SPATIAL MODELLING OF SOLAR RADIATION COMPONENTS USING GEOGRAPHIC INFORMATION SYSTEMS

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Резюме: *Рассматриваются пространственные распределения годовой прямой, диффузной и суммарной солнечной радиации и длительность солнечного сияния на территории Республики Молдова, рассчитанные по разным моделям с использованием ГИС технологий. Приводится сравнительный анализ точности этих моделей.*

Key words: *solar radiation, solar radiation models, values accuracy.*

Rezumat*: Sunt examinate distribuţiile spaţiale ale radiaţiei solare anuale directe, difuze şi totale şi durata strălucirii solare pe teritoriul Republicii Moldova, calculate după diferite modele, utilizând tehnologiile SIG. Este efectuată analiza comparativă a exactităţii acestor modele.*

Cuvinte cheie: *radiaţia solară, modelele radiaţiei solare, exactitatea valorilor.*

Taking into account that Republic of Moldova is poor in local energetic resources and they are represented mostly by non-traditional ones (3% from total country's energetics), thermal power resources spatial distribution's estimation is necessary for their efficient usage.

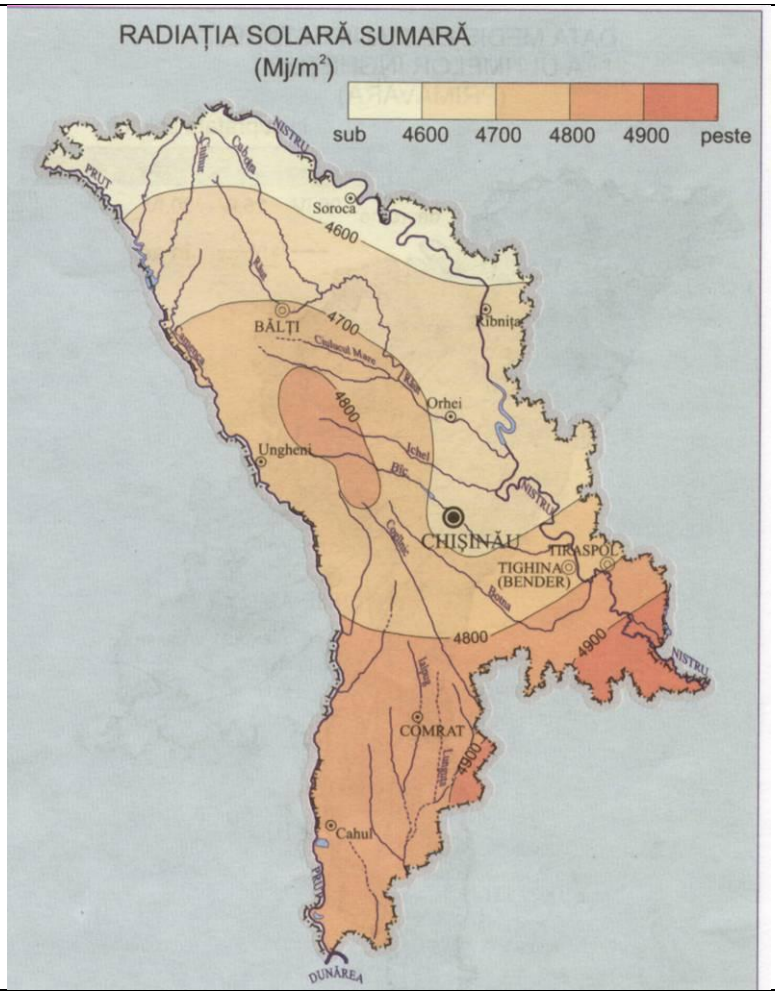

Figure. 1. ***Total solar radiation [1].***

Solar radiation, received by terrestrial surface (insolation), largely determines the thermal regime of land. This value is strongly influenced by slope's angle and orientation, atmosphere's transparency and Sun's position as a function from latitude and local time. Total solar radiation ***Q*** is a sum between direct radiation sum ***S'*** and diffused one ***D:***

$$Q = S' + D$$

The maps of solar energy quantity received by soil's surface are of extreme importance for green mass estimation and for optimum placing of agricultural crops according to their requirements. At the same time these maps can be used also for placing installations that transform solar radiation in electrical and thermal energy.

Traditional method of solar radiation representation by isolines reflects in a very general mode actual spatial distribution and only identifies some areas (figure1).

