UDK 632.61:632.62

TYPIFICATION OF RURAL AREAS IN UKRAINE BY WATER RESOURCES POTENTIAL

Y.O. MYKHAYLOV Doctor of Engineering Science,
I.Y. DANYLENKO PhD in Engineering Science,
S.M. LYUTNITSKY
INSTITUTE OF WATER PROBLEMS AND LAND RECLAMATION NAAS

The method and the results of a spatial typification of water resources potential of rural areas in Kherson and Rivne regions of Ukraine are given. The main factors affecting the formation of water resources potential of rural areas in different climatic zones are defined.

Keywords: *water resources potential, spatial typification, water balance, geoinformational technology*

Problem. Water resources potential of rural areas can be characterized by the amount of water which moves through a fixed volume of soil-plant complex for a certain period.

Considerable geospatial variation of water-physical properties of the complex, the rainfall and water volumes coming into it from various sources make the spatial quantitative identification of water resources potential rather difficult as well as the measures related to its sustainable use.

The problem can be partly solved by a typification of rural areas, sorting out within their territories the plots with uniform conditions for forming water resources potential.

The authors using their own method have made such a typification for Kherson and Rivne regions.

Research Technique. According to the theory of complex systems (processes) the status of each their element correlates with the state of the rest, as well as the status of the whole system [1]. Different factors can be a status indicator, including the value of water resources potential, changes in groundwater (table) supply, normalized difference moisture index (Normalized Difference Water Index - NDWI) of the ground surface [2-4] and so on.

To make the typification it is not necessary to know precisely the value of water resources potential at a given area point, more attention should be paid to the evaluation of a spatial gradient of the potential, which allows to identify the areas with uniform conditions of its formation.

The plots of rural areas with uniform conditions of water resources potential formation are proposed to identify using NDWI isoline maps. Resolution of these maps is about 50 pixel of a raster image in satellite images.

Research results. Within Rivne region the water resources potential during the growing seasons of 2005-2011 years was formed mainly by rain. Its relation with NDWI is approximated by the graphs shown in Fig. 1, with a coefficient of determination of at least 0.85. As it is seen in the graphs, the more natural moistening of the area (less season precipitation probability) the higher water resources potential having the same values of NDWI. In moderately dry seasons when having the values of NDWI in the range of 0.4-0.6 more uniform moistening can be observed in larger rural areas, and the water resources potential increases in half to two times.

According to the results of our evaluation of the spatial distribution of water resources potential (Fig. 2), which is formed by precipitation against the background of artificial drainage in the rural areas of Rivne region, watershed and floodplain types of spatial distribution of the water resources potential are formed which are inherent in the areas with a developed hydrographic network.

The difference between these types can be explained by the fact that in the watersheds the part of rainfall runs off the surface and underground paths towards floodplains, increasing the water resources potential of the last ones.

Territorial distribution of water resources potential is also affected by different intensity of agricultural use within watersheds and floodplains. The first ones are prone to be more intensively ploughed up, that results in soil draining and reducing the amount of groundwater recharge, causing the water resources potential of such areas is less then one in naturally more depressed areas, where it usually occurs water accumulation.

In wet seasons the diversity of rural areas wetting by precipitation is increased due to filling in the topographic lows with rain water and evaporation losses are reduced, leading to increasing and balancing water resources potential within the territory. In dry years, the natural heterogeneity of the spatial distribution of water resources potential is significantly increasing.

Data generalization using the standard image processing sets helps to identify the common trends in the spatial distribution of water resources potential. In Rivne region some zoning in the territorial distribution of water resources potential can be observed in the north in forest area. The water resources potential there is the greatest - 400-500 mm over the growing season. Within the artificially drained area a moderate zoning is formed with the fluctuations of a value of the water resources potential within 350-400 mm. In the forest-steppe zone in the south the value of the water resources potential is minimal - 300-350 mm.

