the Lajanuri River in the southern region of the Lajanuri Reservoir at the junction of the Lajanuri and Rioni

Rivers near the village of Alpana. The Lajanuri River is one of the largest right tributaries of the Rioni River within Lechkhumi. Within the boundaries of the landscape, its lower reaches have been formed in Cretaceous and Tertiary suites. The valley of Lajanuri is erosive along its entire length. There are deep eroded gorges with steep slopes. Steep rocky slopes undergo intense fragmentation, and rock avalanches occur there. The bed of the Lajanuri River has been blocked by large limestone boulders. Rock avalanches are generated due to the cracking processes occurring in limestones and the great inclination of slopes. The Lajanuri basin contains deciduous forest at up to 2000-2100 m; its lower belt is covered with oak, hornbeam and chestnut forests, while beech trees are observed in the upper belt. Coniferous forests are not present here. The landscape includes the Sairme Plateau, the absolute height of which reaches 800-900 m. Its relative height from the Rioni River is 400-500 m. The plateau is built of Cretaceous limestones and marls; karst funnels and wells have developed on the surface. The Rioni River follows the tectonic fault line in the Sairme area and creates the so-called "Narrow Pass of Sairme" in the Cretaceous and Eocene limestones. Similarly, in the Udabno area, in the marl limestones, a pyramidal, truncated cone and pole-shaped landslide relief, called "Sairme Pillars", has formed, which looks like a stone forest as a result of erosion. It is a unique geomorphological phenomenon in the form of landslides and erosion. Landslides are common here, and the "Sairme Landslide" is quite prominent.

Within the landscape, humus-carbonate soils, which are commonly used for fruit orchards and maize, are common, resulting in high yields under favourable terrain conditions. Vineyards are also met in some places.

13. Middle mountains with brown forest soils, beech and hornbeam-beech forests.

The landscape is spread on the right and left banks in the middle reaches of the Lajanuri River. Within the landscape, the slopes of the Lajanuri Valley are devoid of terraces and have a wide bottom full of cobblestones. The landslides are mainly related to diluvium deposits. Mudflows are common during rains. The landscape is characterized by moderately warm summers and cool winters. Among the branches of agriculture, land farming and animal husbandry are mainly developed here. The forests are rich in mushrooms and fruit (crab apple, wild pear, dog rose, cornelian cherry, etc.).

14. Middle mountains with extremely steep slopes, dark grey forest soil, beech forests.

The landscape is spread in the valley of the Lajanuri head river. Here, mainly dark grey forest soil is present; a mix of beech, lime, elm and maple trees is observed at some places.

15. Middle mountains with brown forest soils, beech-hornbeam forests, pine forests (artificially planted), hornbeam forests and pine-hornbeam forests

The landscape covers the extreme western part of Lechkhumi and is adjacent to the limestone massif of Askhi. The dark grey forest soil is covered with beech-hornbeam, hornbeam and pine-beech forests. Man-made pine wood can also be found in the villages of Isunderi, Makhura, Chkumi and Kulbaki.

16. Middle mountains with karst relief, beech-dark coniferous and dark coniferous tree forests, and evergreen undergrowth. The landscape is spread in the extreme northwestern part of Lechkhumi, in the valley of the Jonouli River, and in the area of the head river, including the eastern part of the Egrisi Ridge. It is composed of a Mid-Jurassic porphyritic suite. The landscape is mainly beech-dark coniferous forests, dark coniferous forests (spruce and fir trees), and evergreen undergrowth (holly, cherry laurel, box tree, and Butcher's broom).

17. Middle mountains, built with limestones, with karst relief, humus-carbonate soils with beech and hornbeam-beech forests, with evergreen and deciduous undergrowth.

The landscape is spread in the northern part of the limestone massif of Khvamli, between the villages of Okureshi and Nakuraleshi. The Kvamli Massif is composed of monocline layers inclined toward the north. It presents a double cuesta. Within the landscape, the lower northern cuesta, i.e., the Upper Cretaceous cuesta, unlike the southern cuesta, is relatively less karstic. It is 450 meters lower than the southern cuesta. The northern part of the Khvamli Massif is covered with beech and hornbeam-beach forests, although the main vegetation cover there is leafy shrubbery.

18. The middle mountains are composed of Cretaceous limestone with karst reliefs: karst funnels, cliffs, caves, humus-carbonate soils, spruce-fir forests, and dark coniferous and beech-dark coniferous forests. The landscape is located on the Khvamli Massif between the villages of Okureshi and Korenishi. On the Khvamli Massif at 300-400 m above sea level, up to the upper boundary of the forest zone, dark gray soil is present (up to 1000-1200 m), and further (1400-2000 m), dark gray podzolic and podzolic forest soil is spread under the beech-dark coniferous and coniferous forests.

19. Subalpine meadow shrubland on a limestone massif with mountain meadow soil. The landscape is met by the Khvamli Massif. Here, mainly mountain meadow soil is spread. In the former shrubbery

and forest areas, which were later covered with meadow, secondary podzolic soils were present. The plants are used as natural hay meadows and pasture fields, while shrubbery prevents soil erosion.

