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## ESTIMATION OF AGROCLIMATIC POTENTIAL OF MTSHETA-MTIANETI REGION

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Aiming at further developing of the agrarian sector in Mtskheta-Mtianeti region, the agro-climatic resources on the given location must be used efficiently. This will further increase the production volume of cereal crops, vine, fruit trees, vegetables and cucurbitaceous possible to reach only by using the scientifically proved agro-climatic resources efficiently.

Based on the data of many-year meteorological observations of the vegetation period on the territory of Mtskheta-Mtianeti region [1, 2] the agro-climatic indexes in the given region were calculated (Table 1).

**Table 1. Agro-climatic Indexes in the Warm Period (IV-X)**

| Meteo-station (district) | Active temperature sums, (°C) | Atmospheric precipitation sums, (mm) | Relative air humidity, (%) | Deficiency of air humidity, (mb) | Period of without frost days | Hydrothermal coefficient |
|--------------------------|-------------------------------|--------------------------------------|----------------------------|----------------------------------|------------------------------|--------------------------|
| Gudauri                  | 1140                          | 970                                  | 75                         | 8.2                              | 118                          | 8.5                      |
| Dusheti                  | 3050                          | 500                                  | 70                         | 12.4                             | 203                          | 1.6                      |
| Tianeti                  | 2560                          | 580                                  | 76                         | 12.0                             | 179                          | 2.2                      |
| Kobi                     | 1370                          | 760                                  | 72                         | 8.4                              | 124                          | 5.5                      |
| Mukhrani (Mtskheta)      | 3470                          | 390                                  | 69                         | 13.4                             | 194                          | 1.1                      |
| Sioni                    | 2490                          | 520                                  | 77                         | 12.2                             | 178                          | 2.1                      |
| Kazbegi                  | 1520                          | 570                                  | 71                         | 8.9                              | 154                          | 3.7                      |
| Qvesheti                 | 2280                          | 800                                  | 73                         | 10.9                             | 170                          | 3.5                      |
| Tsinkhadu                | 1570                          | 800                                  | -                          | -                                | 146                          | 5.0                      |
| Pasanauri                | 2570                          | 670                                  | 73                         | 10.3                             | 159                          | 2.6                      |

The indicators given in the table are typical for the moderate climate at 1000-1400 m altitude above sea level, where cucurbitaceous or vine (late) up to 1000 m altitude, grain corn up to 1200 m altitude, early vine up to 1300 m altitude, winter cereal crops, vegetables and fruit trees up to 1500 m altitude can be grown. Less warm-requiring crops, mostly vegetables, berries, juicy forage root crops for cattle can be grown at 2000 m or at higher altitudes, where the areas can also be used as hay-fields or pastures. Up to 1000 m altitude above sea level, in the vegetation period, the water balance does not exceed 1.6. Therefore, the soil humidity must be increased to ensure normal development and productivity of different crops (in particular, 2- or 3-time irrigation in Mtskheta district is required and irrigation in Dusheti district once or twice is needed).

Below we give the indicators of supply of active temperatures sums to estimate the heating regime (Table 2).

**Table 2. Provision by Active Temperature Sums, ( $\geq 10^{\circ}\text{C}$ )**

| Meteo-station (district) | Provision, (%) |      |      |      |      |      |
|--------------------------|----------------|------|------|------|------|------|
|                          | 10             | 30   | 50   | 70   | 90   | 95   |
| Gudauri                  | 1440           | 1270 | 1140 | 1010 | 810  | 750  |
| Dusheti                  | 3400           | 3170 | 3050 | 2910 | 2720 | 2660 |
| Tianeti                  | 2860           | 2670 | 2560 | 2420 | 2250 | 2140 |
| Kobi                     | 1670           | 1480 | 1370 | 1240 | 1050 | 970  |
| Mukhrani (Mtskheta)      | 3780           | 3570 | 3470 | 3340 | 3180 | 3060 |
| Sioni                    | 2790           | 2620 | 2490 | 2360 | 2170 | 2050 |
| Pasanauri                | 2860           | 2720 | 2570 | 2430 | 2250 | 2140 |
| Khazbegi                 | 1820           | 1640 | 1520 | 1440 | 1190 | 1110 |
| Qvesheti                 | 2600           | 2410 | 2280 | 2140 | 1960 | 1850 |
| Tsinkhadu                | 1870           | 1680 | 1570 | 1430 | 1250 | 1140 |

