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GLOBAL RADIATION IN THE SIRET CORRIDOR. A SPATIAL DISTRIBUTION ANALYSIS USING GIS METHODS

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Abstract: The lack of radiometrical observations across Moldavia represents an obstacle for a direct interpolation of this element, so that the GIS techniques are helping us to realize the spatialization using regression equation which are based on astronomical (insolation ratio, transparence factors etc.) and also local elements (exposition, slope etc. derivated from numerical model). In this study we have tried an evaluation using two methods - Angström formula and Kämfert-Morgan nomogram, the first one indicates a much more classical distribution of the global radiation, while the second one overestimates the role of slope's exposition.

Keywords: *sunshine duration, Angström formula, Kämfert-Morgan nomogram*

Because there are only a few meteorological stations in Moldavia concerning the radiometry observations – Iaşi and Galați – the evaluation of radiative input is realized through very different methods. In this study we have applied Angström formula and Kämfert-Morgan nomogram.

Spatialisation using the Angström formula

The Angström formula integrates more elements, as it follows (Patriche C.V., 2005):

$$R_g = R_a\left[a + b\frac{n}{N}\frac{\sin(h_m \pm \alpha)}{\sin(h_m)}\right]$$

where

- α : slope's angle;
- h_m : the medium solar angle of inclination according to terrestrial surface which is evaluated by using the latitude (φ) and the number of days during a year (J) within formula (Allen et al., 1998):
  $\sin(h_m) = \sin[0{,}85 + 0{,}3\ \varphi \sin(2\pi\ J/365 - 1{,}39) - 0{,}42\ \varphi^2]$
- n/N : is the insolation ratio indicated by the ration between effective and astronomical sunshine duration;

- a, b: coefficients of qualitative global radiation; they are estimated by using Köppen and Geiger climatical classification; for Siret Corridor they have values like – a=0.25, b=0.5.

From the elements above the biggest problem is generated by the insolation ratio (n/N), so, primery we have generated a raster for this region with effective sunshine duration. First, to realize a spatialization for the sunshine duration along Siret Corridor, we have considered the relations between sunshine duration and altitude in Moldavian Plateau (fig. 1), using the yearly average values from 14 meteorologica stations. The regional differences within Moldova are a combined result of latitudinal position and altitude of the meteorological stations but we don't have neglect of the role of frequency oceanic and arctic air masses in the northern parts of the regions (Gugiuman I., 1970).

Using the altitudinal lapse rate characteristic for Moldova, we have obtained the spatial distribution of sunshine duration in Siret Corridor (fig. 2). So that, the yearly values are between 1500 hours, in the regions with more than 400 m altitude (Siret-Răcăciuni hilly region, Pietricica and the hills between Siret and Bârlad). In the southern corridor, the yearly average amounts are more than 2000 hours in Siret's lowlands and terraces; we have maximal values of more than 2100 hours in very limited areas like the south of Sascut.

For the astronomical sunshine duration we have created a second raster according to regression estimated on the base of astronomical tables.

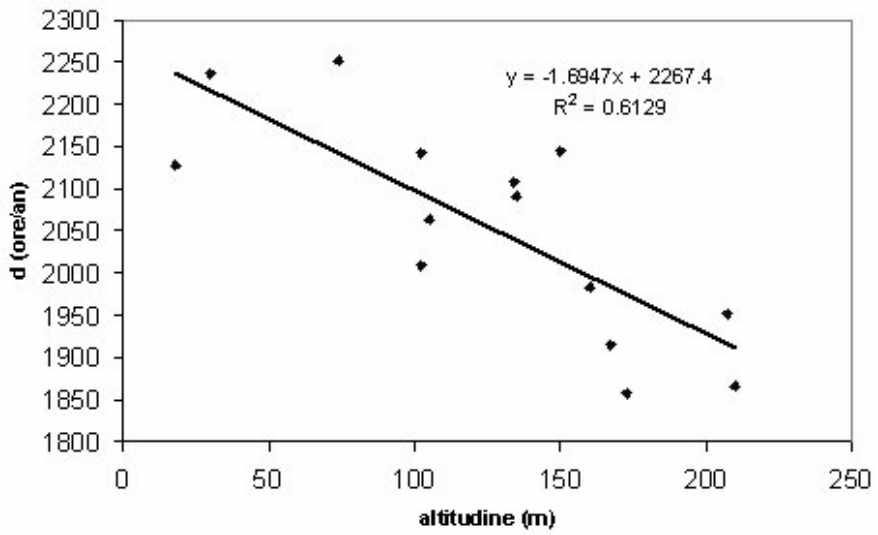

Figure 1. *Correlation between sunshine duration and altitude in Moldavian Plateu*

Integrating all those factors according to Angström formula we have realized a spatial distribution of global radiation within Siret Corridor with the help of TNT Mips software.

