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INTERRELATIONS BETWEEN FOLK ARCHITECTURE  
AND CLIMATE IN GREAT CAUCASUS

Insufficient knowledge of meteorological conditions prevailing in Great Caucasus has not permitted us to put fully a practical use of them for the sake of architecture. Therefore very important is the knowledge of types and forms of the dwelling houses which have developed for centuries in dependence on climatic conditions in a given area. The analysis of nature of dwelling houses in areas from which the meteorological observations carried on for a long time are available for us, permits us to apply the conclusions obtained to the areas in which a similar type of building occurs. This statement may be confirmed by the common character of architecture in the mountain regions of many countries.

Typical houses built on a large scale in our country require special attention paid to adaptation of buildings characteristic of climatic conditions in different geographical regions. Detailed investigations permit to determine the role and influence of climatic conditions and such factors as solar radiation, temperature and humidity of air, direction and speed of winds and atmospheric precipitation exerted upon the planning of space construction of cities, settlements and individual houses as well as on designs of interiors.

The old-time Georgian builders intuitively soothed and removed inconveniences of environment by very simple means. They carefully chose a proper localization of buildings and traced streets according to the direction of winds.

As far back as in the 3-rd century, Vitruvius<sup>1</sup> had pointed to the role of climatic conditions in planning of cities and buildings: „The architect should be oriented in medicine to the extent that he could

<sup>1</sup> Vitruvius, *Ten books on architecture*, transl. K. Kumaniecki, Warszawa 1956.

recognise the inclination of sky called by the Greeks »klimata«, the properties of fresh and polluted air and waters, because without knowledge of these elements no settlement favourable to health can be established". In his opinion, the space structure of a settlement should also depend on climatic conditions: „Once the town is surrounded by a wall, squares, main and side- streets ought to be traced according to the four sides. Their directions will be correct if they are protected against the winds. Cold winds are bothersome, warm ones bring diseases and humid ones are harmful [...] If the streets are traced windward, the current of wind from open areas will increase its strength within narrow streets. They should be diverted from the side the winds blow so that the wind could strike on house corners and be broken and dispersed".

The old-time builders pointed out that the best house to live in is that built on the slope (it concerns the mountainous or hilly terrains). They advised to build houses southward. If position of the house is westward or northward and it is screened from south by the hill slope, the sunshine will never come in, which is very harmful.

The influence exerted by climatic conditions upon the type of building is distinctly reflected in traditional architecture of various regions. In the Swiss Alps, the high steep roofs can hold up a great load of snow. Short thatched huts with small windows are characteristic of Norwegian Fiords. White houses with thick, well-fitted walls and flat roofs are built in desert areas where considerable oscillation of temperature and strong insolation compel to keep thermic balance inside the house.

Investigations of the Georgian folk architecture permit to understand traditions of monumental building in the high-mountain regions of Caucasus, conditioned upon the influence of feudal-serfdom régime and defensive-strategic role of Georgian villages. A not less important factor controlling the forms of buildings were frequent armed forays of hostile mountainous tribes.

Together with the dwelling houses the tall dungeons were built of stone or wood, in which the inhabitants sought shelter during the forays. Such dungeons can be met to the present day in almost all regions of Great Caucasus.

Georgian architecture had been known in antiquity. Mentions about it are to be found in the historical Greek sources, and Roman, Strabon, Xenophont and Vitruvius expressed high opinions on defensive values of Georgian architecture.

For a long time neither climate nor architecture in the mountainous Caucasian regions attracted attention of scholars. Its original architec-

ture differs from that in other high-mountain areas. Harmony and exceedingly simple forms are characteristic of the buildings. In the architecturally uniform terrain some individuality may be observed in the following regions of Great Caucasus: Svanetskiy, Rachinskiy, Pshavo-Mitiuletskiy, Khevsuretskiy, Tushetskiy regions and in southern Osetia. Abkhazian mountainous settlements localized out-of-the-way, such as Gheucvishy, Ptishy, Laty, Pskhu, have not preserved traditions of old architecture and resemble modern mountainous villages. Unlike in lowlands, the settlements are close-ranked, the buildings and main streets arranged according to the structure of terrain, with a net work of narrow passages.