In terms of the said temperatures sum, vegetables and cucurbitaceous, vine, fruit trees and other crops will be quite well supplied up to 500-800 m altitude above sea level. Up to 1500-1700 m altitude above sea level, it is possible

to grow cereals, vegetables, vine (early, at 1300 m asl) and fruit trees. At higher altitudes, up to 2200-2300 m above sea level, winter wheat (up to 2000 m asl) as well as winter and spring barley, oats, vegetables and berries can be produced. Different crops have different demands for the temperatures sum what must be considered when expanding the industrial areas of crops distribution.

The forecast regression equations to calculate the provision of the sum of temperatures needed for the vegetation crops in the vegetation period are drafted [3]:

$$\sum T = -11.9n + 3692 \text{ for Dusheti (1),}$$

$$\sum T = -14.8n + 2942 \text{ for Tianeti (2),}$$

$$\sum T = -15.9n + 4232 \text{ for Mtskheta (3),}$$

$$\sum T = -12.6n + 2110 \text{ for Kazbegi (4).}$$

In the equations,  $T$  - is the active temperature sum above  $10^{\circ}\text{C}$ ,  $n$  - is the number to of days from march 1 for Dusheti, Tianeti, Mtskheta districts, and may 1 for Kazbegi district to the date when the temperature rises over  $10^{\circ}\text{C}$ .

The sum of temperatures calculated with the equations allows estimating the degree of supply of the area in the region with the temperatures sum in the current year. Provided the forecast sum of temperatures exceeds the average temperatures sum of the given district by  $200^{\circ}\text{C}$  or more (alongside with due soil humidity), the development of the agricultural crops will be more guaranteed in the vegetation period.

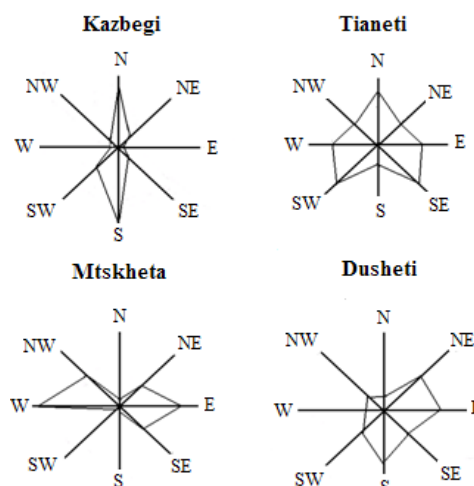
Atmospheric precipitations play an important role in boosting the production and productivity of agricultural crops at the farms of the region. In spring (IV-V), the amount of atmospheric precipitations is sufficient for crops growing up to 2000 m altitude above sea level (70-160 mm), and it is even more above that altitude (140-190 mm); however, the amount of atmospheric precipitations is less at lower altitudes and amounts to 50-100 mm below 1000 m altitude above sea level. In the active vegetation period, up to 1000 m altitude, due to little precipitations, normal development of agricultural crops needs 2- or 3-time irrigation, or soil cultivation and loosening to ensure the needed amount of humidity for the agricultural crops (particularly, annual crops). Above 1000 m altitude above sea level, the same measures may be needed in some years only.

The height of the snow cover above 500-700 m altitude above sea level in the region allows the wintering of the winter crops (in terms of  $-24^{\circ}\text{C}$ ,  $-26^{\circ}\text{C}$ ). Below this altitude, with a thinner snow cover (1-3 cm) and lower temperature ( $-18^{\circ}\text{C}$ ,  $-20^{\circ}\text{C}$ ) (in Mtskheta for instance), the conditions hardly allow wintering of winter crops.

As for dangerous meteorological phenomena, the territory of the region is not secured against droughts of different intensities. For example, the probability of droughts of little intensity occurring every year is 100%, while it is 50-60% for the droughts of average intensity in Tianeti district, 100% in Mtskheta district and 80% in Dusheti district. Intense drought (lasting for 4 or 5 days) in the vegetation period may be the case in Mtskheta district and intense droughts lasting for 1 or 2 days are possible in Dusheti district. Intense droughts are mostly the case in the vegetation period (VI-VIII) below 1000 m altitude. Therefore, the agricultural crops and particularly, cereal crops, vegetables and cucurbitaceous, etc. need improved soil humidity (by means of 2- or 3-time irrigation, soil cultivation and loosening), while perennial plants need soil irrigation once or twice to rescue the harvest.