Forests are certainly a factor which reinforces the territorial homogeneity of water resources potential mainly due to a more uniform spatial distribution of precipitation and surface air temperature. Agricultural

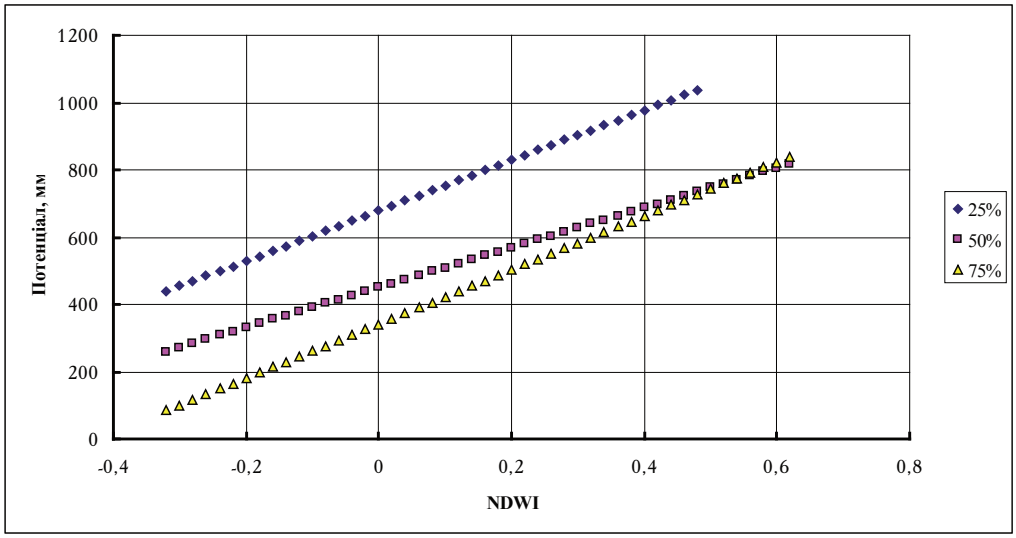

Fig. 1. Relation between water resources potential and NDWI when having different precipitation probability (Rivne region)

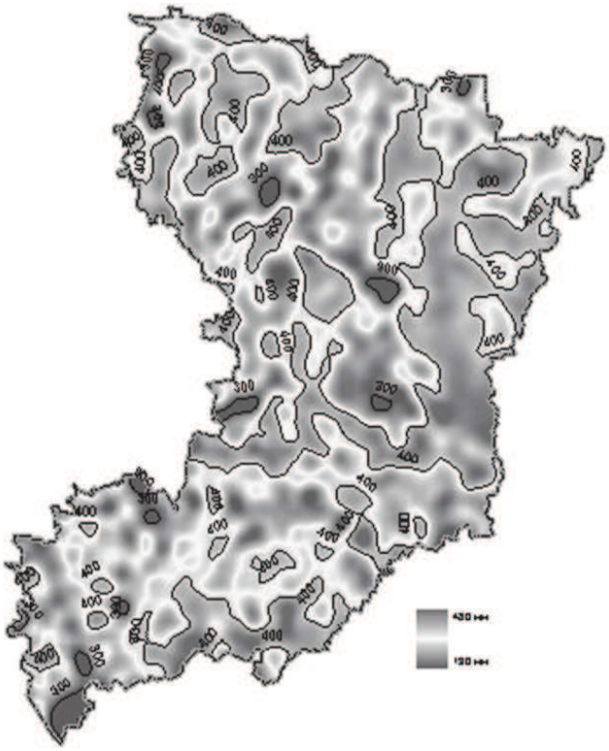

Fig. 2. Distribution of water resources potential within Rivne region (50% precipitation probability)

lands are characterized by a smaller water resources potential, but they have greater heterogeneity of its spatial distribution, which is increased by drainage systems. Unlike Rivne region, Kherson one is located in more arid region of Ukraine. A large area of irrigated land causes the formation of at least half water resources potential due to irrigation water.

A factor that complicates the evaluation of water resources potential of the rural areas in the south of Ukraine is a local type of torrential rains, that leads to an increased moisture diversity index.

It is often very difficult to determine the amount of irrigation water that inflows into rural areas, in particular into the irrigation areas with rice crop rotations. It can be explained by a limited-resolution of the satellite images, which are difficult to identify the areas with rice rotations.

