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*Physical Geography*

# Natural Resource Potential of Western Georgia and Territorial Management of Agrolandscapes

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**ABSTRACT. Agrolandscape study has quite a long history in Georgia, as the natural resource potential of the country and agroresource potential greatly depend on it. Scientific research was carried out aiming at implementing the program of drainage of the high humidity and swamp soils of Kolkheti and their agricultural utilization.**

**Complex analysis of the natural resources of Western Georgia has been carried out by modern methods of research. In view of the average indices of hydrothermal coefficient the study has revealed the space distribution peculiarities of agrolandscapes.**

**All the modifications of the Western Georgian agrolandscapes have been researched and a new model of their territorial organization has been elaborated. This model enables us to reveal the natural resource potential of the region, structural stability of agrosystems and to find optimal ways for improving the ecological situation.** *© 2010 Bull. Georg. Natl. Acad. Sci.*

***Key words:*** *agrolandscape, natural-resource potential, hydrothermal coefficient, soils, Kolkheti.*

Western Georgia is one of the most utilized regions from the agricultural point of view. It determined the basic transformation of its unique and exotic damp subtropical landscapes rich in endemic and relic bioelements. Here we can trace several modifications of agro complexes classified according to the character of anthropogenic impact and degree of natural component transformation. These modifications are phytogenic, pedogenic, lithogenic and absolutely new neo-landscapes can be also created, the typical example of which can be considered, the so-called polders – rather fertile agrolandscapes molded after the utilization of sea shelf (so successfully applied in Holland).

It must be noted that agrolandscape is generally an open system. It means that constant transformation of substance and energy can be traced not only in its structures, but between the neighboring natural systems as well. Its spatial structure is primarily defined by natural factors. As for the agrolandscape efficiency, it depends on natural potential together with socio-economic and technical conditions.

It must be noted that agro system has the capacity of functioning for a long term (in condition of systematic monitoring on its station), but as soon as the anthropogenic impact on it is over, immediately it is replaced by a secondary, non-cultural landscape. Besides that the capacity of stability and homeostasis is also characteristic of agrolandscape, as to one of the mobile modifications of anthropogenic landscapes. But here we should note that the landscapes having suffered from industrial impact are less stable (at least in the short term period). The structure of agrocomplexes is rather simplified compared to its preceding natural (background) landscape, the main representatives of which are monocultures created on the place of diverse natural phyto association. This latter basically changes the situation, soil features in particular; it devours organic and chemical linkages, thus hindering the restoring processes in soil. For instance, in the damp subtropical landscapes of Western Georgia, namely in tea plantations, it is easy to observe three times more absorption of nickel and 1.7 times more absorption of manganese from the soil by tea leaves, than by the leaves of lime and chestnut trees in the same zone. Besides that, they have double aluminum consistency.

On the basis of the research work conducted under the aegis of the UN convention on climate changeability [1, 2], it was decided that some corrections must be made in the tendency of climate change during the last decade (1995-2005). According to this scheme during the $20^{th}$ century and at the beginning of the $21^{st}$ century the average annual thermal change velocity of air was $0.3^{o}$ in damp subtropical landscapes of humid forest lowlands in Kolkheti (type A), while $0.07^{o}$ - in subtropical sub-arid (type B) and humid forest highland landscapes (type H). Moreover, the warming process has replaced the process of cold spell in humid landscapes. This hypothesis will certainly have its impact on the agroresource potential of Kolkheti, as according to the current forecast, the transformation of Caucasus climate is expected in several decades.

## Materials and Methods

The issues discussed in the article and their outcomes are largely based on the scientific works dedicated to this problem and mostly on the results of expeditions and experimental researches conducted by the authors. Apart from the approved methods of agrolandscape research, the methods of time-space analysis and synthesis were also used while carrying out the research.

Qualitative evaluation of soil in the region to be studied was implemented in accordance with the World Database Classification, adopted in Georgia since 2002. This classification implies the introduction of soil code system necessary for enrolling and elaboration of soils in the region to be studied in the international informational base.

