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Natural Environment and Landscape Energy of Western Georgia

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Abstract

The particularly great practical importance of modern physical geography and, in particular, landscape science, is first of all manifested in the detection and study of the resource potential of landscapes, as well as in the optimization of the environment. The resource potential, on the other hand, greatly depends on the balance of substance and energy exchange in the natural resources, *i.e.* the energy of the landscape. In this case, one of the important things is to study the functioning of natural-territorial complexes (NTC). Through it, it is possible and relatively easy to explain, model and, most importantly, predict many complex processes taking place in NTC, including the role of landscape energy balance in increasing the productivity and yield of agro-landscapes, which was the first attempt to research this problem in Georgia.

Keywords

Landscape Energy, Agro-Landscape, Optimization, Solar Radiation, Energy Balance

1. Introduction

Energy, in general, on the basis of which the landscape "works", is divided into two parts: exchange and accumulation. The exchange part of the energy level of the landscape complex—E_g includes: the incoming solar energy—E_1, the amount of heat introduced by air and water masses—T_1, the heat of phase rotation of waters—T_2, the internal heat of the earth's core—T_3; also, the kinetic energy of atmospheric precipitation—E_k and potential—E_p energy (amount of discharge):

$$E_g = E_1 + T_1 + T_2 + T_3 + E_k + E_p$$

The cumulative part of the energy level of the landscape (E_a) is determined by the intensity of the denudation level of rocks, lakes, river waters and glaciers (D_1), above the base line of erosion, in cm, as well as by the chemical energy of inorganic compounds (E_n) and the potential energies of organic compounds (E_0):

$$E_a = D_1 + E_n + E_0$$

It should be noted that the accumulated part of the energy in the landscape is conserved in a way, and it takes part in the development of the landscape only after it is released, and this usually takes place at the expense of exchange energy [1].

Solar energy is the most effective in landscape functioning. It has the ability to transform into all other types of energy, primarily heat, as well as chemical, electronic and mechanical energy. Through solar energy, the processes of internal change in the landscape are carried out, including evaporation, transpiration and biological metabolism. It should be said that all the processes in the landscape, as well as inter-component organizational connections, are directly or indirectly related to the transformation of solar energy, which is one of the important processes taking place in BTKs, which includes radiation and heat balance, as well as albedo. They are important features determining the energy of the landscape, which is related to the annual, seasonal and decadal character of the functioning of NTC. They play a big role in determining the energy level of the landscape.

Early studies of landscape functioning [2] [3] [4] [5] are more general, planetary nature and refer to a higher rank of the landscape, but now, when the question of determining the energy of NTC at the regional and impact level has arisen, it has been found that this process is quite complex and it can be determined only in the case of breaking up BNTC into lower, smallest parts, that is, at the level of geomasses. When assessing the energy level of the landscape at this level, there is the second main source of energy—gravitational energy, whose role in the functioning of the landscape is very large, and its transformation in natural complexes is expressed by such characteristics as the potential energy of the complex as a whole and the work of individual geomasses.

$$E_g = E_p + \sum A_n$$

where, E_p is the potential energy of the landscape, $\sum A_n$ is the arithmetical sum of the work of individual geomasses. In turn, the potential energy of the landscape is calculated by the formula:

$$E = mgh$$

where, m—the mass of the landscape, g—the free fall acceleration (9.81 m/cm^2), h—the absolute height (at the local level, the height difference can be used) of the landscape (geo-horizons). The introduction of this indicator is due to the fact that the hypsometric difference of landscape complexes largely determines the gravitational energy magnitude [6]; in particular, it is expressed in the character and intensity of one or another landscape-forming processes (erosion, avalanche, landslide).

