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Regionalisation of microclimate resources

P. Karing

Euroacademy, Estonia

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Abstract

There are a number of methods used to characterise the microclimate resources in constant flux and significantly affected by man. One of the most popular among them is mapping the differences of microclimate and estimating the climatic resources on the basis of those maps. In most general terms, the changeability of microclimate in a given territory is reflected on maps drawn for defining into regions of the microclimate.

When estimating the microclimate resources, it makes sense to separately consider the global, meso- and microclimatic differences, which technique provides for more detailed description of the share of microclimate in formation of climatic resources of the landscape surveyed.

In Estonia, the research of microclimate has been long in the order of the day. As a result of that work, original methods have been elaborated for mapping the microclimate with computers, and vital recommendations have been issued for use of the microclimate resources in practice.

Keywords: microclimate resources, Estonia

Introduction

The life activity of man carries on in the lower part of atmosphere, in the air layer proximate to Earth. Here, the specificity of climatic conditions is conditional of soil and its structure and of the overall climatic background. There are several methods used to characterise those microclimate's specificities alternating within short intervals, being subject to significant impacts wrought by man. A most recurrent among those methods is mapping differences of microclimate and estimating the climatic resources basing on those maps. Most generally the changeability of microclimate in a territory surveyed is characterised by the maps of defining into regions of the microclimate.

In various parts of the Globe the formation of microclimate and the extent of its impacts is widely variable (Sapožnikova S.A 1950; Geiger,R., 1965; Gol'cberg I.A.,1961; Romanova, et al, 1983, etc.). In Estonia, occurrence of differences in microclimate and their size are mainly determined by geographical location of a territory and by landscape structure of the soil.

Estonia is situated on the eastern shore of the Baltic Sea, bordering on three sides on an open waterline. Estonian territory is like an extensive peninsula of variegated landscape features wedged between the southern shore of Gulf of Finland and the eastern shore of Bay of Riga. As visualised from the viewpoint of formation of microclimate, the territory is situated in the area of lowlands, featuring a sloping relief and large differences in mechanical composition of earth (Gol'cberg, 1967).

Landscape-wise the soil is diverse. Factors giving shape to woodlands, agricultural lands, marshlands, inner water reservoirs and other natural landscape features are changing constantly in the territory. Hamlets and boroughs, industrial objects, improved lands and other factors born from human activity and exerting vast influence on microclimate, gain increasing weight.

Material and methods

The meteorological indicator measured in an

Corresponding author: P. Karing, Euroacademy, 4 Mustamäe Rd, 10621 Tallinn, Estonia.
E-mail: peeter.karing@eurouniv.ee

observation point characterises the general climatic background (zonal background), meso- and microclimate.

$$X_i = X_ü + X_{mes} + X_{mic}, \quad (1)$$

where X_i - size of meteorological indicator measured in an observation point,

$X_ü$- characteristic of general climate background (zonal background),

X_{mes}-characteristic of mesoclimate,

X_{mic}-characteristic of microclimate.

Parameters used for quantitative estimate of microclimate are often referred to in literature as microclimate's correction (Gol'cberg, 1967) or microclimate's variability (Romanova et al, 1983). In this work, the value Xmic has been calculated after the equation:

$$X_{mic} = X_i - (X_ü + X_{mes}) \quad (2)$$

By reference to equation (2), the microclimate's characteristic is equal to the difference between the measured size and zonal background and the sum of mesoclimate's characteristics.

In Estonia, the network of meteorological surveys is rather dense and therefore it is possible to assign to every mesoclimate unit a typical meteorological observation station.

Microclimate's data have been collected in the process of field work especially organised for that end.

Results and discussion

Compilation of maps of microclimate is a labour-intensive and time-consuming process. In Estonia, quite a few maps have been drawn by hand, designed for agricultural lands and focussing on frost hazard and thermal resources. For research purposes, in various parts of Estonian territory there have been compiled the maps on earth temperature and humidity, solar radiation, transpiration, productivity of crops, impacts of land improvement and melioration etc. Analysis of those maps has shown that the specificities of microclimate have predominantly been caused by some prevailing factors, notably by ground relief, vegetation, soil and human activity.

Changes in microclimate arising of impacts of ground relief have met with most interest and they have therefore been widely studied. Declination and orientation of slopes influence the rate of influx of solar radiation. Relative height, disposition and dimensions of landscape cause change in wind parameters, and thermal and humidity conditions.

Prominent among impacts of vegetation are the height of plant canopy, thickness, bio-mass and its vertical distribution and composition by species. In Estonia, the influence of woods on microclimates holds a special place (Pork, et al; 1978; Лдпе et al:, 1979; etc.) Those factors determine the intake of radiation, formation of vertical profiles of air temperature and humidity, and water intake.

Thermal and humidity regime of soils forms under impact of their mechanical composition, thermal and physical properties, density of bedding, capillarity and other properties.