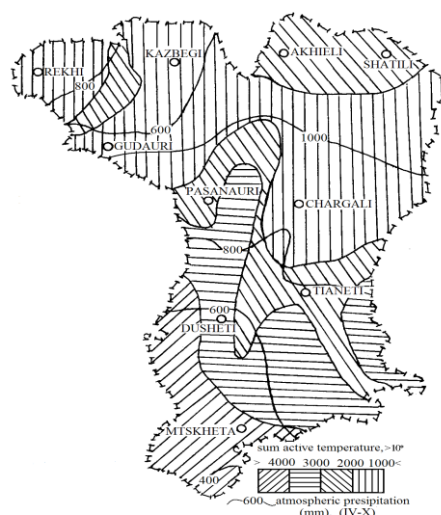
The days with strong winds ( $\geq 15$  m/sec) up to 1000 m altitude above sea level are not a rarity and are most common in Mtskheta and Dusheti districts. Wind has a negative impact on the agricultural crops and reduces the harvest by 30-40% or more. The analysis of the observations over the winds shows that the greatest number of the days with strong winds in the warm period (IV-X), in spring, is fixed in Mtskheta district, which is followed by Tianeti and Dusheti districts. Therefore, up to 1000 m altitude, in the summer vegetation period, annual and perennial crops need irrigation once or twice or even more often. Up to 2000 m altitude above sea level and higher, the same measures are needed in some years only in terms of little atmospheric precipitations.

Strong winds can be alleviated by means of wind break belts giving favorable microclimatic conditions for the agricultural crops to develop. Below we give the diagram of dominating wind directions (Fig. 1).



**Fig. 1. Wind Directions in the Warm Period (IV-X)**

An agro-climatic map based on the daily average air temperature of over 10°C and sum atmospheric precipitations (in warm periods) in Mtskheta-Mtianeti region is drafted (Fig. 2). There are four zones identified in the map.



**Fig. 2. Agro-climatic Zones of Mtskheta-Mtianeti Region**

In the I zone, the sum of active temperatures is 4000°C to 3000°C. The given zone is located at 500 m to 1000 m altitude above sea level. The sum of atmospheric precipitations in the warm period is 390-500 mm. The last frosts are observed from 13.IV to 23.IV on average, at 500 m and 1000 m above sea level, respectively. The first frosts at the same altitudes are observed from 27.X to 3.XI, respectively. Cereals, vegetables, cucurbitaceous, vine (early, of average ripeness and late), fruit trees and other cultures can be successfully produced here.

In the vegetation period (IV-X), the given zone is not sufficiently supplied with atmospheric precipitations. Therefore, rich and guaranteed harvest is possible to gain (particularly, in the active vegetation period (VI-VIII) by means of 2- or 3-time irrigations of annual crops mostly and soil loosening.

The II zone spreads at 550 m to 1200 m altitude above sea level. The sum of active temperatures is 3000°C to 2000°C and sometimes more. The sum of atmospheric precipitations in the warm period is 400-700 mm. The last frosts are observed from 13.IV to 23.IV on average, at 550 m and 1200 m above sea level, respectively. The first frosts at the same altitudes are observed from 22.X to 3.XI, respectively.

Cereals, vine (early and of average ripeness) and vegetables can be grown in the given zone. Soil irrigation (once or twice) or soil loosening in some years, particularly in the VI-VIII months is desirable in the given zone.

The III zone is located at 1000 m to 1800 m altitude above sea level. The sum of active temperatures above 10°C is 2000°C to 1000°C. The sum of atmospheric precipitations in the warm period is 600-800 mm. The last frosts are observed from 28.IV to 12.V on average, as the altitude above sea level increases. The first frosts are observed from 15.X to 3.XI, respectively, with the increased altitude above sea level. Growing capacity of continental fruit trees is limited to a certain extent in the given region. However, early crops can be grown favorably. Barley, rye, oats, vege-

tables, potato, spicery and aromatic crops can be grown here successfully. Besides, the given zone offers favorable conditions to grow root crops needed in cattle-breeding or use the area as hey-fields and pastures.