For the southern areas of Ukraine there is enough close correlation of water resources potential with NDWI (Fig. 3). Unlike Rivne region the correlation here is the same for the growing seasons with different probability by a water consumption deficit.

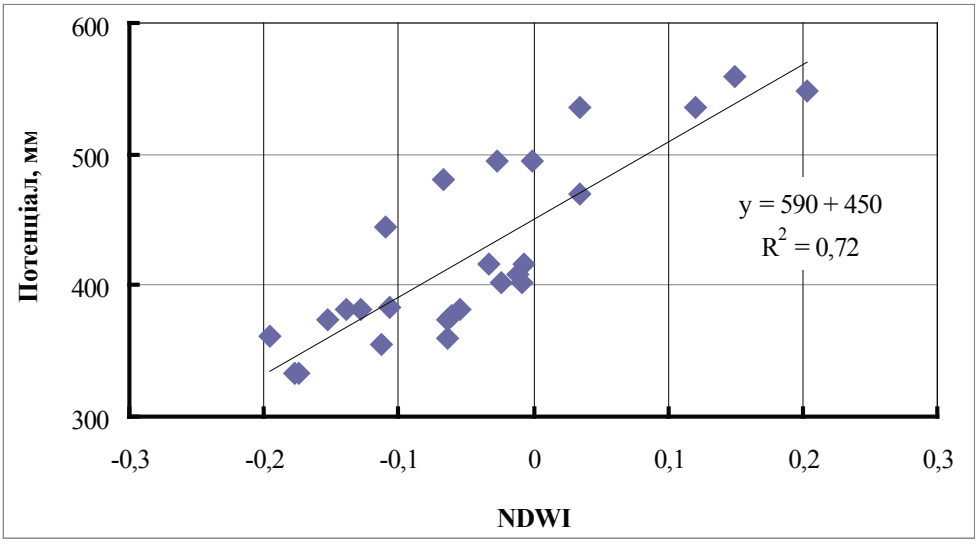

Fig. 3. Relation between the water resources potential and NDWI (Kherson region)