Anthropogenic impacts are versatile. By construction of reservoirs, building of settlements, by implementation of melioration techniques (Romanova et al, 1983; Jxgi, 1982, etc.), the properties of subsoil are changed, bringing about the change in meteorological regime of near-earth air layer.

For finding the size X_{mes} different methods can be used. Figure 1 depicts Estonian mesoclimatic definition into regions (Karing, 2004). In every mesoclimatic unit it is possible to determine the value of X_{mes} necessary to process microclimate data.

Underlying the microclimatic definition into regions are the maps of microclimate elements. In Estonia, the parameters of microclimatic changeability of meteorological regime are determined by special observations or for wider territories, by way of regionalising the characteristic data.

Compilation of microclimate maps on various weather elements or their combinations is a fairly demanding job. Mapping of various microclimatically sensitive indicators however is by and large similar, as to methods used. For that reason it could well be effectuated with the help of computers (Karing, 1979; Karing, 1973, 1995; Metsur, 2005).

For compiling maps of microclimate definition into regions, it is necessary to construct, basing on various indicators, the microclimate complexes in every point under survey. For that purpose, the maps of individual elements of microclimate have been transposed onto one basis, generating a series of microclimate complexes, where all meteorological indicators are located within fixed boundaries, according to gradations used to characterise the weather elements.

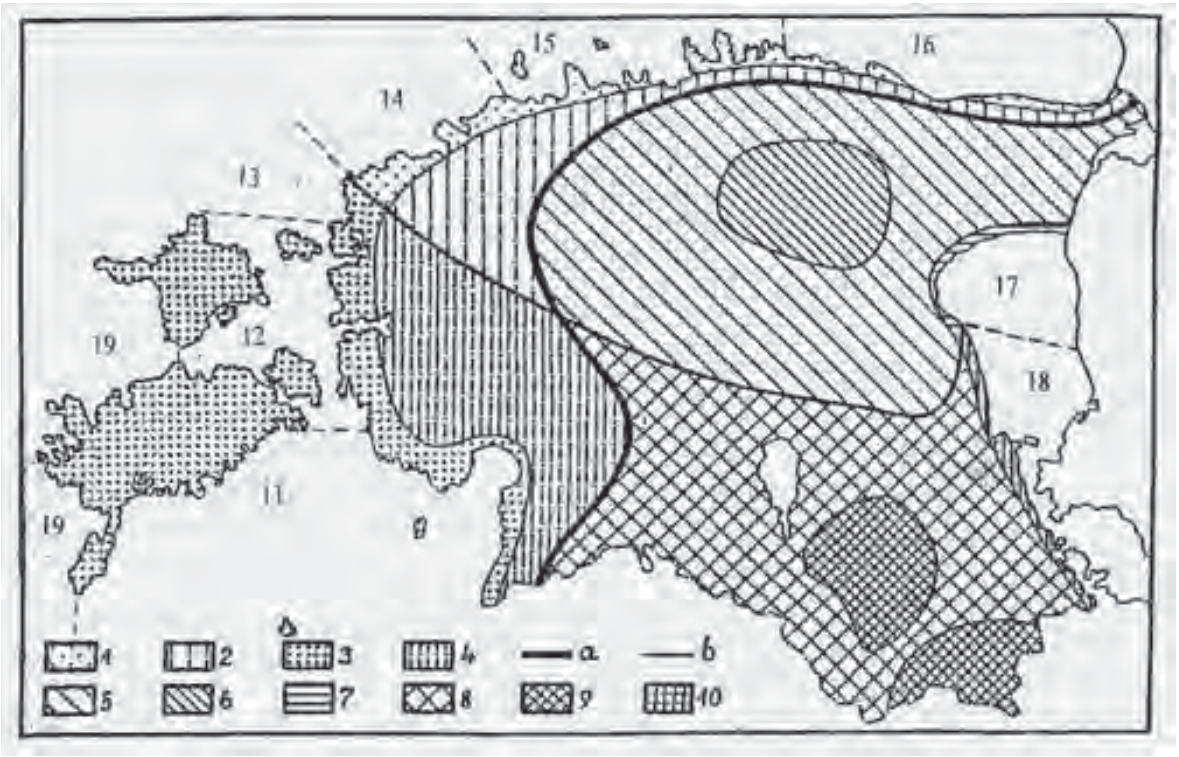

Figure 1. Territorial distribution of units of mesoclimate: a-border line between the Baltic Sea and continental subareas, b-border line between North-Estonian and South-Estonian regions. The Baltic Sea subarea. North-Estonian region. Sub-regions: 1. Coastal land, 2. North-Estonian plain; South-Estonian region. Sub-regions: 3. Coastal land, 4.West-Estonian lowland; Continental subarea. North-Estonian region. Sub-regions: 5. North-Estonian plain, 6. Pandivere, 7. Peipsi's northern coast. South-Estonia region. Sub-regions: 8. South-Estonia's plain, 9. Otepää and Haanja highlands; 10. Peipsi's South-West coast. Coastal sea: 11. Bay of Livonia's northern part, 12.Väinameri, 13. Gulf of Finland southern coast's western part; 19.The Baltic Sea, open parts. Coastal sea: 14. Gulf of Finland southern coast's North-Western part; 15. Gulf of Finland southern coast's central part; 16. Gulf of Finland southern coast's eastern part. Lake Peipsi: 17. Northern part; Lake Peipsi: 18. Southern part