Complete actinometrical observations are executed only at Chisinau weather station and just total solar radiation is registered at several otherweather stations in the country. Therefore it is necessary to use other methods and models of spatial interpolation, other than those of direct spatial interpolation of observational data.

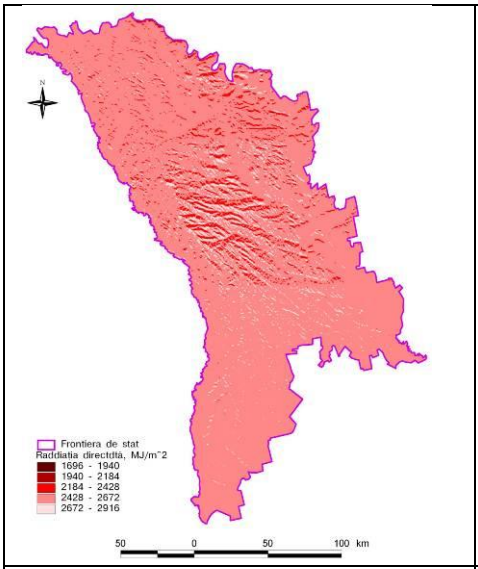

Figure 2. ***Direct solar radiation modelling using coefficients***

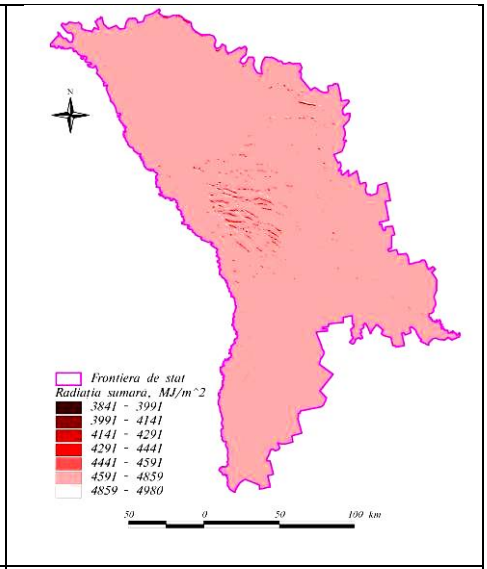

Figure 3. ***Total solar radiation modelling using coefficient*****s**

A more adequate method of solar radiation components estimation was developed by E. N. Romanova [2], and was used 5 years ago [3]. The method consists in using coefficients for different months and slopes with different gradients, aspects and latitudes. These coefficients are calculated for warm period (April-September) for 42-66 degrees latitude with 4 degrees increment and represent relation between radiation on the slopes and those on horizontal surface. Coefficients for 5, 10 and 20 degrees slopes and North, East, South, West aspect are available for direct solar radiation. For total solar radiation only coefficients for slopes of 10 and 20 degrees and North and South aspect are available, while coefficients for 5 degrees slopes and East and West exposition are considered equal to one. This rough estimation of relief's particularities has as a consequence distinct smoothing of radiation values in spatial aspect [figures 2 and 3].

The most appropriate calculation method is using Solar Analyst software, elaborated by Helios Environmental Modeling Institute [4] and included subsequently in geographic informatics systems software of ArcView 3x and ArcGIS 9x. Digital Elevation Model, mean latitude, desired resolution, the number of days from start and finish from year's beginning, day and hour quantification intervals, Z-factor of altitude's multiplication, slope's angle and orientation, the number of directions needed for calculation, the number of azimuth divisions, the number of vertical divisions, relation between diffused radiation and total, atmospheric transparency and names of final files for direct, diffused and total radiation and number of hours of direct solar radiation are used as input data. Input model does not require actinometrical data except for values that characterize relation between diffused radiation, total one and atmosphere's transparency. If the first value can be deduced from data observed on Chisinau weather station, then the second one is not known. Solar Analyst gives possibility to calculate solar radiation components not only for certain area, but also for a certain point. In order to find out atmosphere's transparency value we need to proceed in the following way. The calculations were made for point location Chisinau weather station at various values of transparency of atmosphere and was selected the value of transparency that corresponds to radiation values, registered at station. Subsequently

the values of direct, diffuse, total solar radiation and total number of hours with sunshine were calculated and developed their spatial distribution maps. The final results are presented in figures 4-7.

