Geomorfologiya 2017 vol.2017-January N3, pages 76-87

Morphological typology of small catchments in river basins on cultivated plains

Maltsev K., Sharifullin A.

Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

Small catchments were classified with four morphometric characteristics that determine the relief energy: mean altitude, vertical relief, drainage density and average slope. Classification was produced using the Ward's method and elementary catchment as a basic spatial unit. The created typology allows to elaborate recommendations on spatial distribution of crops aimed at reduction of soil erosion rates and the amounts of sediments yielded from slopes to channels of perennial and intermittent streams. The elaborated methodology was tested in the upper Medveditsa River basin (the Don River system). Six classes of elementary catchments were designated and ranked according to the relief energy. The compiled map of small catchment types may be applied for the improvement of land use practice and planning of crop rotation with respect to soil protection efficiency.

http://dx.doi.org/10.7868/S0435428117030075

Keywords

Erosion, Soil erosion, Sub-basin, Ward's method

References

[1] Gopp N. V. Algorithmic approach in the preparation of digital soil maps based on laboratory and field and satellite data. Issled. Zemli iz kosmosa. 2013. No. 3. P. 58. (in Russ.)

[2] Ermolayev O. P, Malcev K. A, Mozzherin V. V, Giiyazov A. F, Satdarov A. Z, Gareyev R. M., and Mishanina O. E. Estimation of the probability of flooding height and area of the bottoms of river valleys during the spring flood to ensure the safety of oil. Neft. Hoz. 2015. No. 11. P. 145-149. (in Russ.)

[3] Mikolajczak A, MarOchal D, Sanz T, Isenmann M, Thierion V., and Luque S. Modelling spatial distributions of alpine vegetation: A graph theory approach to delineate ecologically-consistent species assemblages. Ecological Informatics. 2015. Vol. 30. P. 196-202.

[4] Gorohov A. N, Makarov VS, Vasilyev N. F., and Fedorov A. N. Methodological approaches to the preparation of the landscape map based on GIS technologies (for example, Neryungri, Yakutia industrial complex). Probl. Region. Ekol. 2009. No. 3. P. 15-19. (in Russ.)

[5] Kalichkin V. K. and Pavlova A. I. Application of neural expert system for the classification of land erosion. Sib. Bul. Agric. Sci. 2014. No. 6. P. 5-11. (in Russ.)

[6] Filosofov V. P. Kratkoe rukovodstvo po morfometricheskomu metodu poiskov tektonicheskih struktur (Quick Guide to morphometric method searches tectonic structures). Saratov: Izd-vo Saratov, un-ta (Publ.), 1960. 94 p.

[7] Mihalev V. V. and Matskevich I. K Modern morphometry Kama reservoir. Vodn. Hoz. Ros.: probl., techn., upravl. 2010. No. 3. P. 4-19. (in Russ.)

[8] Perevoschikova O. A. and Kalinin V. G. By the estimation of the spatial inhomogeneilies bottom topography valley reservoirs (by the example of the Kama). Geogr. Vestn. 2014. No. 3 (30). P. 18-26. (in Russ.)

[9] Aivazyan S. A, Bezhaeva Z. I., and Starovcrov O. V. Klassifikatsiya mnogomernykh nablyudeniy (The classification of multidimensional observations). Moscow: Statistika (Publ.), 1973. 238 p.

[10] Ermolaev O. P. Eroziya v basseynovykh geosistemakh (Erosion in the river basin geosystems). Kazan: Izd-vo Unipress (Publ.), 2002. 264 p.

[11] Dunaeva E. A. and Kovalenko P. I. Typing basins of Crimea in agricultural landscapes and environmental burden on them. Nauch. Zhurn. Ros. Nil probl. Melior. 2013. No. 4 (12). P. 157-167. (in Russ.)

[12] Lindsay J. B. The Whitebox Geospatial Analysis Tools project and open-access GIS. Proceedings of the GIS Research UK 22 Annual Conference. The Univ. of Glasgow. 2014.

[13] SRTM data [elektron. res.].-https://lta.cr.usgs.gov/SRTMIArc. (data obrash. 15.01.2016)

[14] Szaby G, Singh S. K., and Szaby S. Slope angle and aspect as influencing factors on the accuracy of the SRTM and the ASTER GDEM databases. Physics and Chemistry of the Earth, Parts A/B/C. 2015. Vol. 83-84. P. 137-145.