In house designing there has always been taken into consideration the quantity of warmth obtained by vertical surfaces of different positions. It is very important in what direction the wall (window) is exposed: southward or northward. The greatest quantity of warmth falls to the horizontal surface and then to southern wall, with differences according to seasons. This fact has been kept in mind which is shown by the terraces facing southward in the old-time Georgian houses. Solar radiation absorbed by northern wall corresponds with the quantity of radiation obtained by southern wall, albedo of which is 50%. In case of decrease of albedo on the northern wall down to 10%, the supply of warmth will increase in summer almost 1.5 times and will come to the quantity of warmth received by eastern wall with albedo amounting to 30%.

The high regions of Georgia possess greater intensity of solar radiation, especially of ultraviolet and due to it more sterile atmosphere. Practically, during nearly the whole year relative insolation surpasses 50% of possible time (Table 1).

For the building purposes it is more important to determine the quantity of warmth received by slopes of different exposition. Cuckiridze (1959) and Moridze (1956—1960) worked out the sums of direct solar radiation on the horizontal surface as well as on N and S slope for 40° of geographical latitude (Table 2). The inhabitants of mountainous villages know well the effects of different exposition of slopes. Southern slopes are the warmest, therefore in the old houses in Georgia the terraces faced south.

In the historical sources of Georgian medicine can be found the medical handbook written by Chodja Kopali, in which the author advised how to choose a building site: „the house should be built on a flat elevation and not in a depression, because the walls would screen one another. [...] Houses should be high and large with two doors facing south and north, then the northern wind will come clean

Table 1

Relative insolation (% of possible hours)

Stations	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Gudauri	58	56	56	46	45	53	56	58	57	51	50	55
Dzhava	45	41	45	49	51	61	64	67	59	58	53	50

Table 2

Daily amounts of direct solar radiation in square cm according to A. F. Zakharova

Specification	Northern slopes				Horizontal surface				Southern slopes			
	40°	30°	20°	10°	40°	30°	20°	10°	40°	30°	20°	10°
The day of summer culmination of the sun	526	613	661	715	742	749	725	688	617			
The day of equal spring and autumn nights	92	192	288	379	455	519	569	601				
The day of winter culmination of the sun	0	0	23	103	170	233	293	347	423			

through and sunshine will continually remain inside the building". The opinion about the „flat elevation" bears witness to a good knowledge of humidity conditions in high-mountain areas. The region investigated, especially its western part, possesses the excessive humidity which is confirmed by distribution of atmospheric precipitation and relative air humidity (Tables 3 and 4). Acquired experience was turned to account in choosing the localization of settlements in Great Caucasus where they are built on uncovered tops and slopes of mountains, such as Ghebi, Shevi etc. These rules have always been observed in Georgian architectural planning.

Secular Georgian architecture in high regions resolved perfectly the problems of defensive functions of houses according to the historical, socio-economical, climatic and landscape conditions of the area and in very simple forms met all needs of inhabitants. Regional differentiation of mountainous settlements in Great Caucasus are presented by ryc. 1.

Such names as: Kakhetsia, Svanetsia, Racha-Lechhuni, Tush-Pshava-Khevureti and Mtiuleti are chiefly connected with historical events. Individual parts of Great Caucasus, however, differ in their land forms, climatic conditions and landscape, therefore these names got the geographical meaning and entered into toponomy.

#### 1. THE SVANETSKIY REGION OF GREAT CAUCASUS

The folk architecture of this region has an outstanding position in Georgian architecture. Old complexes of dwelling houses and individual houses are still in a good state of condition. They have preserved their ancestral features. The ancestral system of government used to prevail in Svanetsia till the end of the 19-th century. Big families of 30—50 members joined one another and formed a tribe. It may be confirmed by the huge basements about 500 sq. m. under some complexes of houses. The Svanetskiy communities assembled some couples of villages separated by natural borders. The village itself, occupying about 500—700 sq. m. consisted of 2—3 houses, which together with a dungeon covered the surface of 150 sq. m. The village was a uniform architectural complex (photo 1). Against the background of houses there were erected monumental, shapely dungeons 3 or 4 storied (about 20—25 m. high) covered with black schist. They were located in picturesque disorder throughout the village and harmoniously composed within the mountainous landscape. The houses are tall (8—12 m) but dim. Usually they are twostoried, without windows which are replaced by narrow slits — loopholes.