As for the second indicator of gravitational energy, it is determined mainly by the work of individual geomass (litho-hydro-phyto, etc.) and is calculated by the formula:

$$A = mg\left(H_1 - H_2\right)$$

where, m—the magnitude of geomass, g—acceleration of free fall (9.81 m/cm^2), (H_1 − H_2)—height difference. It should be noted here that the acceleration of free fall is a very important parameter and it determines a number of processes taking place in the landscape and their intensity, in particular, the arrival of atmospheric precipitation and its filtering in the soil, biogeocycle processes, surface and underground runoff, slope gravity processes, etc. [1].

Using the geophysical, namely balancing method, it is possible to determine the main energy balance (in MJ/m, yr) at the level of the smallest morphological unit of the landscape - facies, using the formula:

$$B = \text{LE} + \text{LT} + P_a + P + F + A + B_z - \text{LC}$$

where, B—radiation balance, L—latent heat of evaporation, E—physical evaporation, T—transpiration, P_a—heat loss spent with the atmosphere as heat, P—heat exchange of vegetation cover, F—assimilation of solar energy as a result of photosynthesis, A—heat flow in the soil, B_z—heat removal by runoff, LC—heat by condensation of water vapor.

When evaluating the bioenergetic characteristics of NTC, the so-called Photosynthetically active radiation (PAR), which is the main energy flow for the plant to the extent that it drives such an important physiological process as photosynthesis, is calculated by the formula:

$$\text{FAR} = 0.4R_p + 0.62R_m$$

where, R_n are the values of direct solar radiation, and R_m are values of scattered radiation.

2. Material and Methods

It is known that the diversity of the soil in general and, in particular, the diversity of the soil of Western Georgia as the main component of the landscape, is significantly related to the different amount of energy entering the soil. The energy flow regulates the activity of soil biota, the process of transformation of organic matter, etc.

The most powerful energy source for soil formation is solar energy, which essentially changes both according to geographical zones and altitude zones, as evidenced by the magnitude of the radiation balance, which is 210 - 250 kJ/cm^2 in the subtropics of Western Georgia [7].

Together with organic residues, the amount of energy entering the soil is determined by the data on the amount of annual precipitation and the calorific value of organic residues (**Table 1**).

To determine the energy of soil formation, it is important to determine the amount of energy that is spent on different soil processes, although this is a very difficult process, since the processes taking place in the soil are closely related to each other and it is not always possible to differentiate them. Nevertheless, it was possible [8] to represent the energy balance of soil formation in the following form:

$$Q = w_1 + w_2 + b_1 + b_2 + i_1 + i_2 + g + c$$

where, Q—the amount of energy that enters the soil during the year, w_1 and w_2—energy consumption, physical and chemical exhaustion of the soil;

b_1 and b_2—energy spent on biochemical reactions and accumulated in soil organic matter;

i_1 and i_2—energy spent on evaporation and transpiration;

g—energy losses in the processes of mechanical migration of salts and suspensions in the soil thickness;

c—energy spent in heat exchange processes in the "soil-atmosphere" system.

In order to calculate the energy balance of soil formation in different hydrothermal conditions, the data of radiation balance, total evaporation and transpiration, annual increase of organic mass, precipitation, and the energy spent on the dissolution of mineral crystal mass are used [7]. This ratio is expressed as follows:

$$(i_1 + i_2):(b_1 + b_2):(w_1 + w_2) = 100:1:0.01,$$

Thus, the main part of energy is spent on evaporation and transpiration ($i_1 + i_2$), about 10 times less on biochemical process and transformation of organic matter ($b_1 + b_2$) and much smaller, 100 times less on mineral depletion ($w_1 + w_2$). Due to such unequal distribution of energy to different processes in the soil, the speed of the processes is also different: the fastest is the process of evaporation and transpiration (a few hours or days), the process of humification and mineralization of organic waste is slower (ten years) and the slowest is the process of physical and chemical exhaustion (centuries), since a very small part of the total energy of soil formation is spent on it.

Based on this, if we evaluate the importance of environmental factors in the

Table 1. Amount of soil energy obtained from plant fall.