## Results and Discussion

Agriculture, together with tourist-recreational potential, can be considered as the basis for the sustainable socio-economic development of Georgia. Western Georgia, especially the Kolkheti region is to play one of the major roles in it. Soil-climatic conditions (citrus, maize, tea, tobacco industries) with intensive application of winter vegetation period, in their turn are main determining factors of agrolandscape potential.

Various types of soils developed in humid subtropical conditions play an important role in forming the agrolandscapes in Western Georgia. The most significant among them are Subtropical Podzols (Stagnic Acrisols), Yellow (Chromic and Ferralic Cambisols), Red (Acrisols) and Alluvial acid (Dystric Fluvisols) Soils [3].

The total area of subtropical podzols is 4.3 % of the whole country (2 983 833 ha). These soils are distributed on the old marine terraces at the altitude between 30-200 m above sea level. They are characterized by extremely different profile : $A\text{-}A_{2(f)}\text{-}A_2B_{gf}\text{-}Bg\text{-}BC_{f(g)}$ or $A\text{-}A_1A_2\text{-}B\text{-}BC_{(f)}$. The main diagnostic data of soils is well distinguished eluvial horizon, acid reaction, moderate content of humus, desaturation, impoverished by silt and clay fraction in eluvial horizon and increasing of atmosphere and crystalline iron with depth.

Yellow soils occupy 4.1 % of the whole country (2 898 034 ha). These soils occur on the clay slate in the altitude between 100-500 m above sea level. They are characterized by the following profile: $A\text{-}AB\text{-}B_1\text{-}B_2\text{-}BC$ and acid reaction, yellow color, moderate content of humus, desaturation, heavy texture and more or less high content of iron.

Red soils occupy 2.2 % of the whole country (1 533 303 ha). Red soils are formed on the basic effusive rocks at the altitude between 100-300 m above sea level. Red soils are characterized by the following profile: A-B-BC-C or $A\text{-}B_1\text{-}B_2\text{-}BC\text{-}C$ and acid reaction, red color, moderate or low content of humus, heavy texture and high content of iron.

Alluvial acid soils occupy 4.1 % of the whole country ( 2 866 949 ha). Alluvial soils are formed on the river terraces. These soils are characterized by the following profile: A-BC-C-CD and acid reaction and layer texture.

As mentioned above, one of the main determining factors of agroresource potential (together with soil conditions) is agroclimatic indices, the most important among them is duration of day-night temperature period above average $10^{0}$C (Table 2).

The research has shown that during the vegetation period the average indices of hydrothermal coefficient in different parts of Georgia ranges from 1.5 to 3.5. while its maximum is observed in Ajara-Guria regions (Chakvi).

One of the main determining characteristics of agroresource potential is sunshine duration. The maximum sunshine duration is characteristic of Samegrelo region, a lower coefficient can be observed in Ajara-Guria region (unlike the previous data). In Anaklia this coefficient equals 2223 $^{h}/_{year}$, in Poti – 2183 $^{h}/_{year}$. The research