Table 3

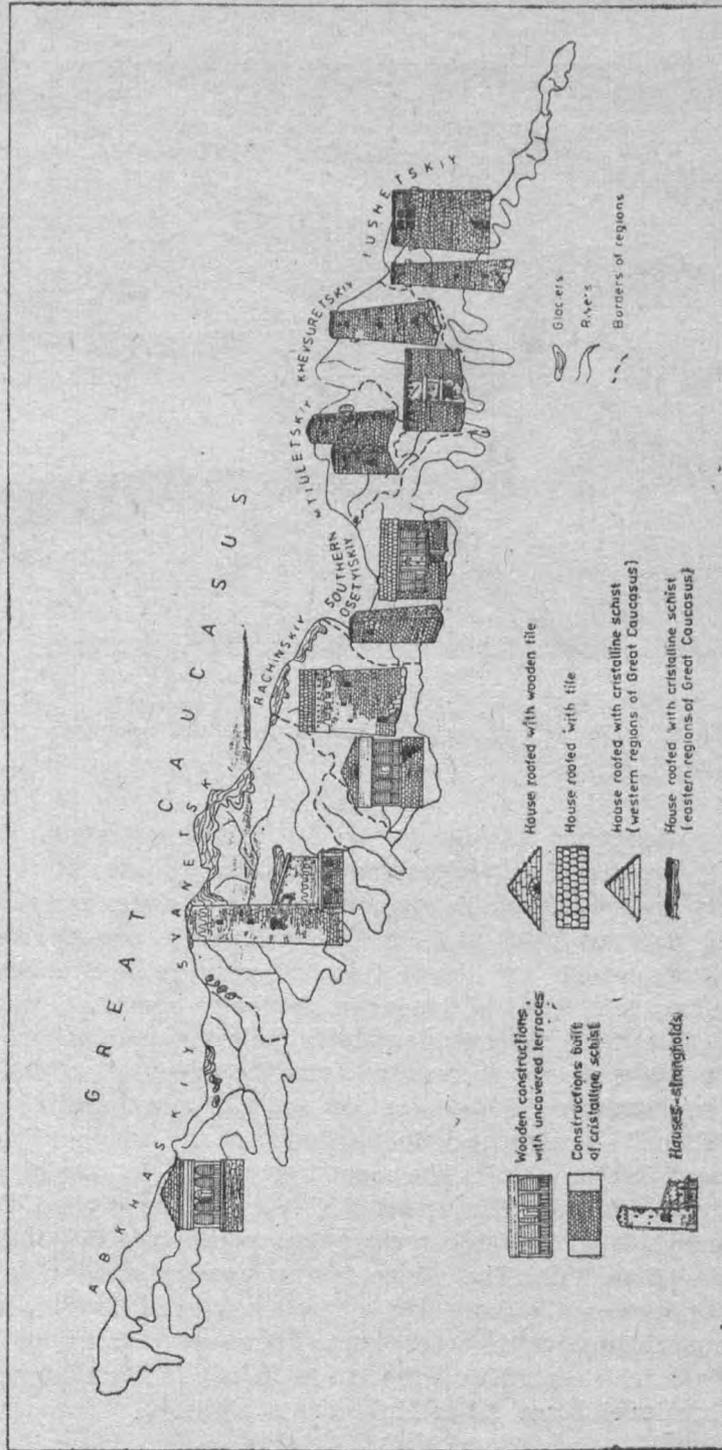
Mean monthly and yearly relative humidity of the air

Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Lebarde	74	74	76	71	72	75	80	75	77	72	76	72	74
Omilo	70	70	70	68	69	70	70	65	70	67	68	71	69

Table 4

Absolute lowest temperatures of the air (in Centigrades)

Station	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Mestija	-35	-30	-26	-16	-6	-2	-1	0	-5	-14	-24	-30	-35
Becho	-33	-29	-22	-12	-5	-1	0	1	-4	-12	-22	-28	-33



Ryc. 1. Ancient folk architecture of dwelling buildings in high-mountain region of Great Caucasus (prepared by M. G. Bokeria)

