PREDICTING FOREST LAND COVER CHANGES OF DONG NAI RESERVE, VIETNAM

Vasiliy F. Kovyazin
Saint-Petersburg Mining University, 2, Vasilyevsky Island, 21 line, St. Petersburg, 199106, Russia, D. Sc., Professor, Department of Engineering Geodesy, phone: (911)954-26-89, e-mail: vfkedr@mail.ru

Dang Thi Lan Anh
Saint-Petersburg Mining University, 2, Vasilyevsky Island, 21 line, St. Petersburg, 199106, Russia, Ph. D. Student, Department of Engineering Geodesy, phone: (961)807-21-49, e-mail: lananhvfu2@mail.com

Dang Viet Hung
Vietnam National University of Forestry – Dong Nai Campus, 54, Tran Phu St., Trang Bom, Dong Nai, 810000, Vietnam, Ph. D. Student, Department of Forest Plant, phone: (962)708-27-30, e-mail: viethungvfu@gmail.com

The study was conducted in Dong Nai Reserve, specially protected natural area (SPNA), Vietnam. It aims to analyze and forecast forest land cover in the Reserve. For these purposes were studied satellite images (Landsat 5, Landsat 7 and Landsat 8) taken in 2003, 2011 and 2019. The Normalized Difference Vegetation Index (NDVI) was used to identify vegetation quality. Forest land cover was divided into 5 categories using maximum likelihood classifier algorithm. In order to detect and evaluate forest land cover changes, supervised classification and image differencing method are applied. Then, Cellular Automata and Markov Chain model was employed for making forecast of forest land cover in this area. The results of the study indicate that forest land cover change is being transformed in Dong Nai Reserve. According to our estimation, from 2003 to 2019, the area covered by woody vegetation increased by 7.0 %. By 2035, the area of broad-leaved forests will increase by 1.6 %, due to a decrease in areas of meadows and shrubs. The dynamics of increasing forest land is explained by the measures taken by the Vietnamese government to expand the area of forests in SPNA.

Key words: Dong Nai nature reserve, forest land, vegetation cover, satellite images, Markov chains.

REFERENCES

1. Nguyen Van Thinh. (2015). Biodiversity and soil properties Dong Naibiosphere reserve. *Candidate's thesis.* Rostov-on-don [in Russian].

2. Dang Viet Hung, & Potokin, A. F. (2019). Diversity of plant species composition and forest vegetation cover of Dong Nai Culture and Nature Reseve, Vietnam. *Earth and Environmental Science*, 316, 1–9.

3. Le Trong Trai, Dang Thang Long, Phan Thanh Ha, & Le Ngoc Tuan. (2003). Hunting and Collecting Practices in the Central Truong Son Landscape. *Central Truong Son Initiative Report*, 7, 32 p.

4. Groombridge, B., & Jenkins, M. D. (2000). *Global biodiversity: earth's living resources in the 21st century*. Cambridge, World Conservation Press, 254 p.

5. *Report on land statistics for 2013 in the Dongnai nature reserve*. (2013). Dong Nai Province Department of Natural Resources and Environment, 12 p.

6. Hlebnikova E. P., & Arbuzov S. A. (2020). Using of geospatial data for solution of tasks of monitoring the specially protected natural territories. *Vestnik SGUGiT [Vestnik SSUGT]*, *25*(1), 96–105 [in Russian].

7. Kovyazin, V. F., & Dang, T. L. A. (2019). Monitoring of forest lands of Kim Hy reserve of Vietnam using GIS Technologies. *Astrahanskij vestnik ekologicheskogo obrazovaniya [Astrakhan Bulletin of Environmental Education]*, 3, 95–102 [in Russian].

8. Rouse, J. W., Haas, R. H., Schell, J. A., & Deering, D. W. (1974). Monitoring vegetation systems in the Great Plains with ERTS. *Third Earth Resources Technology Satellite-1 Symposium. Greenbelt, NASA SP-351*, *1*, 309–317.

9. Zholobov, D. A., & Baev, A. V. (2015). Refining the values of the normalized vegetative index (NDVI) by applying a transpiration mask. In *Sbornik statey XLV mezhdunarodnoy nauchno-prakticheskoy konferentsii: No. 5 (42). Innovatsii v nauke [Proceedings of XLV International Scientific and Practical Conferences: No. 5 (42). Innovations in Science]* (pp. 164–185). Novosibirsk: SibAK Publ. [in Russian].