Table 1

The main properties of the subtropical soils

| № | Horizon, depth, cm | pH | Humus, % | Exchangeable cations, mgq/ 100 g. s. | | | | | | | <0.001 | <0.01 | $Fe_2 0_3$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ca | Mg | H | Sum | % of Sum | | | | | Amorph. | Noncryst. |
| | | | | | | | | Ca | Mg | H | | | | |
| Subtropical podzols | | | | | | | | | | | | | | |
| 1 | A – 0 - 14 | 6.1 | 3.84 | 19.25 | 7.73 | 0.99 | 27.47 | 69 | 28 | 3 | 33 | 69 | 1.55 | 3.88 |
| | $A_{2(f)}$-14-26 | 5.6 | 1.90 | 5.14 | 4.02 | 1.98 | 11.14 | 46 | 36 | 18 | 31 | 69 | 1/55 | 3.45 |
| | $A_2B_{fg}$-25-38 | 6.0 | 0.53 | 2.60 | 0.74 | 3.96 | 7.30 | 36 | 10 | 54 | 32 | 74 | 0.98 | 2.16 |
| | Bg 35 - 65 | 5.4 | 0.37 | 16.22 | 2.96 | 4.96 | 24.14 | 67 | 12 | 21 | 38 | 75 | 0.93 | 2.88 |
| | $BC_{f(g)}$ -65-90 | 5.4 | 0.19 | 13.73 | 4.85 | 0.99 | 19.70 | 70 | 28 | 2 | 42 | 59 | 1.16 | 2.16 |
| 5 | A – 0 - 15 | 4.6 | 2.64 | 2.20 | 1.48 | 1.98 | 5.66 | 39 | 26 | 35 | 19 | 60 | 0.98 | 2.63 |
| | $A_1A_2$ –15-28 | 5.2 | 1.49 | 4.04 | 0.33 | 1.98 | 6.35 | 64 | 5 | 31 | 39 | 61 | 0.85 | 2.54 |
| | B – 28-50 | 5.3 | 1.22 | 2.89 | 0.33 | 0.99 | 4.21 | 69 | 8 | 23 | 29 | 66 | 0.84 | 1.83 |
| | $BC_{(f)}$-50-90 | 5.3 | 0.86 | 3.99 | 1.33 | 1.98 | 6.30 | 63 | 5 | 32 | 21 | 60 | 1.07 | 2.13 |
| Yellow soils | | | | | | | | | | | | | | |
| 7 | A – 1 – 12 | 4.6 | 6.51 | 6.48 | 4.43 | 3.71 | 14.62 | 44 | 30 | 26 | 18 | 45 | 1.32 | 3.04 |
| | AB – 12 – 24 | 5.2 | 2.05 | 3.88 | 1.73 | 4.53 | 10.14 | 38 | 17 | 45 | 19 | 47 | 1.40 | 3.31 |
| | $B_1$ – 24 – 38 | 4.8 | 1.25 | 2.81 | 2.05 | 7.95 | 12.81 | 22 | 16 | 62 | 19 | 48 | 1.55 | 3.51 |
| | $B_2$ – 38 – 50 | 4.9 | 0.85 | 3.24 | 2.27 | 12.15 | 17.66 | 1 8 | 13 | 69 | 20 | 49 | 1.65 | 4.00 |
| | BC – 50 - 80 | 4.7 | 0.20 | 4.54 | 4.75 | 15.21 | 24.50 | 18 | 19 | 63 | 22 | 49 | 1.80 | 4.66 |
| 9 | A – 1 - 10 | 5.4 | 4.35 | 11.14 | 5.78 | 1.96 | 18.88 | 59 | 31 | 10 | 20 | 46 | 1.10 | 2.30 |
| | AB – 10 - 22 | 4.9 | 1.82 | 15.71 | 10.98 | 7.12 | 33.81 | 46 | 32 | 22 | 21 | 47 | 1.28 | 2.75 |
| | $B_1$ – 22 - 36 | 5.2 | 0.94 | 18.63 | 12.24 | 5.56 | 36.43 | 51 | 34 | 15 | 22 | 52 | 1.20 | 2.21 |
| | $B_2$ – 31 - 55 | 5.4 | 0.63 | 20.44 | 14.33 | 2.80 | 37.47 | 54 | 38 | 8 | 22 | 53 | 1.08 | 1.59 |
| | BC – 55 - 90 | 6.3 | 0.15 | 29.48 | 15.02 | 0.40 | 44.90 | 66 | 33 | 1 | 24 | 54 | 1.01 | 1.34 |

has also revealed that territorial distribution of atmospheric precipitation in this area is of inversion character deviating with natural regularity. But generally the tendency of its reduction from the sea to inner regions can still be observed.