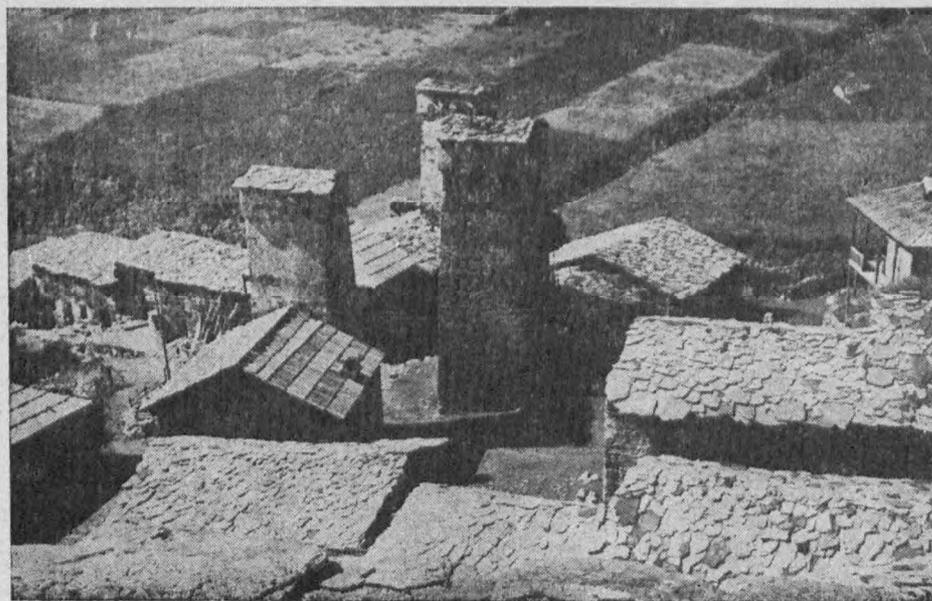


Photo 1. The village as a uniform architectural complex

Building of dungeons was dictated by the defensive-strategic reasons. According to reports of travellers the Svanetskiy houses were white-washed, only in the Ushghuli community they have preserved their natural dark grey or black tint. In this community can be seen the houses-fortresses which are absent from other parts of Svanetsia.

The dwelling complexes of Svanetsia should be considered the component of a definite architectural system; their inhabitants being „big families” the forms of houses resulted from the needs of collective life of tribes. The Svanetskiy house was composed of „machuba” — winter lodging, „dabrazi” — summer lodging, dungeon and surrounding courtyard enclosed in stony wall. The most important role was played by „machuba” and dungeon. The „machuba” was on the ground floor or in the basement. It was a large rectangular room, some 60—100 sq. m. wide and 4—4.5 m high. The whole family usually spent time there. Along two or three walls there was a wooden, carved dividing wall — in such an enclosure cattle were kept. There were openings at the suitable height which permitted the cattle to eat in standing position. On the higher level, some 1.8 m high, was a piggery.

Table 5

Station	Altitude over the sea-level in metres	Mean monthly and yearly precipitation (in mm)												
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
Shovi	1 600	77	78	83	95	118	115	96	112	100	116	73	71	1 134
Oni	789	118	113	106	88	98	94	80	90	114	134	111	114	1 260
Cherga	1 131	70	71	73	78	93	92	75	75	81	92	86	82	960

„Darbazi" was on the first floor, it was summer lodging with a hearth. From south there was an open terrace which in summer was the centre of all housework. The surface of the room was a little smaller than „machuba" (40—70 s q. m.) but it was better illuminated. Between the ceiling of „machuba" and the floor of „darbazi" there was continuous ventilation. It shows how much attention the inhabitants paid to microclimatic conditions; the constant ventilation cleared the air in lodgings.

The third element of the Svanetskiy house was a three- or four-storied square dungeon. During an armed assault the household went to the dungeon by an airy passage which ran 5—6 m above the ground. From the ground floor an entrance to upstairs lodging led through a man-hole. On both sides of the dungeon there were 2—5 loopholes, protruded some 50—80 cm beyond the wall which permitted to observe countryside and fight in defence of the house. The most important architectural element is the bay storey covered with a ridge roof. The walls of houses and dungeons, laid with a crystalline schist, are 1.2—1.3 m thick on the ground floor, and 80—90 cm thick on the top of the house. The inclination of ridge roofs depended on the quantity of precipitation. The oldest element of the Svanetskiy house was „machub", later as functions of the house extended, it was necessary to build a dungeon and „darbazi".