Landscapes	Amount of falling energy
Mountain-Meadow	126 - 168
Dark pines	419 - 838
Chestnut-beech forest	1048 - 1257
Polydominant humid forest of plain	2933 - 3143

energy of soil formation and rank different soils accordingly, we will get a series in which the most intensive soil formation position will be occupied by subtropical moist soils (3000 - 3500 J/cm^2).

Since the presence of moisture is a necessary condition for the life of a plant and, in general, a living organism, in addition to heat, therefore there is a certain relationship between, on the one hand, bio-productivity and organic part of the soil, and on the other hand, the ratio of heat and moisture. So, for example, in the case of the same thermal conditions, when humidity increases, more energy is spent on evaporation and transpiration, but more solar energy is absorbed by the vegetation, which through shedding energetically enhances the biochemical process of soil formation.

It is determined that with relatively high soil moisture, the share of energy spent on photosynthesis and bio-cycle increases significantly, from 0.5% to 4%, as the radiation balance increases, and in the case of moisture deficit, it remains practically insignificant, despite the high value of solar radiation. Thus, the lower the humidity, the smaller the difference in the internal energy of the soil of different landscape zones, and it increases from the nival zone of the highlands to the humid landscapes of the bar (from 20 to 270 kJ/cm^2)—**Table 2**.

3. Results and Discussions

It should be noted that the heat exchange between the surface of the earth and the soil-soil has a cyclical nature: in the warm period of the year, the warm flow is directed from the surface to the soil, and in the cold period—the other way around. However, the intensity of this heat exchange is high in continental landscapes, with pronounced fluctuations in air and soil temperatures. In addition, the amount of heat exchange depends on the synotypic and lithological composition of the soil; therefore, in the landscapes of Western Georgia, the peat-swamp layer plays the role of a heat insulator and prevents the heat exchange between the atmosphere and the soil. Therefore, due to the decrease in the amount of solar heat flow under forests, heat exchange on the soil surface is weaker than in non-forested areas. Heat exchange in the soil reaches a depth of about 10 - 20 m. Its value is several percent of the annual radiation balance (for example, in the alpine zone it is up to 15%).

Since, one of the main characteristics of the biogenic part of the landscape is the energy function (the ability to absorb solar energy, convert chemical bonds

Table 2. Energy costs for soil formation (J/cm^2) and energy reserves (J) in humus and plant matter in a soil prism with a cross section of 1 cm^2.

Landscape zone and soil type	Energy storage, kJ/cm^2	Energy storage in humus layer, cm		Energy storage in plant matter
		0 - 20	0 - 100	
Broad-leaved forest, Cambisol	125,000	22,626	49,422	-
Subtropical forest, yellow soil, Alisols	171,790	19,693	40,643	298,538

into energy and transmit it through food chains), it is natural that this indicator differs according to individual landscapes of Western Georgia (**Table 3**, **Table 4**) and it increases From the bar to the mountain. A clear confirmation of this is the so-called Also the trophic pyramid, where it is shown how solar energy is spent on different types of living organisms—the higher we go in this pyramid, the less energy is consumed by NTC for functioning.

The presence of moisture and its turnover in NTC are closely related to turnover, that's why the quantitative and qualitative indicators of turnover were determined according to individual phytocenosis [9]. Thus, for example, 52.5% of the 2500 - 3500 mm of atmospheric precipitation that falls on average in the oak-deciduous forest zone per year returns to the atmosphere, transpiration, and water evaporated from the soil surface; 47%—seeps into the soil and only 0.5% accumulates in biomass growth.

The issue of spatio-temporal regulation of metabolism in landscapes is also related to solar energy flows. The provision of solar energy determines (under conditions of equal provision of moisture) the intensity of landscape functioning, and the seasonal fluctuation of insolation mainly determines the annual cycle of functioning.

