STUDY OF THE RELIEF AND COASTLINE DYNAMICS OF LARGE COASTAL ACCUMULATIVE FORMS ACCORDING TO REMOTE SENSING DATA

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The study of the relief of large coastal accumulative forms, based on modern technologies, is relevant for solving many applied problems. Coastal and underwater bars, shoals, banks are characteristic elements of large coastal accumulative forms' geosystems. Previously existing methods of relief researches, especially underwater, were labor-intensive and expensive. Accordingly, the development and implementation of new methods of geographical research are necessary. The Dolgaya Spit, including its underwater shoal and the Elenin Bank, is one of the largest accumulative forms of the Sea of Azov. The purpose of our work was to obtain new information on the relief structure and the shoreline dynamics of the Dolgaya Spit based on the use of new research methods. Digital models of surface and underwater relief were built on the basis of processing Sentinel-2 satellite images and data from unmanned aerial photography. The subsequent analysis allowed identify regularities that reflect the current and previous hydro-lithodynamic conditions that determined the transformation of the Dolgaya Spit during its evolution. The fulfilled studies confirmed the possibility of successful use of modern remote methods for studying the relief of coastal accumulative forms.

Keywords: Sea of Azov, accumulative form, remote sensing, relief, Sentinel-2 data, Dolgaya spit, Bank of Elenin, s, Sentinel-2, UAV, relief, coastline

REFERENCES

1. Pogorelov, A. V. (2011). Study of the the coastal zone dynamics of the Sea of Azov based on satellite images. *Zashchita okruzhayushchej sredy v neftegazovom komplekse [Environmental Protection in the Oil and Gas Industry]*, 12, 19–27 [in Russian].

2. Kosyan, R. D., & Krylenko, V. V. (2014). *Sovremennoe sostoyanie Azovo-Chernomorskih akkumulyativnyh beregov i rekomendacii po ih racionalnomu ispolzovaniyu [The current state of the Azov-Black Sea accumulative shores and recommendations for their rational use]*. Moscow: "Scientific World" Publ., 256 p. [in Russian].

3. Mekush, G. E., & Ushakova, E. O. (2016). Assessment of the value of ecosystem services for the development of recreation and tourism. *Vestnik SGUGiT [Vestnik SSUGT]*, 1(33), 200-209 [in Russian].

4. Zharnikov, V. B., & Koneva, A. V. (2017). On the problem of the tourist resources' cadastre and its main content. *Vestnik SGUGiT [Vestnik SSUGT]*, *22*(4), 148–155 [in Russian].

5. Kosyan, R. D., & Krylenko, M. V. (2019). Modern state and dynamics of the Sea of Azov coasts. *Estuarine, Coastal and Shelf Science*, *224*, 314–323.

6. Razumov, P., & Glushko, A. (2010). Riverside territories of South-Russian subjects: the land's degradation as a result of abrasion processes. *Vestnik MGOU [Vestnik MSRU]*, 3, 112–119 [in Russian].

7. Krylenko, M. V., Krylenko, V. V., & Volkova, T. A. (2018). Development prospects of natural-territorial complex of the Dolgaya spit. *Ocean and Coastal Management*, *166*, 98–102.

8. Pogorelov, A. V., & Antonenko, M. V. (2011). Application of satellite images in the study of the coastal zone dynamics of the Sea of Azov: opportunities and results of analysis. *Vestnik Severo-Kavkazskogo gosudarstvennogo tekhnicheskogo universiteta [Bulletin of the North Caucasus state technical University]*, 2, 95–98 [in Russian].

9. Krylenko, V. V., & Krylenko, M. V. (2018). High-precision relief survey of the Bakal spit. *Ekologicheskaya bezopasnost pribrezhnoj i shelfovoj zon morya [Environmental Safety of Coastal and Offshore Zones of the Sea]*, 4, 65–72 [in Russian].

10. U. S. Department of the Interior U.S. Geological Survey (USGS). (n. d.). Retrieved from http://earthexplorer.usgs.gov.

11. Sentinel. Online technical website. (n. d.). Retrieved from https://sentinel.esa.int/web/sentinel/technical-guides/sentinel-2-msi/level-1c/product-formatting.

