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# Basic Factors of Climate Peculiarities Formation and Climatic Zoning of Samtskhe-Javakheti

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**Abstract:** In the article the main factors: solar radiation, atmosphere' circulation processes and relief defining the climate features of Samtskhe-Javakheti are discussed. On the basis of mentioned factor analysis, it is revealed that their impact and intensity is changed according territory and by seasons. This difference and weather particular conditions connected with it determine the climate conditions features in different places according the seasons. On the basis of these factors analysis it has become possible to divide Samtskhe-Javakheti into climate areas, for which article of Sh. Javakhishvili "Climatic zoning map of Georgia" and 40-year series were used. In the Samtskhe-Javakheti region the following 7 climatic areas areal located: -Moderately humid climate with cold winter and short summer (1); -Moderately dry (steppe) subtropical mountainous climate with small snow cold winter and long warm summer (2); -Moderately dry(steppe) subtropical mountainous climate with cold, small snow winter and long cool summer (3); -Mountain climate with cold winter and long summer transferred from humid maritime to humid continental one (4); -Mountain climate with cold winter and short summer transferred from humid to moderately humid one (5); -Moderately dry subtropical mountainous climate with cold, small snow winter and short summer (6);- Mountainous moderately humid climate with exception of real summer conditions (7).

**Keywords:** Solar Radiation, Orography, Atmosphere Circulation Proceses, Climatic Zoning, Samtskhe-Javakheti

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## 1. The Relevance of the Problem

Georgia is very diverse due to natural environment, particularly because of climate conditions. In this regard, particularly is distinguished Samtskhe-Javakheti-one of the region of Georgia.

It is located in country southern part and climatically differs from other regions of Georgia. According to M. Kordzakhia, Samtskhe-Javakheti is located in the definite subarea-transition zone from subtropic continental climate to marine climate area.

This sub-area is highlighted with features of climatic conditions. Climate here is more continental: hot summer, cold winter and atmospheric precipitations are much less than in other areas of Georgia that located on the similar height [1].

Despite the fact that the region's climate is characterized by great diversity, due to its hypsometric development and vegetation nature it is rather continental one. A little bit difference is observed in valleys and Akhalkalaki plateau settlements, where previously, in much warmer climate and terraced system the various sphere of farming had been developed [2].

As the climate is one of the most important natural components for agriculture, so it is necessary to analyze the climatic peculiarities and defining their factors. The agriculture is the leading sphere in the region (cattle breeding, arable farming etc). The region is rich with recreational resources. There are variety of them for mountain skiing, spa, mineral springs, so the region' study is particularly important for economic' various fields sustainable development. The research is based on multiyear meteorological observation data-Applied Science of Georgia, 2004; Stock Materials of

Hydrometeorological Institute: Akhalkalaki (1967-2006), Akhaltsikhe (1971-2010), Paravani (1967-2006) [3].

## 2. The Results of Research

### 2.1. General Overview of Main Factors Defining the Climate

Samtskhe-Javakheti, in comparison to other regions of Georgia sharply distinguished with natural conditions. This difference is primarily related to the climate, which is defined due to the diversity of relief—large amplitude (range 900-3300 m high above mean sea level) of ridges' absolute height, as well as the striping of plateaus and gorges, orographic barriers (Arsiani and Adjara-Imereti ridges, which detract the humid air masses propagation), frequent change of the mountain ridges orientation, that causes the atmosphere circulating processes change, the partition of surface complex, as well as the diversity of plants cover and anthropogenic factors. From the climatic point of view, the existence of barrier ridges strongly inhibits large scale circulation processes propagation and significantly increases the impact of local relief conditions. [4]

There are many factors influence on the climate formation: the latitude of territory location, its height, the atmosphere circulation and character of sub-surface. Samtskhe-Javakheti climate is formed by the whole complex of natural factors. Among them, particularly has to be mentioned solar radiation, atmosphere circulation and underlying surface character. These factors are in close connection with each to other, simultaneously act and create enough diverse of local climate.

### 2.2. Solar Radiation

Solar radiation plays an important role in the climate formation, that caused by the region' Southern location and complicated orography. This factor takes place in the current atmospheric processes of Samtskhe-Javakheti. In the West part of region, where the cloud is relatively large and the horizon is closed, the sun lighting is relatively low (average 1950 hrs.), but in the Eastern part' open places—almost 2500 hours.