In general, the incoming solar radiation is converted by reflecting part of it from the earth's surface. The amount of radiation spent on reflection varies widely depending on the nature of the landscape surface. Alpine and subalpine landscapes (77%), followed by coniferous forest landscapes (65%) and broad-leaved

Table 3. Quantitative characteristics of radiation balance in humid subtropical landscapes of Western Georgia, kcal/cm^2.

Main landscapes	Total radiation, kcal/cm^2	Radiation balance, kcal/cm^2
Plain Alder	100 - 120	50 - 55
Low mountain deciduous forests of hilly foothills	120 - 130	30 - 40
Mountain-forest	130 - 140	20 - 30
Mountain-Meadow	140 - 150	20 - 10
Eternal snow and glaciers	≤150	≥10

Table 4. Qualitative-quantitative indicators of moisture turnover according to the phytocenosis of Western Georgia.

Phytocenosis	evaporation, mm-%	amount of precipitation, mm
Lowland deciduous forests	140 - 150	1400 - 2500
Hilly Colchic	130 - 140	2500 - 3500
Mountain-forest, tundra	120 - 130	1500 - 2500
Mountain-meadow	100 - 120	800 - 1500
Eternal snow and glaciers	≥100	550 - 800

forest landscapes (62%) lose a large part of the total radiation. The lowest total radiation loss occurs in humid subtropical forest and swamp landscapes (37%) [10].

When the landscape is functioning, a large part of the radiation balance is also spent on evapotranspiration, that is, on the total evaporation of water from the surface of the landscape's vegetation and soil components, in other words, it is mainly energy spent on heating and air heating. These two parameters are different depending on the landscape, in particular, in subtropical humid landscapes, a large part of the radiation balance is spent on evapotranspiration, in contrast to arid landscapes, where the radiation balance is mainly spent on transpiration (**Table 5**). All this leads to a decrease in the biological productivity of landscapes and its limitation.

Undoubtedly, the transformation of solar energy plays an important role in biota, however, only 0.5% (of the total radiation flow) is spent on the biochemical reaction of photosynthesis, and 1.3%—of the total amount of radiation balance. It should be noted that during photosynthesis, the so-called Photosynthetically active radiation (PAR), which makes up 45% of the total radiation. Vegetation absorbs 90% of the heat, although a significant part of it is spent on transpiration and only 0.8% - 1% is used directly for photosynthesis [11].

It is interesting to see the change of the photosynthetic rate of action (MQC) according to the altitude zones of Western Georgia. It is the highest in the highlands of the Western Caucasus, and this coefficient is also high in the humid subtropics of the Black Sea—up to 2% [11]. About half of the energy spent on photosynthesis is released during the respiration of producers, and the rest is stored as pure primary products (**Table 6**).

As can be seen from the table, the essence of mutual influence in the landscape is limited not only to the circulation of matter and energy between components or adjacent complexes at the typological level, but also to the transformation of matter-energy flows, which causes various feedback reactions in each block of the geosystem, as a result of which the latter acquires new properties.

Based on the fact that one of the characteristics of landscape energy assessment is the indicator of the intensity of landscape functioning. In the absence of

Table 5. Heat loss due to evaporation and turbulent exchange according to the landscape zones of Western Georgia.

Western Georgia Landscape zones	Radiation balance, mjoule/m^2-year	Energy spent on evaporation		Energy spent on turbulent exchange	
		joule/m^2-year	%	joule/m^2-year	%
Lowland extra-humid	2500	2000	80	500	20
Hilly humid	1550	1300	84	225	16
mountain-wood (broad-leaved)	1550	1300	84	225	16
High mountain coniferous forests	1400	1180	75	185	14
Subalpine and alpine meadows	1200	980	63	155	12
Eternal snow and glaciers	1000	850	52	132	10

Table 6. Indicators of the intensity of functioning of wet subtropical landscapes of Western Georgia.