The Svanetskiy villages concentrate along the Ingushi river valley, behind the high Svanetskiy ridge. This valley permits the humid air masses from the sea to penetrate far into the mountains to

the cooled off crests of Great Caucasus. However, due to the more distant position of this region from the Black Sea and protection of high ridges, the annual sums of atmospheric precipitation are much lower than in westward the lying Abkhazia. The following meteorological data from different stations may serve as a good example: in Abkhazia the station at Avadkhera has the sum of annual precipitation 2185 mm, at Pskhu situated 660 m a.s.] — 2204 mm, at Khaishi (600 m a.s.l.) — 1299 mm while in Svanetsia the station at Mestia situated 1400 m a.s.l. noted only 849 mm. In winter time the centre of continental anticyclone occurs over the Svanetskiy region of Great Caucasus and in consequence the winter months have a very low rate of precipitation. From the 894 mm of annual precipitation noted at Mestia, 194 mm fall to three winter months, the sum of precipitation in January and February amounts to 62 mm.

Continental character of the climate is also proved by a wide amplitude of air temperature: while in Abkhazia the mean annual temperature of air is 18°C (the Kodori valley), it exceeds 21°C at Khaishi, and reaches 24.4°C at Mestia.

In the pot-holes during the windless winter days the inversions of air temperature occur. On such days there have been noted the following temperatures: at Mestia -26°C (February 1932) and -31°C (January 1950), whereas the mean temperature of these months is -4.7°C and -7.6°C respectively. This fact explains the need of thick walls in houses built in this region.

## 2. THE RACHINSKIY REGION OF GREAT CAUCASUS

In the Rachinskiy region the villages are less peculiar than in the Svanetskiy one. They are situated along the Rachinskiy ridge and river valleys. Houses, though built near one another, do not blend and are seen as individual buildings.

It should be stressed that in the eastern part of Racha bordering on southern Osetia, the houses of the „darbazi” type used to be widespread but they were destroyed and since 1939 the investigators have failed to reproduce them. In the west part of Racha, bordering on Svanetsia, the same houses as in the latter are very common. The settlement Ghebi is a typical Racha village. The plan of village is based on its localization on an uncovered elevation confined by the river Rioni and the river Choshuri. Typical Racha house is a house-stronghold called „duroyani sakhli”. Only three houses of that type are in state of preservation. Houses-strongholds were three-storied, the top story had an entirely

defensive function. Later evolution of „duroyani sakhli” led to the present appearance in which the elements of archaic forms can be seen.

The houses-strongholds or houses-dungeons are of the same type in Racha as in Khevsuretsia. Their exterior is very severe, more like the one of a fortress than a dwelling house. In plain grey walls with narrow windows-loopholes (5—15 cm wide and 20—30 cm high) is the door of archaic shape, somewhat larger at the bottom. The open-work of dungeons with arched excisions is most impressive. The ridge roof is adapted to severe winter conditions in this region and to a large quantity of annual atmospheric precipitation and its seasonal rhythm. That kind of roofs is more suitable for houses built in the humid mountainous climate than the flat ones called „bania”, widespread in eastern part of Great Caucasus where atmospheric precipitation is scarce and the climate is much more continental.

Walls of the house-stronghold, built on limy mortar, are inclined inside: on the ground floor they are about 85 cm thick and on the defensive top floor — 70 cm. The surface of dungeons is ca 70—80 sq. m. The first tier, partly beneath the ground surface, was meant for cattle keeping; the entrance is on westward side where the floor is on the ground level. The floor is boarded. The interior is dark because the entrance is the only one opening. This tier has no connection with the lodging upstairs. The second tier is a dwelling place. It has two windows-loopholes. There are some niches in walls adapted for housekeeping purposes. From the second floor to the third one lead the corner manholes to which the portable ladders might be put. The third tier has six loopholes, two on each side except for the eastern wall. The remnant of a hearth in the middle of the chamber bears evidence that there also was a dwelling room. The walls less sooty than on the second tier prove that fire was seldom there. There are fewer niches in the walls. The last defensive tier covered with a ridge roof presents the most interesting architectural element. There are four loopholes in each wall protruding some 15—20 cm out of the wall. The open work in the Racha houses-fortresses does not differ from that in the Svanetsia houses; the width of arches-loopholes is 40—80 cm.