20. High-mountain subalpine meadow-shrubbery on mountain meadow soils.

The landscape is located on the ridges of Egrisi and Lechkhumi. Under harsh weather conditions, mountain meadow soils are dominant on slopes. Subalpine tall herbaceous vegetation consists mainly of umbelliferous and complex flowering plants. Reach pasture fields are located in the upper part of the Lajanuri Valley, where subalpine meadows full of various high grasses are spread.

21. High-mountain alpine meadow-shrubbery on mountain meadow and peaty soils.

The landscape is spread on the Ridges of Egrisi and Lechkhumi. The alpine meadow territory is characterized by flattened relief, a high mountain climate and dense grass cover and is used as pasture fields in summer. The cover consisting of various grasses creates a dense meadow in the upper horizon of the soil that prevents the denudation of the hay meadows and pasture fields.

22. High-mountain subnival landscape with cliff vegetation and primitive mountain meadow soils (the Egrisi and Lechkhumi Ridges).

The landscape includes the highest peaks and summits of Egrisi and Lechkhumi Ridges. Here, mechanical erosion intensely occurs. The relief is characterized by a rocky surface. Washed-off soils and certain representatives of rock vegetation are observed in some areas of primitive mountain meadows.

23. After they were cut, secondary meadows at former forests met on the Egrisi and Lechkhumi Ridges, on the Askhi and Khvamli Massifs, and in former forests.

24. The reservoir.

Discussions

The goals of this research are to reveal the transformation of the environment of the Lechkhumi Region, which is affected by both natural and anthropogenic factors; to assess natural resources; to identify separate natural-territorial complexes (landscapes) as landscape types; and to create a geoinformational database. For that purpose, we had a scientific field examination in Tsageri Municipality (in 2022). Observations were made on the landslide and mudflow areas and the landscapes that had changed as a result of their activities. The materials obtained in the field immensely helped us to reveal the natural and anthropogenic landscapes of the region and define their boundaries. We distinguished natural and anthropogenic landscapes and created a geoinformation system of the landscapes of Tsageri Municipality. We also created a database on the basis of which we constructed a large-scale (1:50000) landscape map of Tsageri. During the study of the natural landscapes of the Lechkhumi Region, the potential of the landscapes was taken into account. It included identifying the set of resources that might be used for the purpose of protection and improvement of living conditions, economic growth, and complex development at present or in the future. In the case of landscapes, this means taking into account the set of properties on the basis of which and according to which a landscape can perform this or that (socioeconomic, ecological) function. It adequately reflects the degree to which a landscape participates in satisfying the diverse needs of society.

Conclusion

As a result of comprehensive studies of Lechkhumi by GIS technology, a large-scale landscape map (1:50 000) of the Lechkhumi (Tsageri Municipality) region was constructed. We distinguished 23 low-rank landscape entities—landscape types. The distinguished landscapes provide a clear image of the diversity and potential of the natural resources of the study region. It is noteworthy that most (67. 6%) of the landscapes is made of mountain landscapes. Certain parts of the distinguished landscapes are useful for agricultural activities; some parts can be used as forest resources, while others can be used for tourism and recreation. Most of the agricultural landscapes are located in considerably lower hypsometric zones (400-800 m) in the Tsageri Depression on either side of the Tshenistskalii River. The landscapes (#1, #3, #4, #5, #10, and #11) here play a special role in the development of viticulture and for fruit growing in Lechkhumi. The landscapes (#10,12) on the alluvial soils along the Rioni River are the most useful for fruit and vegetable growth and cereal farming. The landscapes in the high-mountainous subalpine (#19, 20) and alpine (#21) zones are the best pastures and meadows for mowing and are necessary for cattle breeding, with a total area of 24 000 ha. The pastures and hay meadows of Lechkhumi have great potential. These findings can aid in the development of livestock breeding in this region. The forest landscapes occupy the dead territory of Lechkhumi. They have high value in industry as well as in preserving ecology and biodiversity. Here, the landscapes of river-side forests (#2), low

mountain forests (#9, #10, #11 landscapes) and middle mountain forests (#13, #14, #15, #16, #17, #18) are met. Among them, virgin forests occupy a considerable area. Great touristic and recreational potential has been unlocked in the landscapes (#6, # 13) around the balneoclimatic (Lashichala, Akhalhala) and balneological (Dzughuri) resorts, as well as in resort places (Kulbaki, Tabori, Surmushi) and other significant tourism and recreation objects.

Among the landscapes of Lechkhumi in the Tsageri, Orbeli and Zubi Depressions, the boundary landscapes of low mountains, middle-mountainous forests and high-mountainous meadows have changed. In many places, secondary meadows can be observed in former forests. The natural landscapes that existed in the past here include varieties of anthropogenic and natural-anthropogenic landscapes.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

E.S. led the writing of the article, distinguished the separate landscapes of the Lechkhumi Region as landscape types and compiled a large-scale landscape map with a diagram, Map: Viticulture Areas of Lechkhumi Region (Tsageri Municipality) and a table: Agro-climate characteristics of Lechkhumi Region (Tsageri Municipality); Viticulture Areas of Lechkhumi Region (Tsageri Municipality). T. C. compiled a geoinformational database of Lechkhumi landscapes in GIS and provided an electronic version of the landscape map of the Lechkhumi Region (Tsageri Municipality) and a map of the Viticulture Areas of the Lechkhumi Region (Tsageri Municipality).

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