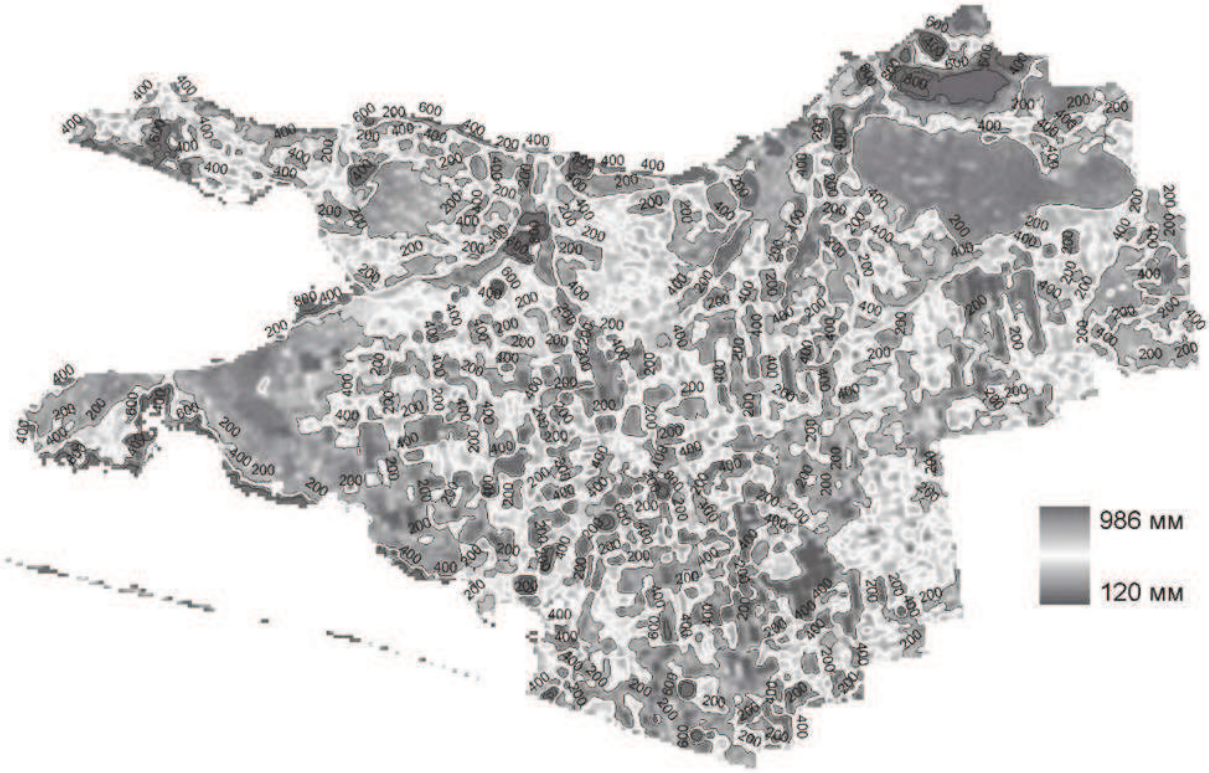

Fig. 4. Spatial distribution of the water resources potential over the territory of Skadovsk district of Kherson region

The spatial distribution of the water resources potential within Kherson region has a strong diversity (Fig. 4). The value of potential increases to 450 mm in irrigated areas, which are located fragmentarily (Skadovsk district) or as large solid lands (Kakhovky district).

In Skadovsk district an ancient delta of the Dnieper river influences on the formation of the water resources potential. Water from the sea through the hidden quaternary sediments along the river arms penetrates deep into the territory, moistening its some parts, that is clearly seen in Fig. 4.

The value of the water resources potential within the Kakhovka irrigation land ranges from 400 to 800 mm, reaching a maximum at the center positions of "Frigate" sprinkling machines.

The spatial distribution of the water resources potential in Skadovsky district can be characterized as irrigation-sporadic.

In the territory of Kakhovka district of Kherson region (Fig. 5) the intensity of irrigation is larger and the density of irrigated lands is higher. As a result of more uniform and constant artificial moistening of irrigated lands the diversity of spatial distribution of the water resources potential is less. In Fig. 5 it can be clearly