The IV zone is located 1200m to 2000 m altitude above sea level and a bit higher. The sum of active temperatures above 10°C is less than 1000°C. The sum of atmospheric precipitations in the warm period is 800-1000 mm. The frosts end from 28.IV to 9.VI on average. The first frosts are observed from 3.X to 21.X. Potato, vegetables, cauliflower and early cabbage can be grown in the given zone. It is also possible to grow berries and root crops needed in cattle-breeding or use the area as hey-fields and pastures.

### ლიტერატურა - REFERENCES – ЛИТЕРАТУРА

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3. Meladze G.G., Meladze M., G. Agro-climatic Resources of Western Regions of Georgia. Publ. „Universal”, Tbilisi, 2010, p.293

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**მცხეთა-მთიანეთის რეგიონის აგროკლიმატური პოტენციალის შეფასება** /მელაძე მ.გ., მელაძე გ.გ./ საქართველოს ტექნიკური უნივერსიტეტის ჰიდრომეტეოროლოგიის ინსტიტუტის შრომათა კრებული-2013.-ტ.119.-გვ.-87-90 ინგლ., რეზ. ქართ., ინგლ., რუს.

შეფასებულია აგროკლიმატური რესურსები და მათი ეფექტურად გამოყენება აგროკულტურების მაღალი პროდუქტიულობისათვის. მრავალწლიური მეტეოროლოგიური დაკვირვებების მაჩვენებლების მიხედვით, სავეგეტაციო პერიოდისათვის (IV-X) გამოთვლილია აგრომეტეოროლოგიური მახასიათებლები (აქტიურ ტემპერატურათა ჯამი >10°, ატმოსფერული ნალექების ჯამი (მმ), ჰაერის შეფარდებითი ტენიანობა (%), ჰაერის ტენიანობის დეფიციტი (მბ), უყინვო პერიოდის ხანგრძლივობა, ჰიდროთერმული კოეფიციენტი). შედგენილია ჰაერის აქტიურ ტემპერატურათა ჯამებით უზრუნველყოფის ცხრილი. განხილულია აგროკულტურებისათვის არახელსაყრელი მეტეოროლოგიური მოვლენები. დადგენილია გაბატონებული ქარების მიმართულებები, ქარსაფარი ზოლების გაშენების მიზნით. გამოყოფილია აგროკლიმატური ზონები შესაბამისი აგროკულტურების გავრცელებისათვის.

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The agro-climatic resources and their efficiency use for the crops productivity have been evaluated.

According to materials of the long-term meteorological observations are calculated corresponding of agrometeorological indices (sum of air temperatures >10°, sum of atmospheric precipitations (mm), relative air humidity (%), deficiency of air humidity (mb), number days of without frost period, hydrothermal coefficient) for the vegetation period (IV-X) are presented. Table representing provision by sum of active temperatures are given. The estimation of dangerous meteorological phenomena for agricultural crops is considered. Directions of prevailing winds are established in order to plant shelter wind belts. Agro-climatic zones for propagation of corresponding crops are selected.

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**ОЦЕНКА АГРОКЛИМАТИЧЕСКОГО ПОТЕНЦИАЛА РЕГИОНА МЦХЕТА-МТИАНЕТИ.** /Меладзе М.Г., Меладзе Г.Г. /Сб. Трудов Института Гидрометеорологии Грузинского Технического Университета Грузии. -2013.-т.119.-с.87-90 - Англ., Рез. Груз., Англ., Рус.

Оценены агроклиматические ресурсы и их эффективное использование для высокой продуктивности сельскохозяйственных культур. Представлены рассчитанные по материалам многолетних метеорологических наблюдений, соответствующие агрометеорологические показатели (сумма температур воздуха >10°, сумма атмосферных осадков (мм), относительная влажность воздуха (%), дефицит влажности воздуха (мб), число дней безморозного периода, гидротермический коэффициент) для вегетационного периода (IV-X). Составлено таблица обеспечения сумм активных температур воздуха. Дана оценка опасных метеорологических явлений для сельскохозяйственных культур. Установлены направления господствующих ветров с целью создания ветрозащитных полос. Выделены агроклиматические зоны для распространения соответствующих сельскохозяйственных культур.