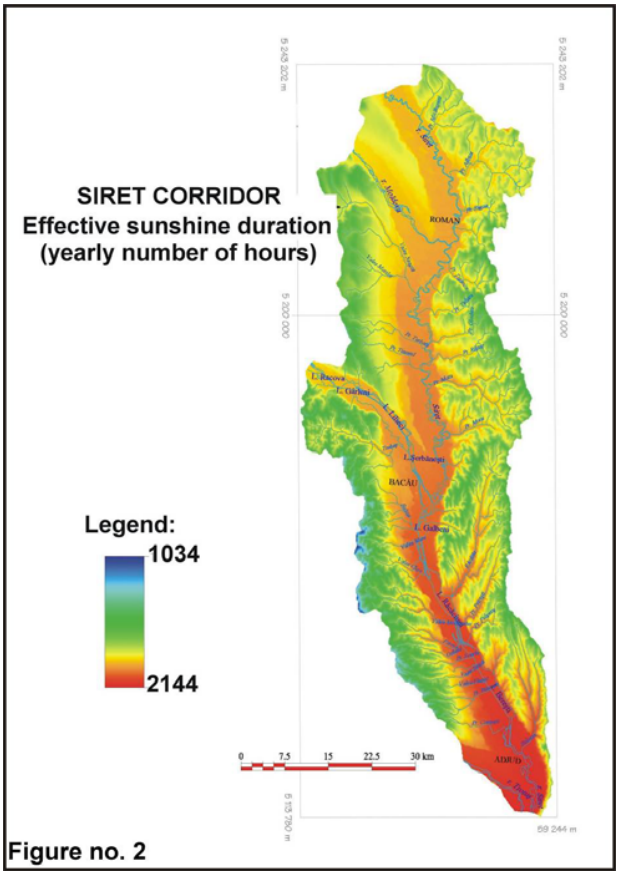

Figure no. 2

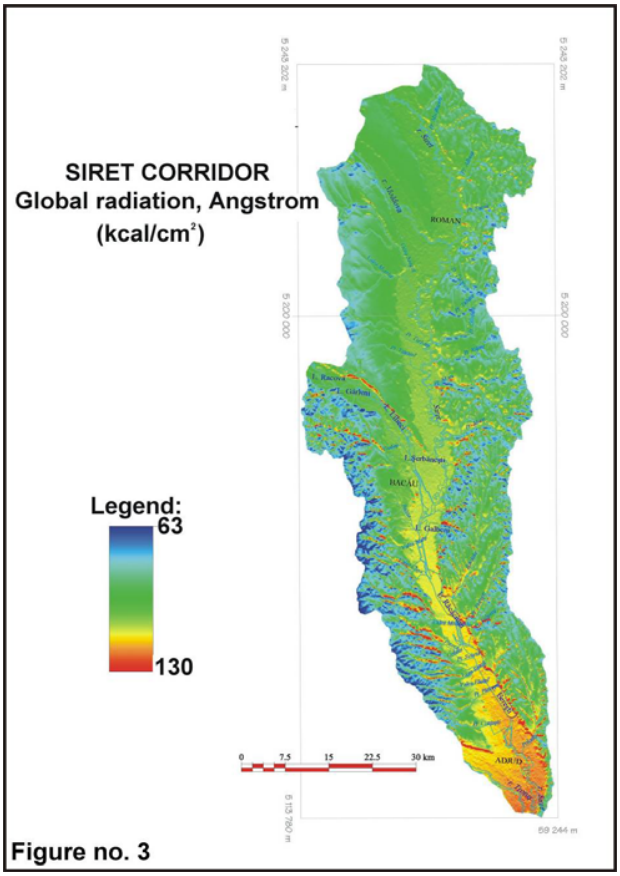

Figure no. 3

The obtained distribution of global radiation (fig. 3) demonstrates the role of those two important factors included in the radiative input: the latitude who managed the astronomical sunshine duration and morphological characteristics showed by slope and exposition of terrestrial surface. Considering all these characteristics we can conclude more aspects for global radiation distribution according to Angström formula:

- decrease of global radiation values from north to south, from more than 110 kcal/cm² in the south, from the junction of Siret and Trotus , until below 105 kcal/cm² in the northern area of Roman. In this region we can notice also the raised values from terraces foreheads with southern orientation wich has a reception of more than 115 kcal/cm²;

- the slopes orientation is also very important; the values are different with almost 10-15 kca/cm² between northern and southern expositions. This distribution is a characteristic for these areas with east-west orientation as

Coastele Icuşeştilor or Petricica. So that, on the slopes with southern orientation we have 105-110 kcal/cm² and on the northern orientation we have 90-95 kcal/cm².