12. MultiSpectral Instrument (MSI). (n. d.). Retrieved from https://sentinel.esa.int/web/sentinel/missions/sentinel-2/instrument-payload.

13. Krylenko, V. V., Aleynikov, A. A., Boyko, E. S., & Krylenko, M. V. (2016). Assessment of the coastline dynamics of the Dolgaya spit using satellite images. *Geograficheskie issledovaniya Krasnodarskogo kraya [Geographical Studies of the Krasnodar Territory]*, 10, 253–260 [in Russian].

14. Krylenko, M., Krylenko, V., & Kosyan, R. (2015). Accumulative coast dynamics estimation by satellite camera records. *Proceedings of SPIE*, *9535*, 95351K.

15. Gao, B. C. (1996). NDWI – a normalized difference water index for remote sensing of vegetation liquid water from space. *Remote Sensing of Environment*, *58*, 257–266.

16. Krylenko, V. V., Krylenko, M. V., & Aleynikov, A. A. (2019). Specifying the length of the Azov sea coastline using satellite data Sentinel-2. *Vestnik SGUGiT [Vestnik SSUGT]*, *24*(4), 78–92 [in Russian].

17. Krylenko, V. V., Krylenko, M. V., & Aleynikov, A. A. (2019). Investigation of the underwater relief of the Bakalskaya Bank based on Sentinel-2 satellite images. *Ekologicheskaya bezopasnost pribrezhnoj i shelfovoj zon morya [Environmental Safety of Coastal and Offshore Zones of the Sea]*, 2, 30–39 [in Russian].

18. Stumpf, R., Holderied, K., & Sinclair, M. (2003) Determination of water depth with high-resolution satellite imagery over variable bottom types. *Limnology and Oceanography*, *48*(1), 547–556.

19. Lyzenga, D. R., Malinas, N. P., & Tanis, F. J. (2006). Multispectral bathymetry using a simple physically based algorithm. *IEEE Transactions on Geoscience and Remote Sensing*, *44*(8), 2251–2259.

20. Chybicki J. (2017). Mapping south Baltic near-shore bathymetry using Sentinel-2 observations. *Polish Maritime Research*, *24*, 15–25.

21. Traganos, D., Poursanidis, D., Aggarwal, B., Chrysoulakis, N., & Reinartz, P. (2018). Estimating Satellite-Derived Bathymetry (SDB) with the Google Earth Engine and Sentinel-2. *Remote Sensing*, *10*(6), 859–877.

22. Bathymetric mapping in the coastal zone based on Earth remote sensing materials, RRW by SCANEX R&D Centre. (2018). Moscow, 91 p. [in Russian]

23. Litchi. (n. d.). Retrieved from http://flylitchi.com

24. Boyko, E., Krylenko, V., & Krylenko, M. (2015). LIDAR and airphoto technology in the study of the Black Sea accumulative coasts. *Proceedings of SPIE*, *9535*, 95351Q.

25. Artyukhin, Yu. V. (1987). Genesis and dynamics of the "Azov type" spits. *Geomorphology*, 3, 27–30 [in Russian]

26. Matishov, G. G., & Polshin, V. V. (2019). New result on the history of the Azov Sea in the Holocene. *Doklady Akademii nauk [Reports of the Academy of Sciences]*, *489*(2) [in Russian]

27. Sukhomlin, A. M. (1854). *Lotsiya Azovskogo morya i kerchenskogo proliva [Lotsia of the Sea of Azov and the Kerch Strait]*. Nikolaev, 96 p. [in Russian].

28. Mamykina, V. A., & Khrustalev, Yu. P. (1980). *Beregovaya zona Azovskogo moray [Coastal zone of the Sea of Azov]*. Rostov-on-Don, 176 p. [in Russian]

29. Matishov, G., Polshin, V., Kulygin, V., Titov, V., Kovalenko, E., & Sushko, K. (2020). New data on the structure of the Dolgaya spit of the Sea of Azov (drilling, study of outcrops, malacofauna). *Science in the South of Russia*, *16*(3), 26–39.

30. Papacoma. (n. d.). Retrieved from http://papacoma.narod.ru/maps-index.htm.

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