Landscapes	Tk, %	P, %	E, %	MN, %
Plain	66	60	68	50
Subtropical broadleaf forests of the foothills	52	44	52	36
Low-mountain deciduous-mid-mountain coniferous forests	47	30	36	28
Subalpine and alpine meadows of the highlands	22	16	21	15
Alpine and subalpine mountain-meadow	0	2	4	2

a unified evaluation system, many things are debatable, however, according to individual indicators of functioning (transformation of solar energy, internal heating, biological circulation of substances, etc.), the comparison of landscapes gives a certain idea about the intensity of landscape functioning. For example, the higher this indicator is, the more intense the circulation of energy and matter is in it, which is expressed in the magnitude of the biological productivity of the landscape. In turn, all the listed processes are determined by the ratio of heat supply and moisture. It should be noted that until now the universally accepted correlation coefficient of these two quantities has not been obtained; in this regard, the so-called "climate biological efficiency index" (CBI), obtained by multiplying the sum of temperatures higher than 100 by the annual humidity coefficient, can be considered relatively perfect. In this case, 1 is taken as the optimal limit indicator, above which wetting does not have a positive effect on the productivity of the landscape and, in general, its functioning, although this coefficient "does not work" in the alpine and subalpine zone, where the temperature is below 100 (Table 7).

Thus, the main parameters determining landscape energy (LE) are:

Geodynamic energy—GE (determined by the indicators of the internal heat of the subsurface and the energy of decay of radioactive substances)

Terrain energy—AE (determined by the difference between the highest and lowest points of the terrain, indicators of vertical and horizontal divisions and tilt angle);

Climate energy—KE (defined by the solar radiation energy, total radiation, effective radiation, radiation and heat balance and climate biological efficiency index (Tk), which is determined by the sum of temperatures higher than 100 and humidity coefficient equal to 1);

Water energy—WE (determined by surface and underground water consumption, annual runoff, fall and slope data);

Soil energy—ZE (determined by the energy balance of soil formation; energy spent on biochemical reactions; energy losses in the processes of mechanical migration of salts and suspensions and energy spent in heat exchange processes in the "soil-atmosphere" system;

Biological energy—BE (determined by the amount of residual energy in the process of photosynthesis, quantitative and qualitative indicators of temperature,

Table 7. Duration of sunshine in the region of Western Georgia (hours).

Meteostation	elevation (a.s.l), m	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Batumi	2 - 3	99	105	126	148	199	235	214	223	201	176	125	107
Anaseuli	460	92	97	126	156	199	215	175	196	180	167	122	103
Sairme	950	54	64	100	119	158	158	154	169	154	109	69	51
Bakhmaro	1900	101	104	154	186	209	220	206	213	185	172	130	98

the amount of heat spent on transpiration, the primary amount of phytomass products, the amount of the plant's annual demand for nitrogen and ash elements), thus,

$$LE = GE + AE + KE + WE + ZE + BE$$

Since, a detailed study of the morphological and biological features of plants is a necessary condition in order to reveal the potential possibilities of adaptation of varieties and the amount of bioproductivity in changed natural conditions, biochemical-physiological research in order to reveal the energy of the landscape [12]. It was carried out on two forms of one of the varieties of Feijoa - Superba - early and control. As a result of the research, it was determined that the amount of hectic substances and ascorbic acid in the feijoa fruit changes significantly depending on the weight of the fruit, the seasons of the year and the place of cultivation. It was revealed that the feijoa plant grown near the sea produces fruits with a high content of biologically active substances, which are related to the energy of the landscape, in particular, the activity of the photosynthesis process.

The amount of solar energy largely depends on the duration of sunlight, and the latter indicator determines the normal course of the physiological processes of landscapes in general and agricultural crops in particular, therefore it is necessary to take into account the duration of sunlight in any area in order to create better agro-climatic conditions for the bio-component of landscapes and to determine the regularities of their spatial distribution (**Table 7**).