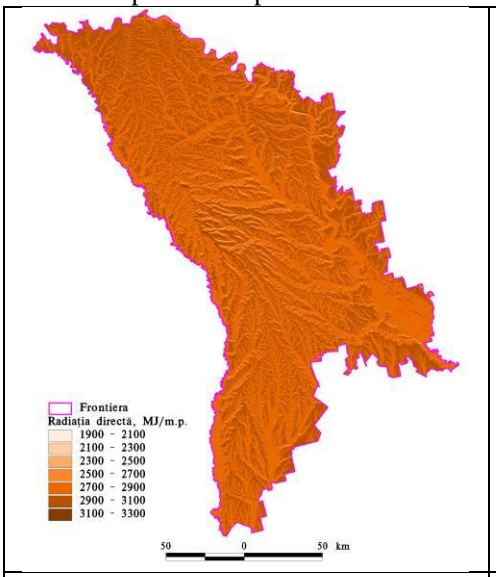

Figure 4. Direct solar radiation modeling using Solar Analyst software

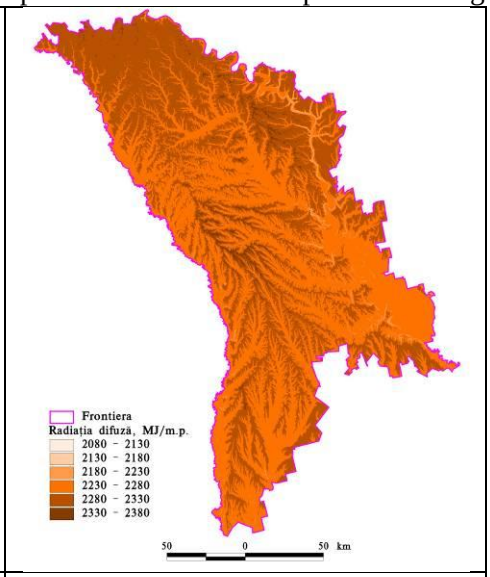

Figure 5. Diffused solar radiation modeling using Solar Analyst software

Characteristics of used models are presented in the following table.

Characteristics	**Romanova E.N. model**	**Solar Analyst Model**
Slope resolution, degrees	10, 20 (total radiation) 5, 10, 20 (direct radiation)	1
Exposition resolution, degrees	180 (total radiation) 90 (direct radiation)	1
Resolution of latitude, degrees	2 (total radiation) 4 (direct radiation)	< 0,000001
Total radiation's spatial variation interval, MJ/m^2	3800 - 4900	4000-5800
Direct radiation's spatial variation interval, MJ/m2	1700 - 2900	1900 - 3300
Horizon effect	No	Yes
Calculation possibility for every time interval	No	Yes

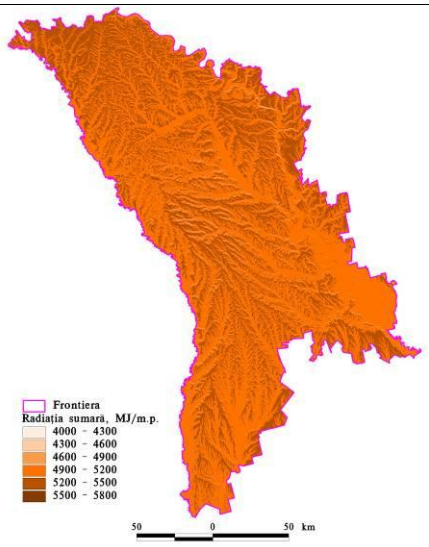

Figura 6. **Total solar radiation modeling using Solar Analyst software**

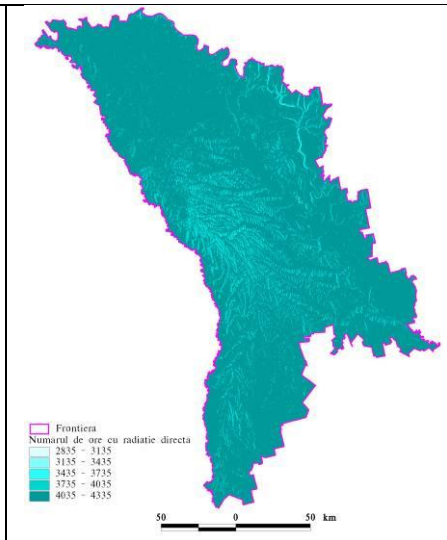

Figura 7. **Number of hours with direct solar radiation**

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4. *The Solar Analyst 1.0. User Manual. Helios Environmental Modeling Institute,* LLC. http://www@hemisoft.com