10. Congalton, R. G., Oderwald, R. G., & Mead, R. A. (1983). Assessing landsat classification accuracy using descrete multivariate analysis statistical techniques. *Photogrammetry Engineering and Remote Sensing*, *49*(12), 1671–1678.

11. Kovyazin, V. F., & Nguyen, T. X. (2019). Development of a forecast model for the transformation of land in Vietnam. *Izvestiya Tomskogo politekhnicheskogo universiteta. Inzhiniring georesursov [News of Tomsk Polytechnic University. Engineering of Georesources]*, *330*(9), 221–229 [in Russian].

12. Sang, L., Zhang, C., Yang, J., Zhu, D., & Yun, W. (2011). Simulation of land use spatial pattern of towns and villages based on CA-Markov model. *Mathematical and Computer Modelling*, *54*, 938–943.

13. Liping, C., Yujun, S., & Saeed, S. (2018). Monitoring and predicting land use and land cover changes using remote sensing and GIS techniques – A case study of a hilly area, Jiangle, China. *PLOS ONE*, 13(7), 1–23.

14. Nguyen, T. A., Le, P. M. T., Pham, T. M., & et al. (2019). Toward a sustainable city of tomorrow: a hybrid Markov–Cellular Automata modeling for urban landscape evolution in the Hanoi city (Vietnam) during 1990 – 2030. *Environ Dev Sustain*, *21*, 429–446.

15. Praveen Subedi, Kabiraj Subedi, & Bina Thapa (2013). Application of a Hybrid Cellular Automaton – Markov (CA-Markov) Model in Land-Use Change Prediction: A Case Study of Saddle Creek Drainage Basin, Florida. *Applied Ecology and Environmental Sciences*, *1*(6), 126–132.

16. Zhang, J., Su, Y., Wu, J., & Liang, H. (2015). GIS based land suitability assessment for tobacco production using AHP and fuzzy set in Shandong province of China. *Comput. Electron. Agric*, *114*, 202–211.

17. Marcel Török–Oance, & Dorel Micle. (2010). Digital terrain analysis as a tool for the identification of possible areas with rural post – Roman archaeological sites in the S-W Dacia. *Annales d'Universite 'Valahia' Targoviste, Section d'Archeologie et d'Histoire*, *2*, 139–147.

18. Sudhir Kumar Singh, Prosper Basommi Laari, Sk. Mustak, Prashant K. Srivastavad, & Szilárd Szabó. (2017). Modelling of Land Use Land Cover Change using Earth Observation Datasets of Tons River Basin, Madhya Pradesh, India. *Geocarto International*, 1–21.

19. Wang, S., Zhang, Z., & Wang, X. (2014). Land use change and prediction in the Baimahe Basin using GIS and CA-Markov model. *IOP Conf. Ser. Earth Environ. Sci.*, 17 p.

20. Ozturk, D. (2015). Urban Growth Simulation of Atakum (Samsun, Turkey) Using Cellular Automata-Markov Chain and Multi-Layer Perceptron-Markov Chain Models. *Remote Sens.*, *7*, 5918–5950.

21. Yousheng, W., Xinxiao, Y., Kangning, H., Qingyun, L., Yousong, Z., & Siming, S. (2011). Dynamic simulation of land use change in Jihe watershed based on CA-Markov model. *Transactions of the Chinese Society of Agricultural Engineering*, *27*(12), 330–336.

22. J. von Neumann. (1971). *Teoriya samovosproizvodyashchihsya avtomatov [Theory of self-replicating automata]*. Moscow: Mir Publ., 326 p. [in Russian].

23. Naumov, L., & Shalyto, A. (2003). *Kletochnye avtomaty. Realizatsiya i eksperimenty [Cellular automata. Implementation and experiments]*, 15 p. [in Russian].

24. Hou, X. Y., Chang, B., & Yu, X. F. (2004). Land use change in Hexi corridor based on CA–Markov methods. *Transactions of the CSAE*, *20*(5), 286–291.

25. Pontius, R. G. Jr. (2002). Statistical methods to partition effects of quantity and location during comparison of categorical maps at multiple resolutions. *Photogramm. Eng. Remote Sens.*, *68*(10), 1041–1050.

26. Feinstein, A. R., & Cicchetti, D. V. (1990). High agreement but low kappa: I. The problems of two paradoxes. *J Clin Epidemiol*, *43*(6), 543–549.

27. Azizi, A., Malakmohamadi, B., & Jafari, H. R. (2016). Land use and land cover spatiotemporal dynamic pattern and predicting changes using integrated CA-Markov model. *Global J. Environ. Sci. Manage*, *2*(3), 223–234.