The annual course of the duration of sunshine in the territory of Western Georgia is non-linear: it increases from the winter months to July (with the increase of cloudiness), and decreases from July to August. In August, this indicator is relatively high, it continues to decrease from August and is minimum (95 - 107 hours) in the month of December. The image of the height distribution of the duration of sunlight is interesting:

Altitude of 200 - 500 m (a.s.l), the duration of sunlight varies (from January to July, from 90 - 100 hours to 120 - 125 hours). As for the average mountainous zone (up to 2000 m), the duration of sunlight is 50 - 220 hours, respectively. It should be noted that in this region there are frequent sunny days during the flowering and ripening phase of agricultural crops, in particular citrus fruit, which has a negative effect on the ripening of fruits (on late varieties of tangerines and oranges). That is why it is better to choose south, south-east and south-west exposure slopes for them [13].

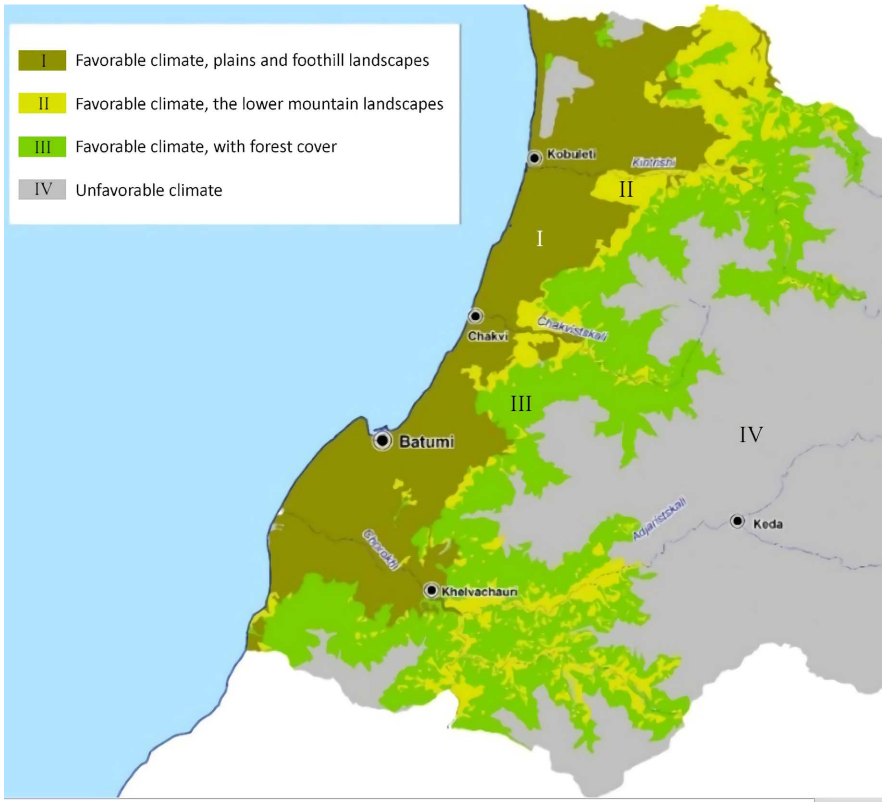

Figure 1. Agro-ecosystem ranking of the subtropical-humid zone of Western Georgia.

As a result of the multifactorial analysis of the energy indicators of the landscape, the agro-landscape ranking of the subtropical-humid zone of Western Georgia was carried out and scientifically justified recommendations were developed [14] [15], on the basis of which two agro-landscape zones (30 - 200 m; 200 - 400 m) accepted until now for the spread of citrus crops were added. The third zone, in the range of 400 - 700 m (**Figure 1**), will increase the area of distribution of citrus crops and what is important, it will contribute to their high yield.