### 2.3. Circulation Processes of Atmosphere

Air mass meridian circulation—moderate, tropical and sometimes polar ones' air masses invasion impacts on the climate formation of Georgia. Among them the most repeatable are the air masses of moderate latitudes, which are humid since their spreading from the West. In the summer, the frequent tropical air masses invasion mainly forms dry and hot weather [5]. Generally, in Georgia, air masses invasion happened from East and West, or from both side at the same time. The weather sharp change in region is also related to the air masses invasion. During the air masses propagation from the West, air temperature reduction, cloudy and precipitated (wet) weather has place. While the Black Sea crossing, it gains moisture and brings huge quantity of precipitation basically to western part of Georgia. The air masses invasion from the

West is typical for all seasons, but especially in the warm period [6, 7].

It should be mentioned that Samtskhe-Javakheti climatic conditions sharply differs from other regions' ones, that are caused due to impact of local factors. Air masses invasion also happens from the South, due to which the air masses vapor content, during the moving to the North (because of the ridges impact), gradually reduces and respectively rainfall decreases. Territory's morphology (depression, cavern, plateau) of Samtskhe-Javakheti in the winter contributes to air' sub-layers strong cooling, but in summer convective processes' powerful development, to which short heavy rain, thunder and hail are connected. It should noted that in the summer, amount of precipitation (30-40%) directly connected with these processes there.

### 2.4. The Relief Impact on Climate

The main reasons of Samtskhe-Javakheti territories' climate diversity are: the character of underlying surfaces, the territory surface' fracturing, the striping of ridges and valleys, ground vegetation (forest, grassland, field), which differently absorb of the sun radiant energy, i.e. warmed unevenly [8].

The ridges' location so changes the circulation processes in the atmosphere that in its lower layers, on different sides of ridges, during the same process' time, weather conditions (precipitation, temperature, humidity and wind) sharply differs from each other.

Climatic features of the area are also significantly defined by the orographic barrier.

Arsiani and Adjara-Imereti ridges, causing reduction of humid air masses propagation, create the orographic barriers for Samtskhe-Javakheti. Their windward slopes are characterized with huge precipitations, but downwind ones—valleys, and adjoined depressions, with small precipitations.

This provides a significant climatic contrast. Although the Javakheti-Armenian mountainous has no the great importance in the weather formation as the Caucasus, but it effects on the air masses direction and their speed [1, 9].

Surface character, depression, cavern, plateaus, contributes to the winter air sub-layers strong cooling, and in the summer heating. On Samtskhe-Javakheti climate, beside the height of region location, affects the slope exposure and the shape of the terrain. In the cavern/depression daytime air is heated and cooled at night, rather than on mountain or hill. The terrain and vegetation significantly effects on absolute temperature distribution. The forest is moisture natural regulator. It protects the soil from erosion, evenly distributes snow in winter, at the same time it changes wind mode and growth relative humidity. Samtskhe-Javakheti absolute height is changed in the range of 900-3300 m. above m.s.l. (3300 m—Didi Abuli). The region territory is rough, significant part of which presented by high mountains. Therefore, the atmosphere' general circulation so transformed that cloudiness takes special mode.

Type of plants significantly determines the climatic features formation there, where the climate is continental [5], the air dryness is supported by the field plants, that propagated on the

vast area. The different circumstance creates the forest powerful cover, where deciduous and coniferous forests occupy region's huge area.

### 2.5. Samtskhe-Javakheti Climatic Zoning

Region's climatic zoning was based on its location,

physical-geographic features, special character of the terrain, the radiation mode, the conditions of atmosphere circulation and the average and extreme values of the basic elements. In the region quite different 7 climatic areas (figure 1) are allocated [10]:

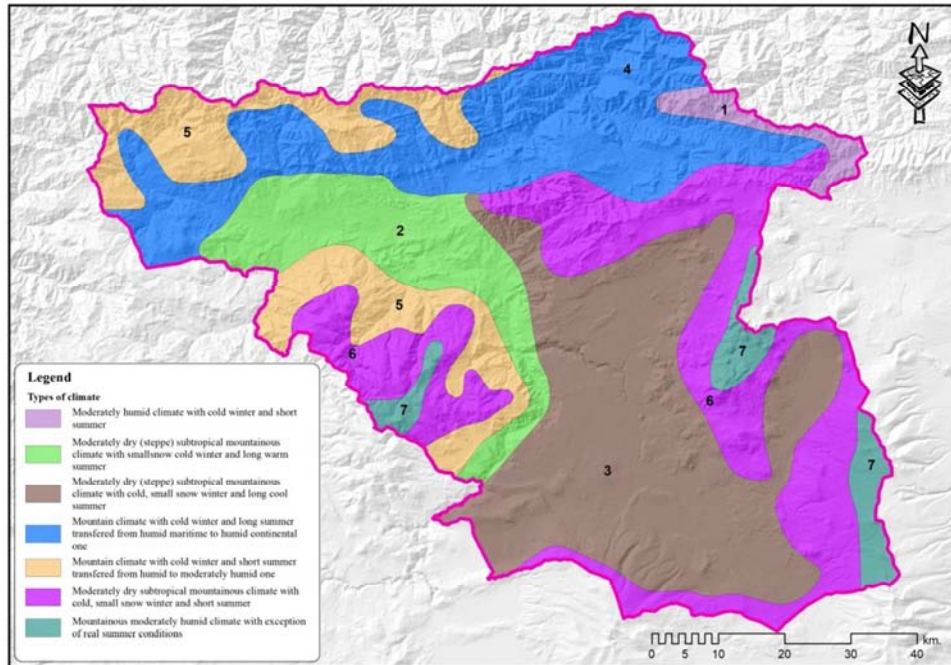


Figure 1. Samtskhe-Javakheti climatic zoning.

1. Moderately humid climate with cold winters and short summers. The area covers: Trialeti ridge and the Caucasus' Northern and Southern slopes, in the range of eastern Georgia above sea level at height from 1800-1900 m. till 2500-2600 m above m.s.l. The average temperature ranges  $-6-9^{\circ}\text{C}$ . Temperature absolute minimum drops to  $-25-30^{\circ}\text{C}$ . During the summer months (July-August) average temperature is equal to  $10-14^{\circ}\text{C}$ , but the absolute maximum reaches  $25-30^{\circ}\text{C}$ . Even in the summer months the absolute minimum is lower for  $5^{\circ}\text{C}$ . The precipitations annual quantity on Trialeti ridge, is 600-800 mm. Wind mainly blow along the gorge. Prevailed wind has Western direction.

2. Moderately dry (steppe) mountainous subtropical climate with cold, little snow winter and long, hot summer. The area covers the central part of Akhaltsikhe depression and its southern and eastern slopes, above mean sea level at 1400-1600 m. altitude. Akhaltsikhe depression is located at average of 1000-1300 m. height above mean sea level, and surrounded by high ridges, because of which the outside air invasion effect is weakened there. The average January temperature ranges in frame of  $-4-7^{\circ}\text{C}$ .

Three winter months the temperature is below of  $0^{\circ}\text{C}$ . The annual amount of rainfall is 400-520 mm. The maximum precipitation of 70-85 mm is in the summer (June), but the smallest one of 15-25 mm in the winter. Number of precipitation days per year is 120-130. Because of the area

altitude and winters low temperatures the precipitation comes mainly in the form of snow, from October to April. The duration of the vegetation period, the sum of active temperatures (2900-2800) and the duration of sunshine is enough for diverse agriculture like are: the viticulture (1000-1100 m above m.s.l. height), fruit and vegetable growing, up to 1400 meters above m.s.l.

3. Moderately dry (steppe) mountainous subtropical climate with cold, small snow winters and long cool summers. Area covers Javakheti plateau and the ridges slopes, limited from south of Akhaltsikhe depression at altitude from 1600 m to 2100 m, above m.s.l. Landforms contribute to air suspension, which leads to radiation overcooling type weather domination during the cold period, while in warm periods it causes increase of the frequency of the radiation and convection heat type weather. As a result, in this area, the winter is noticeably cold and summer more warm than on the other heights of the Caucasus slopes. The temperature's annual amplitude, regardless of the location high altitude, is enough significant and in the open central part reaches  $24^{\circ}\text{C}$ .