In the Rachinskiy region of Great Caucasus, besides the houses-fortresses also more modern stony houses, 2-storied, can be met. From northern side they are deepened in earth in such a way that the floor of the first story is on the ground level and the house looks like one-storied one. From south there is a wooden wing with the balcony. Upstairs is a room 40 sq. m. large. Its appearance has been completely changed except for some niches preserved for housekeeping needs. Over the room there is a high attic covered with the ridge roof. The walls

laid with schist are 110 cm thick on the first floor and 80 cm. on the second one.

### 3. THE KHEVSURETSKIY REGION OF GREAT CAUCASUS

Central part of Great Caucasus, much lower than Svanetsia, displays a strongly diversified landscape due to numerous gullies among which the most remarkable are the deeply incised valleys of two big rivers — the Aragvi and the Arguni. „Khevi“ in Georgian language means a gully, then Khevsuretsia it is a country cut by gullies.

The mountainous climate of Khevsuretsia situated a long way from the sea is typically continental. Severe winters and hot summers are characteristic of this region. In some places, as for instance in the vicinity of a big settlement of Barisakho, the deep gullies produce some quiet corners in which can be found small sites with mild winters and not very hot summers. The mean monthly temperature of the coldest month (January) is  $-4.7^{\circ}\text{C}$ , and of the warmest (July)  $16.5^{\circ}\text{C}$ . The absolute minimum amounts to  $-31^{\circ}\text{C}$  in January and absolute maximum exceeds  $33^{\circ}\text{C}$ .

In this high-mountain region of Great Caucasus, characterized by severe climate, the inhabitants created a noteworthy folk architecture presenting mature, perfect forms.

In Khevsuretsia the régime of tribal community ruled till the 20-th century; the regional centre was the village Barisakho situated on picturesque river terraces in the Aragvi gully.

The localization and plan of villages were strictly connected with defensive purposes. Land forms always control the way of farming; here, each patch of the earth taken away from mountains is of greatest value. Lack of earth compelled the inhabitants to a very economical utilization of the soil. It developed in them an exceptional purposefulness and economy in designs of not only the villages but even of every house and dungeon. The analogous social-economical conditions prevailed in eastern regions of Great Caucasus; Tusheti, Mtiuleti, Pshavi.

In Khevsuretsia the house-stronghold and dungeon were the most typical. At present there only are a few dungeons preserved, others are dilapidated. Hoses-fortresses were built by the whole community. The basic material was schist, commonly occurring in valleys of Great Caucasus. Homogeneity of material and forms created the Khevsuretskiy complex of buildings unique of its kind, harmoniously adapted to the surrounding landscape.

The village Shatili in the Arguni gully is representative of this

region. The ancient peasant house in this village, a very valuable architectural relic, even today makes the impression of a stronghold. Such a type of houses is also characteristic of Tusheti and Pshavi, the number of tiers varying between three and six. The village is built on slope steps. All the houses cling to one another in such a way that the roof of one house forms kind of terrace of the next house standing higher. It proves that in winter time the precipitation is scarce and does not disturb the pedestrian traffic.

The house-stronghold consists of three elements: ground floor for cattle, dwelling tier and defensive tier. The ground floor, some 2 m high, has one door in northeastern wall; it is connected with the lodging upstairs by a manhole, instead of a ladder a thick beam with steps cut in it was used. The second tier was the piggery, the height of this lodging is also some 2 m. and the door is at northeastern side of the house. On the next floor there is one chamber 50 sq. m., 3.5 m high, with a hearth and a window-loophole, the only opening through which the smoke could get out. The door in northeastern wall leads to the open terrace, to which one could come using portable stairs. Localization of the terrace as well as all functions of the house was subordinated to the defensive purposes and the prevailing climatic conditions were not taken into account. At Barisakho lying at the altitude of 1350 m a.s.l. and at Shatili (1400 m a.s.l.) the mean monthly air temperature amounts to 17°C in July and August, while the absolute minimum of air temperature is -33°C. It should be stressed that at present the houses are built with balconies facing south. The fourth tier was of defensive character. The lodgings are 5 m high, windows-loopholes are cut all around the room, the door is in northeastern wall. There is also a place for hearth.

#### 4. SOUTHERN OSETIA

Architectural relics of southern Osetia resemble those of Khevsuretsia: houses-strongholds and dungeons are very common. The dungeons are connected with houses of the „dabrazi” type which are deepened in ground and have two openings: door and upper source of light. Instead of the name „dabrazi” the term „erdoniani sakhli” is used in southern Osetia<sup>2</sup>.