Spatialisation using the Kämpfert-Morgen nomogram

To estimate the global radiation according to exposition and slope's angle, we can use also Kämpfert-Morgen nomogram. This nomogram (fig. 4) has been esspecialy used to appreciate the solar radiation in temperate latitude. By analyzing it we can reach the regressions which use to determinate the modifications of global solar radiations intensity in strong connection with exposition and slope's values. So that, comparing with horizontal surfaces, the one with southern and south-eastern orientation are receiving more radiation (fig. 5).

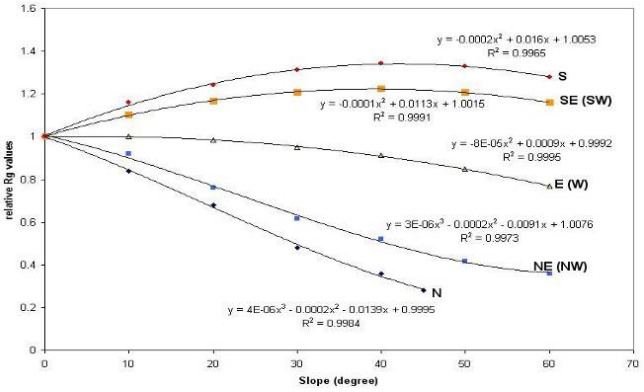

Figure 4. *Polynomial regression between global radiation – slope and slope's exposition according to Kämpfert-Morgen nomogram (modified by Patriche C. V., 2005)*

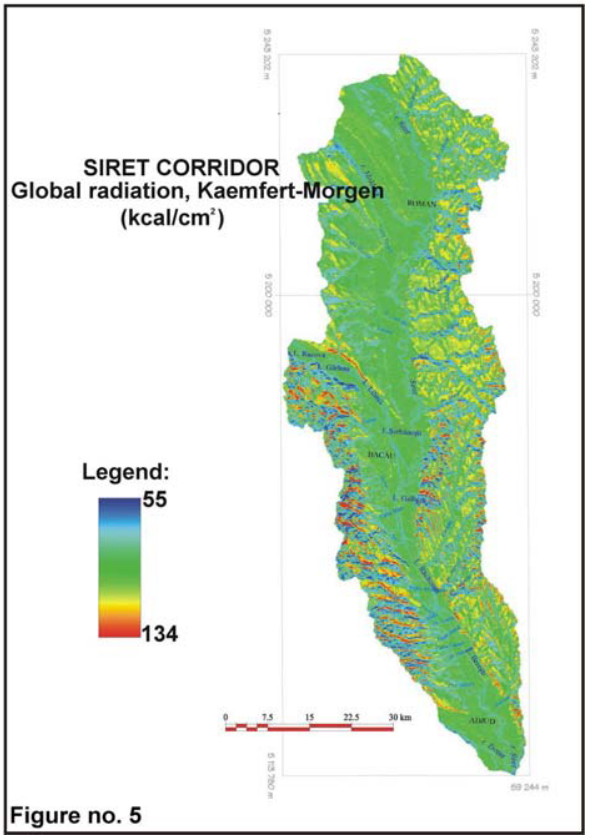

Figure no. 5

Brief conclusions

To make a spatialization of global radiation using Kämpfert-Morgen nomogram is very different by that obtained by using Angström formula. This method determinates an overestimation of the radiative input from the level of

the southern slopes which are indicates through values which usually can reach 125 kcal/cm² while the terraces and lowland areas of Siret not more than 110-115 kcal/cm².

This overestimation of the radiative input is characteristical for the average values also from the entire region. So that if according to Angström formula, this values is 102 kcal/cm² (with a standars deviation of 5 kcal/cm²), according to Kämpfert-Morgen nomogram this values is 106 kcal/cm².

References

Buiuc M, *Estimarea radiației solare pe teritoriul României*, Stud. şi cercet.„Fundamentarea meteorologică şi hidrologică a resurselor energetice neconvenționale", I.M.H, Bucureşti, 1984.

Gugiuman I, *Câteva observații referitoare la durata de strălucire a Soarelui pe cer în partea de est a României*, Analele Ştințifice ale Universității „AL. I. Cuza", secț. II, c., Geografie, Tom XVI, Iaşi, 1970.

Oprea C, Costache, M, *Climatul radiației solare în Moldova*, Romanian Journal of Climatology, vol.I, Iaşi, 2005.

Neacşa O., Susan Viorica, *Unele caracteristici ale duratei strălucirii soarelui deasupra teritoriului României*, Stud. şi cercet. „Fundamentarea meteorologică şi hidrologică a resurselor energetice neconvenționale", I.M.H, Bucureşti, 1984.

Patriche C. V, *Podişul Central Moldovenesc dintre râurile Vaslui şi Stavnic- studiu de geografie fizică*, Editura „Terra Nostra", Iaşi, 2005.