In January average temperature is  $-7-10^{\circ}\text{C}$  and in July it is equal to  $17-14^{\circ}\text{C}$ . During 4-5 months per year temperature is below the "0".

Number of frozen days is 170-195. The annual amount of precipitation in most parts of territory is 450-550 mm, only in southeastern part of ridge' slope the amount of precipitation

increases up to 650mm. Maximum precipitation is in June (80-100 mm), the lowest one in winter. The number of days with precipitation is 120-150.

4. Mountain climate transforming from a marine humid to moderately humid continental, with cold winters and long summers on the mountain. Area includes southern slopes of the Adjara-Imereti mountain ridge, the eastern slope of the Arsiani ridge and western part of Trialeti one, in borders of Borjomi-Bakuriani, at the average altitude of 900-1800 m. above m.s.l. Zone is adjoined to western Georgia. Mountain ridges, dividing Georgia to Western and Eastern parts, have no steep slopes, that is why, marine air masses coming from the west, are characterized by relatively small transformation and mostly retain their properties. The climate there is the continental and a little bit warmer than in other areas of eastern Georgia. The area is divided into 2 climatic sub area: 1) Borjomi-Bakuriani and 2) Eastern slope of Arsiani ridge and the southern slope of Akhaltsikhe - Imereti ridge.

Borjomi-Bakuriani sub-area is located in the western part of Trialeti ridge. It includes valleys of Kura river, Gujaretistsqali and Borjomistsqali's at altitude from 800 to 1800 m. above m. s.l. The whole area is forested (mixed and pine trees). It is rich by tourist resorts and cottage sites, which are located at different heights, ranging from 800-900 m (Borjomi) to 1800 m. (hotels) above m.s.l. The average temperature of coldest month (January) ranges between -3°C and -6°C. In the lower zone (800-1000 above m.s.l) the average temperature during the winter' three months is negative. In mid-zone (within 1100-1500 m. above m.s.l.) the average temperature is negative for four months, while in the upper zone (1500 m. above m.s.l.) –five months.

Eastern slope of Arsiani ridge and the southern slope of the Akhaltsikhe-Imereti ridge Sub-area includes Akhaltsikhe depression northern and western parts. It is propagated to the eastern and southern slopes of Arsiani and Adjara ridges, at the altitude of 1200-1600 m. above m.s.l. It is allocating by large amount of precipitation throughout the year, by abundance of snow in winter and by more moderate temperature in summer. The whole area is covered by forested territory, a major part by coniferous trees. The average temperature ranges between -4°C and -7°C. During the year, 3-4 months' temperature is below the "0". Average annual precipitation is 600-700 mm. Number of precipitation days equal to 130-140 ones.

5. Mountain transitional climate from humid to moderately humid one, with the cold winters and short summers. District includes Arsiani and Akhaltsikhe-Imereti ridges eastern and southern slopes, at 1600-2400 m. altitude above mean sea level. The average temperature in January ranges from -6°C to -9°C, and from 10°C to 14°C in August. The temperature absolute minimum can be fall down from -2°C to -30°C, the absolute maximum reaches to 30°C. Precipitation annual quantity ranges between 900-1300 mm.

6. Moderately dry subtropic mountain climate with cold low snow winter and short summer. District covers the southern mountains, from 2100 m. to 2800 m. altitude above mean sea level. The January' average temperature is equal to

10-13°C below "0", August 10+14°C. The average temperature of summer three months is higher than 10°C. Absolute temperature minimum falls down from -25°C to -30°C. In the summer freeze is possible to happen throughout of three months. Annual rainfall is 500-600 mm. The maximum precipitation is observed in the summer, but the minimum in winter. Zone is characterized by alpine vegetation, and as the best land for summer pasture (Javakheti plateau). Only in the north and north-west part of the zone coniferous forests are propagated.

7. Mountainous humid climate, devoid of real summer. Zone of the Southern Highlands ranges between 2800 and 2900 m. height above mean sea level. The average temperature of January and February months varies within -11°-14°C. In July-August months it is lower than 10°C. Absolute minimum temperature falls down to -30°C and more. In the summer months an absolute minimum is lower than 5°C. During the year the western wind is dominated. There are often observed strong ones. The duration of persistent snow' cover is equal to 7-10 months. In the depressions, rest snow during the summer is observed.

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