4. Conclusions

- Based on the fact that energy is a constant and important component of the landscape, which determines the unity and integrity of the landscape, the functioning of components and processes and their interrelationship, in order to determine the energy of the landscape:
- The main parameters determining landscape energy (LE) were determined.
- The difference in the total energy indicators of the parameters (components) composing the bar and mountain landscapes was revealed.
- As a result of the multifactorial analysis of the energy indicators of the landscape, the agro-landscape ranking of the subtropical-humid zone of Western Georgia was carried out and scientifically substantiated recommendations were developed, on the basis of which a third zone was added to the two

agro-climatic zones (30 - 200 m; 200 - 400 m) accepted until now for the spread of subtropical crops in the range of 400 - 700 m, thus increasing their distribution area and, accordingly, the yield of citrus crops.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Armand, A.D. (1975) The Role of Models in the Study of Natural Complexes. *Methodology of Landscape Studies*, **1**, 115-129.

[2] Davitaia, E. and Seperteladze, Z. (2014) Landscape Science and Landscape-Ecological Problems. *Proceedings of the Geographical Society*, Tbilisi, 128-134. (In Georgian)

[3] Davitaia, E. and Seperteladze, Z. (2018) Landscape Energy—The Main Parameter Determining the Functioning of NTC. *Proceedings of the Geographical Society of Aleksandre Javakhishvili*, 180-189. (In Georgian)

[4] Lvovich, M. (1986) Water and Life: Water Resources, Their Transformation and Protection. 256 p. (In Russian)

[5] Shuitsev, I.K. (1981). Questions of Geography. No. 117. 208-215. (In Russian)

[6] Gongadze, M.A. (1985) Anthropogenic Transformations of Relief in Georgia. PhD Thesis, Autoref, Baku, 10-14. (In Georgian)

[7] Urushadze, T. and Bloom, V. (2011) Geography of Soils with the Basics of Soil Science. TSU, Tbilisi, 425 p. (In Georgian)

[8] Volobuev, V.R. (1974) Introduction to the Energy of Soil Formation. Nauka, Moscow, 128 p. (In Russian)

[9] Beruchashvili, N.L. (1986) Four Dimensions of Landscape. Misl, Moscow, 182 p. (In Russian)

[10] Samukashvili, R. (2015) Radiation Regime and Solar Energy Resources of the Caucasus Region. Universal, Tbilisi, 336 p. (In Georgian)

[11] Gvasalia, N.B. (1986) Thermal Balance of Georgia. Universal, Tbilisi, 77-102. (In Russian)

[12] Kedelidze, N., Baratashvili, D., Meskhidze, A., Khalvashi, N. and Nakashidze, I. (2015) Biological Specifics of male Gametophyte in Feijoa Sellowiana Berg. *International Journal of Current Research*, **7**, 19315-19318.

[13] Meladze, G. and Meladze, M. (2012) Agroklimatic Resources of Western Regions of Georgia. Institute of Hydrometeorology at the Technical University, Tbilisi, 114-123.

[14] Seperteladze, Z., Davitaia, E., Alpenidze, M., Gaprindashvili, G., Maisuradze, R., Memarne, G., Khalvashi, N., Kedelidze, N., Aleksidze, T., Rukhadze, N. and Khardziani, T. (2021) Ranking of Feijoa (FEIJOA Sellowiana) in Subtropical Humidified

Zone of Adjara and Forest Ecosystem by Multiple-Factor Approach. *Open Journal of Forestry*, **11**, 1-13. https://doi.org/10.4236/ojf.2021.111001

[15] Seperteladze, Z., Davitaia, E., Aleksidze, T., Memarne, G., Khalvashi, N. and Gaprindashvili, G. (2015) Natural Environment Zoning of West Georgia for Identifying the Perspective Regions of Actinidia Chinensis Planch Culture Spreading. *Global Journal for Research Analysis*, **3**, 82-86. https://doi.org/10.15373/22778160/June2014/29