Basing on map material describing natural conditions (Raudsepp, 1971; Metsur, 2005; et al) (Base map of Estonia, soil and landscape maps etc.) and microclimate complexes, microclimate elementary areas have been isolated. Those are the landscape parts, where physical properties of the potent layer are similar; within confines of that area, a microclimate of analogous indicators forms.

For definition into regions of microclimate of a territory under survey, it is necessary to classify the microclimate elementary areas by criteria incidental to the tasks set. The differences in microclimate in the area under survey are characterised most generally by classifications, basing on automatic classifying of microclimate data.

For obtaining a general estimation on microclimate's variability in Estonia, a polygon has been selected in the hillocky area of South-Estonia, to study the microclimate's specificities. It has been the site for detailed field surveys, resulting in a series of different microclimate maps.

To find the microclimate complexes in different landscape parts, a complex map of four microclimate sensitive indicators has been drawn. Those indicators are maps of solar direct radiation sums (S), frost hazard (T), soil temperature (Tm) and humidity (W). Adding new indicators to the list of complexes has not appeared to make major changes.

For classifying microclimate complexes, algorithm „Optimum cycle" has been used (Nikolaev, 1976).

Fig. 2 depicts an example of a map's fragment on definition into regions of the hillocky area of South Estonia. For easier handling of the map, also recorded have been approximate borders of microclimate elementary areas.

Analysis and generalising of the material collected reveals that in Estonia, the differences of mi-

croclimate should be characterised most generally by four independent microclimate types.

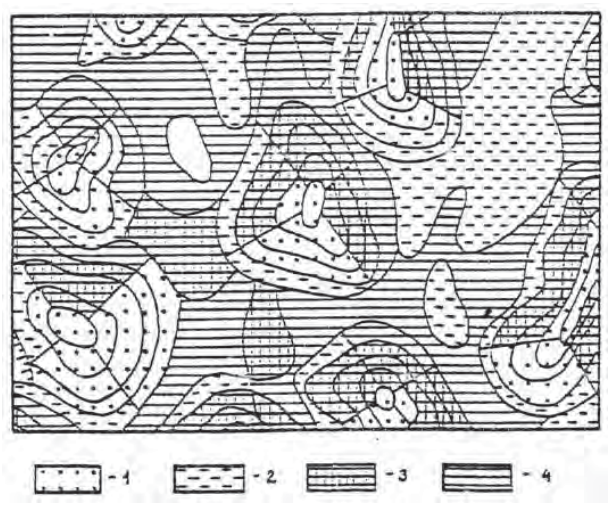

Figure 2. Fragment of map of definition into regions of microclimate: 1-Warm and dry microclimate, 2-Moderately warm and dry microclimate,3-Moderately cold and humid microclimate,4-Cold and humid microclimate.

The warmest and driest are upper parts of the slopes, and on plains, the light soils of mechanical composition. Areas of moderately warm and relatively drier microclimate are situated on different relief parts of light soils and on level areas of light soils. Areas of moderately cold and humid microclimate are situated on northern slopes of different mechanical composition and on level areas of sandy clay and argillaceous soils. Areas of cold and humid microclimate are to be found on level areas of moist soil and on some parts of the slopes of heavy soil.

The major factor forming differences of microclimate on hillocky area is the ground relief, on level areas it is the mechanical composition of soil.

Climatic resources of microclimate are usable in various ways of life, in particular in agriculture (Pxiklik, 1973; Kivi K. 1980; Int,. 1985; Karing, 1995 etc.). Endemic to microclimate's differences is their wide variability therefore solution of every given case calls for an individual approach.

Conclusions

1. When estimating microclimate resources it is practical to consider separately the global, meso-microclimatic differences. Such avenue of approach enables more detailed characteristics of the share of microclimate in formation of climatic resources of the landscape under scrutiny.

2. There is a host of micro-climatically sensitive indicators of climate. Compilation of maps for all indicators and their complexes, and their analysis is labour intensive. It is rational to solve those issues with computers. In the process of long microclimate survey works performed in Estonia, there has been elaborated a respective approach and methods.

3. Specificities of microclimate in Estonia in most general terms are to be characterised as four individual microclimate types: warm and dry; moderately warm and dry; moderately cold and humid; cold and humid.

4. The major factor dictating formation of differences in microclimate on a hillocky area is the situation on ground relief, and the mechanical composition of soil on a level area.

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