It must be noted that drainage works carried out (in the 1960s-70s) did not have any serious impact on Kolkheti climate humidity. In our opinion, the reason of it is that humidity is generally dependent on climate determining factors, such as solar radiation, atmospheric circulation, lower surface character, the global changes of which have not occurred yet. This question is still a subject of discussions, but one thing is certain: as a result of the marshland area utilization, hydroclimatic changes generally occur at the expense of total evaporation changes. It is calculated [4] that annual drainage increase after marshland area utilization in Kolkheti equals 5%, during the vegetation period it rises to 10%, but during the cold period it remains practically unchanged. The above-mentioned indices are of great importance in agricultural development phases in Western Georgia, the main determining factors of which are soil humidity, plant characteristics and climate regime [5], that is why it is so important to use the following dependence:

$$E = \beta E_o \, \psi(w),$$

Table 2

Duration of day-night temperature period above average $10^0$C

| № | Average duration (day) | Provision % | | | | |
|---|---|---|---|---|---|---|
| | | 95 | 75 | 50 | 25 | 5 |
| 1 | 220 | 190 | 205 | 220 | 235 | 250 |
| 2 | 230 | 200 | 215 | 230 | 245 | 260 |
| 3 | 240 | 210 | 225 | 240 | 255 | 270 |
| 4 | 250 | 220 | 235 | 250 | 265 | 280 |

Table 3

Agroclimatic zone characteristics in Western Georgia

| Zone | Altitude above sea level (m) | Actual temperature total (more than 10%) | Average of absolute and minimal temperature ($^oC$) | Nonfreezing days |
|---|---|---|---|---|
| I | 0-350 | 4000-4500 | -3 | 280-310 |
| II | 351-560 | 3500-4000 | -14-16 | 190-275 |
| III | 561-780 | 3000-3500 | -18-8 | 186-267 |
| IV | 781-990 | 2500-3000 | -12-22 | 175-216 |
| V | 991-1250 | 2000-2500 | -14-23 | 140-205 |
| VI | 1251-1750 | 1500-2000 | -15-28 | 120-180 |
| VII | 1751-2100 | 1000-1500 | -19-29 | 100-150 |

where $\beta$ - determining parameter of plant development dependence on total evaporation, $E_0$ - is evaporation, $\psi(w)$ - soil humidity function. According to the given dependence, the dependence parameters of humidity provision and yield of main cultures have been defined. It has been determined that during the grape vegetation period in Georgia, the lower index of optimal soil humidity ranges from 60 to 80%, for citrus this index is – 65-90%, for tea -75-95%, for maize – 60-85% [6].

## Conclusion

On the basis of landscape analysis and material obtained after the field research works [7], three districts and 7 agro-zones have been distinguished in Western Georgia (Table 3) with appropriate regions classed according to humidity rate.

Thus, the researched region landscapes have great agroresource potential which was determined by complex analysis of the quantitative and qualitative indices of agroclimate resources and soil fertility and structural peculiarities. In spite of the fact that Western Georgia is one of the most utilized regions of the country and well researched in agroclimatic respect, aiming at optimal utilization of its agroresources and at better arrangement of nature protection and ecologic issues, we think it will be reasonable if scientific analysis of natural and anthropogenic transformation of all agrolandscape modifications are carried out by using modern research methods. These activities will reveal its agroresource potential in many respects and encourage agrosystem structural stability and improve the ecological situation.

*ფიზიკური გეოგრაფია*

# დასავლეთ საქართველოს ბუნებრივ-რესურსული პოტენციალი და აგროლანდშაფტების ტერიტორიული ორგანიზაცია

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**სტატიაში კვლევის თანამედროვე მეთოდების გამოყენებით ჩატარებულია დასავლეთ საქართველოს აგროკლიმატური რესურსების, მათ შორის ნიადაგის ნაყოფიერების და სტრუქტურული თავისებურებების**

რაოდენობრივ-ხარისხობრივი მაჩვენებლების კომპლექსური ანალიზი. შესწავლილია ამ რეგიონის აგროლანდშაფტების თითქმის ყველა მოდიფიკაცია და შედგენილია აგროკომპლექსების ტერიტორიული ორგანიზაციის ახალი მოდელი, რაც შესაძლებლობას იძლევა სრულად გამოვლინდეს აგროსარესურსო პოტენციალი და ხელი შეეწყოს როგორც აგროსისტემის სტრუქტურულ მდგრადობას, ისე ეკოლოგიური მდგომარეობის გაუმჯობესებას.

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