In this area three types of „erdoniani sakhli” can be met: 1) wooden in the village Lesora, 2) stony in Leta, 3) four-pillared in Loro.

<sup>2</sup> „Erdo” means the construction framing the roof with the central light opening, which in „dabrazi” was called „ghvirghviniani”.

The wooden house has 120 sq. m. and consists of three lodgings: hallway, dwelling chamber and granary. The walls are built of closely fitted beams notched till half the size. The whole work was done by means of an axe only, no saw was used, nevertheless the beams are well decorticated, hewn and fitted. The „erdo” has the shape of an octahedron pyramid situated on a square. The octahedron forms something like a lampshade over the hearth and it can be readily removed. The ceiling is built of smooth match boards supported by the central pillar. The roof was usually covered with rammed soil, the opening which used to be the main source of light later turned into chimney, when the window was cut out. Thus, the dusky „erdoniani sakhli” became a modern house with windows. As the example of similar transformation may serve the stony house in the Lesora village, composed of two lodgings and roofed balcony 2.5 m above the ground level. The vaulted ground floor under the balcony in the dwelling unit is used for housekeeping needs. Stony stairs lead to the balcony which has the door to the chamber. Three walls of the house, built of schist mixed with lime mortar, are 65—70 cm thick, the fourth wall with balcony is wooden. The house is covered with a ridge roof.

The third type of „erdoniani sakhli”, built some 50 or 60 years ago, is in the village Loro. Its three walls of 200 sq. m. are deepened in ground. There are three lodgings: chamber, hallway and piggery. „Erdo” has 12 finials and leans on four pillars.

Folk architecture in high-mountain regions of Great Caucasus has many common elements. Similarity of shapes and forms of buildings depended on defensive functions as well as of physical-geographical conditions, especially climate. The commonly used material — crystalline schist supplemented with wood gave the buildings harmoniously adapted to the landscape a specific originality. They differ from one another in the roof shape which was adapted to the amount of atmospheric precipitation. In the area of Abkhazia, Racha, Svanetsia and southern Osetia abundant in precipitation, the houses are covered with ridge roofs. In other regions of Great Caucasus where in winter months atmospheric precipitation is small, the houses are covered with flat, step-like or even pyramidal roofs. Buildings are compressed and situated on terraces (Khevsuretsia).

Because of defensive purposes, the number of entrances from outside was limited and the lodgings were connected by manholes which also served as ventilative openings. The arrangement of dwelling interiors as well as localization of houses was dictated by thermic conditions. Consequently, there are separate winter lodgings with hearths and the summer ones which are draughty and possess a balcony or

terrace built on the frontal southern elevations, with the exception of Khevsuretsia where the northeastern orientation was required by defensive purposes.

The care of ancient Georgian builders to assure the inhabitants favourable conditions is proved by the localization of settlements on small elevations or on quiet southern slopes.

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#### CECHY LUDOWEGO BUDOWNICTWA WIELKIEGO KAUKAZU A KLIMAT

Budownictwo wysokogórskich obszarów w szczególny sposób uzależnione jest od lokalnych warunków klimatycznych. Wyrazem takiego przystosowania się są typy i konstrukcyjne rozwiązania ludowego budownictwa mieszkaniowego wysokogórskich obszarów Gruzji. Kształtowały się one przez stulecia, formą swą nawiązując zarówno do lokalnego klimatu i krajobrazu, jak i do warunków społecznych i potrzeb obronnych.

Można prześledzić wyraźne zróżnicowanie przestrzenne typów ludowego budownictwa mieszkalnego w poszczególnych regionach Wielkiego Kaukazu. Różnice zaznaczają się w typie zabudowy wsi i formie budynku. Domy, zbudowane z łupków krystalicznych, harmonijnie wkomponowane w krajobraz, różnią się kształtem dachów, przystosowanych do wielkości opadów atmosferycznych.

Dbłość budowniczych gruzińskich o stworzenie mieszkańcom korzystnych warunków zamieszkania przejawiała się zarówno w konstrukcji formy budynku i odpowiedniej orientacji jego elewacji, jak również w lokalizacji osiedli na niewielkich wyniosłościach lub zacisznych stokach o wystawie południowej.