[15] O'Callaghan J. and Mark D. M. The extraction of drainage networks from digital elevation data. Cornput. Vis. Graph. Image Process. 1984. Vol. 28 (3). P. 323-344.

[16] Pogorelov A. V. and Dumit Zh. A. Rel'ef basseyna reki Kubani: morfologicheskiy analiz (The relief of the Kuban River basin: morphological analysis). Moscow: GEOS (Publ.), 2009. 218 p. (in Russ.)

[17] Ermolayev O. P, Malcev K. A., and Ivanov M. A. Automated building basin geosystems boundaries for the Volga Federal District. Geogr. Prir. Resur. 2014. No. 3. P. 32-39. (in Russ.)

[18] Lastochkin A. N. Rel'ef zemnoj poverhnosti (Principy i metody staticheskojgeomorfologii) (The relief of the earth's surface (Principles and methods of static geomorphoiogy)). Leningrad: Nedra (Publ.), 1991. 340 p.

[19] Simonov Yu. G. Morfometricheskiy analiz relefa (The morphometric analysis of relief) - Moskva-Smolensk: Izd-vo SGU (Publ.), 1998. 272 p.

[20] Shary P. A. Land surface in gravity points classification by a complete system of curvatures. Mathematical Geology. 1995. Vol. 27. P. 373-390.

[21] Shary P, Sharaya L., and Mitusov A. Fundamental quantitative methods of land surface analysis. Geoderma. 2002. Vol. 107 (1-2). P. 1-32.

[22] Florinsky I. Accuracy of local topographic variables derived from digital elevation models. Intern. Journ. of Geograph. Inform. Sc. 1998. No. 12 (1). P. 47-62.

[23] Zevenbergen, L. and Thome C. Quantitative analysis of land surface topography. Earth Surface Processes Landforms. 1987. Vol. 12. P. 47-56.

[24] Pennock D, Zebarth B., and de Jong E. Landform classification and soil distribution in hummocky terrain. Geoderma. 1987. Vol. 40. P. 297-315.

[25] Kochetkova Yu. O. Ecological and geomorphological evaluation of morphometric characteristics of the relief of the Ryazan region. Vestn. Volzh. Univ. 2011. No. 12. 25 p. (in Russ.)

[26] Pogorelov A. V. Experience of automated identification of elements of the morphological structures of the Greater Caucasus. Inzhener. Izyskan. 2010. No. 5. P. 32-35. (in Russ.)

[27] Chupina D. A. An automatic identification of landforms and their complexes based on GIS analysis of morphometric parameters (Vengerovsk area of Novosibirsk Region as an example). Geomorfologlya (Geomorphoiogy RAS). 2014. No. 3. P. 43-50. (in Russ.)

[28] Verhagen P. and Dragut L. Object-based landform delineation and classification from DEMs for archaeological predictive mapping. Journal of Archaeological Science. 2012. Vol. 39. Iss. 3. P. 698-703.

[29] Kassouk Z, Thouret J.-C, Gupta A, Solikhin A., and Liew S. C. Object-oriented classification of a high-spatial resolution SPOT5 image for mapping geology and landforms of active volcanoes: Semeru case study, Indonesia. Geomorphoiogy. 2014. Vol. 221. P. 18-33.

[30] Burrough P. A. and McDonell R. A. Principles of Geographical Information Systems. New York: Oxford University Press, 1998. 190 p.

[31] Mordvincev M. M. and Kuvalkin A. V. Methods of typing parts of the catchment area for the construction of computational models "Precipitation-Stock", in XIII Plen. Interuniv. Coord. Meeting on the probl. of erosion, fluvial and estuarine processes (Naberezhnye Chelny, 8-10 October 2015). Naberezhnye Chelny. 2015. P. 176-179. (in Russ)

[32] Ward J. H. Hierarchical grouping to optimize an objective function. Journal of the American statistical association. 1963. Vol. 58. No. 301. P. 236-244.

[33] Morfostruktura i morfoskulptura platformennyh oblastej ravnin SSSR (Morphostructure and morphosculpture of the USSR platform regions). Moscow: Nauka (Publ.), 1986. 195 p.