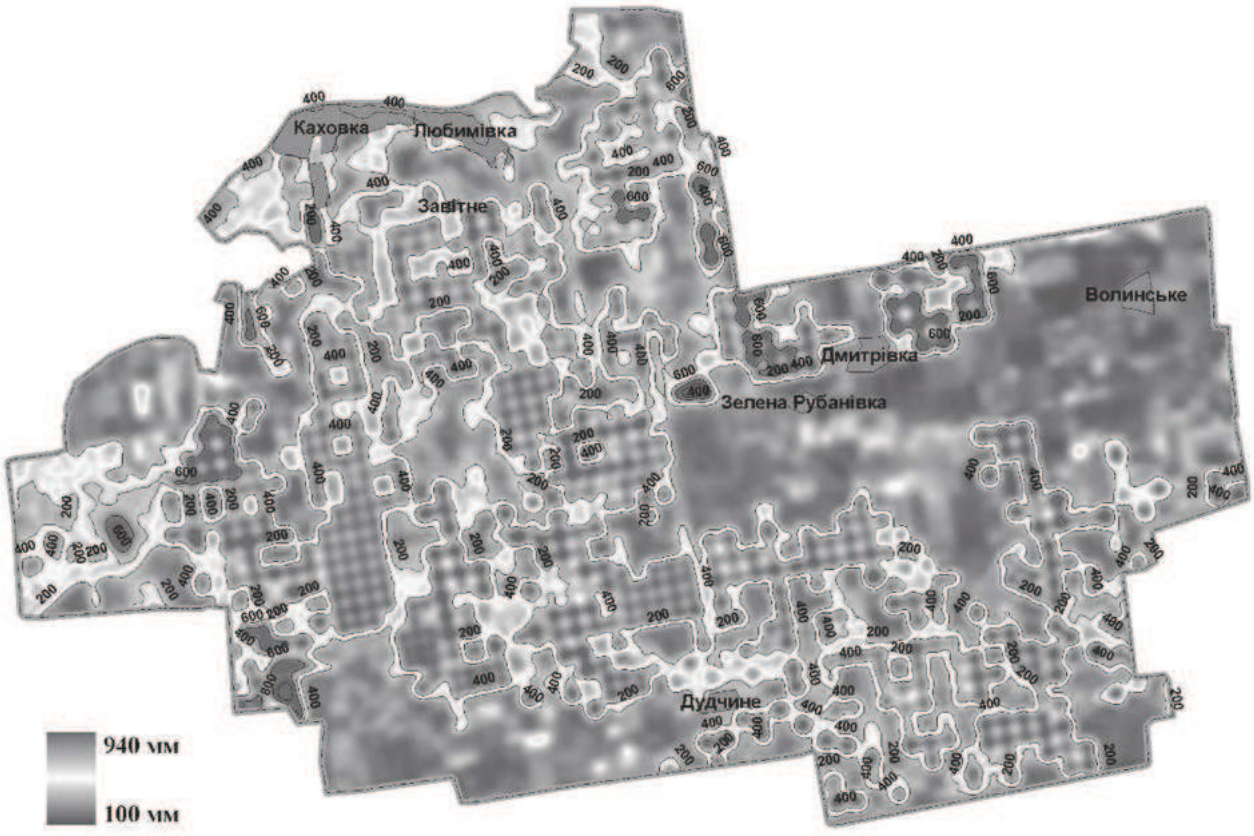

Рис. 5 – Spatial distribution of the water resources potential over the territory of Kakhovsky district of Kherson region

seen the lands equipped with the center pivot sprinkling machines.

The type of spatial distribution of the water resources potential in the territory of Kakhovky district be characterized as irrigation-solid.

The flat plain with large cavities determines the presence of areas within which the water resources potential is formed solely by rainfall, which is insufficient in this region. Such conditions of the potential formation can be characterized as a depression type.

Conclusions. In terms of natural moistening of rural areas the character of the spatial distribution of the water resources potential approaches to a zonal type and meets the structure of agricultural lands. The manifestations of azonal character (heterogeneity) are related to the artificial draining and the type of area afforestation. Based on the results of the typification of the humid zone of Ukraine the watershed and floodplain types of water resources potential formation can be determined.

In terms of irrigation the character of the spatial changes in water resources potential can be attributed to a mixed type, when it is close to the zonal type within the irrigated lands but beyond them it is azonal. In the given area the irrigation-sporadic, irrigation-solid and depression types can be determined.

Бібліографія

1. 1. Общая теория систем: математические основы / М. Месарович, Я. Такахара // Под ред. С. В. Емельянова. – М.: Мир, 1978 г. – 312 с.

2. 2. Karnieli A. Use of NDVI and land surface temperature for Drought Assessment: merits and limitations / A. Karnieli, N. Agam, R. T. Pinker, M. Anderson, M. L. Imnoff, G. G. Gutman, N. Panova, A. Goldberg // Journal of climate. – № 23. – 2010. – P. 618 – 623.

3. 3. Roerink G.J. S-SEBI: A simple remote sensing algorithm to estimate the surface energy balance / G.J. Roerink, Z. Su, M. Menenti // Phys. Chem. Earth. – v. 25. – № 2. – 2000. – P. 147 – 157.

4. 4. Оцінювання водоресурсного потенціалу сільських територій / Ю.О. Михайлов, Ю.Ю. Даниленко, С.М. Лютницький // Меліорація і водне господарство. – 2013. – №100. – С.163 – 170.

5. 5. Даниленко Ю. Ю. Типізація зрошуваних агроландшафтів за природними меліоративними властивостями / Ю. Ю. Даниленко // Вісник Дніпропетровського державного аграрного університету. – 2011. – № 1. – С. 89 – 91.

Наведено метод і результати просторової типізації водноресурсного потенціалу сільських територій Херсонської та Рівненської областей України. Визначено основні фактори, що впливають на формування водоресурсного потенціалу сільських територій в різних природно-кліматичних зонах.

Приведен метод и результаты пространственной типизации водоресурсного потенциала сельских территорий Херсонской и Ровенской областей Украины. Определены основные факторы, влияющие на формирование водоресурсного потенциала сельских территорий в различных природно-климатических зонах.