http://doi.org/10.29227/IM-2021-02-44 Received: 12 Jun 2021, Accepted: 18 Sep 2021, Published: 10 Nov 2021

Assessing Impacts of Mining Activities on Land Use/Land Cover Change Using Remote Sensing and GIS Techniques: A Case Study in Campha City, Vietnam

LE Thi Thu Ha[1, *]

[1] Hanoi University of Mining and Geology, 18 Vien street, Hanoi, Vietnam

Corresponding author: lethithuha@humg.edu.vn

Abstract. Coal is one of the most mining commodities to date, especially to supply both national and international energy needs. Coal mining activities that are not well managed will have an impact on the occurrence of environmental damage. The present study was undertaken to analyze the process of human-induced landscape transformation in the coal mines affected areas of Cam Pha, northeast Vietnam by interpreting temporal remote sensing data and using Geographic Information System. This experiment revealed that most of the study area was dominated by forest in all the time sequence period. The forest cover has decreased about 21.3%, meanwhile having nine fold increase in mining area from 1990 to 2020. The forest area lost during the study period was 7983.45 ha due to land cover conversion into mining area. The mining activities were also detrimental to the bare land and water body cover. The results of this study are expected to be used to support government efforts and mining managers in post-mining coal activities.

Keywords: Land use/land cover change, Mining activities, Remote sensing, GIS

1. Introduction

Coal which is commonly called as the “black gold” of Vietnam, which contributes a major part to its commercial energy production and is widely used in the power industry to generate electricity. Mining of coal both surface and subsurface causes enormous damage to the flora, fauna, hydrological relations and soil biological properties [1]. Open-pit mining operations are processes of denudation, handling, and accumulation [2]. Therefore, open-pit mining areas are not only affected on the vegetation, soil, and terrain, but also created big pits, transit sites, solid waste, and changed in land use/land cover (LULC) [3, 4]. Although land is the natural resource of the utmost importance and original source of all material wealth of human being, the mining of natural resources is invariably associated with land use/land cover changes [5]. Modern techniques of mining using heavy equipment can produce dramatic alterations in land cover, both ecologically and hydrologically [6, 7]. In this context, it is essential to scrutinize the effect of mining on land use/land cover change to minimize its impact on environment as well as for proper land management and decision making [8, 9, 10]. To ascertain such changes, earth resource satellite data are critically important and useful for land use/land cover change studies [11].

Recently, integrated remote sensing (RS) and GIS technology has enabled environmentalists and natural resources managers to acquire multi-temporal data and detect periodical changes [12, 13]. Multi-temporal RS data associated with GIS tools have been used for the detection of the LULC dynamics [14, 15, 16]. Landsat TM, ETM+, and OLI with spectral channels are chosen specifically to map vegetation type, LULC, and other landscape features [17, 18]. These types of data are particularly relevant to the scope of the study and the free of charge of the data. GIS is an important tool for monitoring environment impacts from a wide coverage and a tool repetitive coverage of RS data [12, 16, 19]. Moreover, it can detect the change at multi-resolutions to generate multi-level information of LULC changes. This is to support the planning and cost-effective decision marking.

Coal mining has been most extensively practiced in all the area of Cam Pha city, northeast Vietnam, as a result of this, the original landscape have been converted to mine spoils. The total deposit of coal in Cam Pha city is approximately 2.2 billion tones spreading over patches of different sizes [20]. Coal extraction in the city is done mainly by primitive surface mining method commonly known as ‘open-pit’ mining. Mining operations in Cam Pha city consist of the fours largest open-cast mines in Vietnam (Deo Nai, Tay Nam Da Mai, Cao Son, and Coc Sau). Coal mining activities in Cam Pha city have had a great impact on the regional environment, including the LULC [21].

A detailed understanding of the impact of coal mining activities on changes of land use/land cover on time and space is pre-requisite for the city. Therefore, present study was undertaken to analyze the process

http://doi.org/10.29227/IM-2021-02-44 Received: 12 Jun 2021, Accepted: 18 Sep 2021, Published: 10 Nov 2021

of human-induced land cover transformation in the coal mined affected areas of Cam Pha city of Quang Ninh, Northeast Vietnam by interpreting multi-temporal remote sensing data (in 1990, 2000, 2010 and 2020) and using geographic information system. In order to achieve this objective, the land cover types consits of forest, mining area, settlement, water body and bare land were taken into consideration to know the trend due to the impact of mining activities in different time periods.

2. Study areas

Cam Pha is a city of Quang Ninh province in the Northeast region of Vietnam (Fig. 1). Coal mining activities in Cam Pha started over 100 years ago. Cam Pha is also principally known for its proximity to extensive coal mines, and it is home to the largest mines in Vietnam, namely the Coc Sau, Cao Son, Deo Nai, Tay Nam Da Mai open-pit mines. The coal mining and processing industry are the primary economic sector generating income for the people. Its main economic activities are industry and construction (73.5 %), trade and service (25.1 %), and agroforestry and fishery for local consumption (1.4 %) [22].

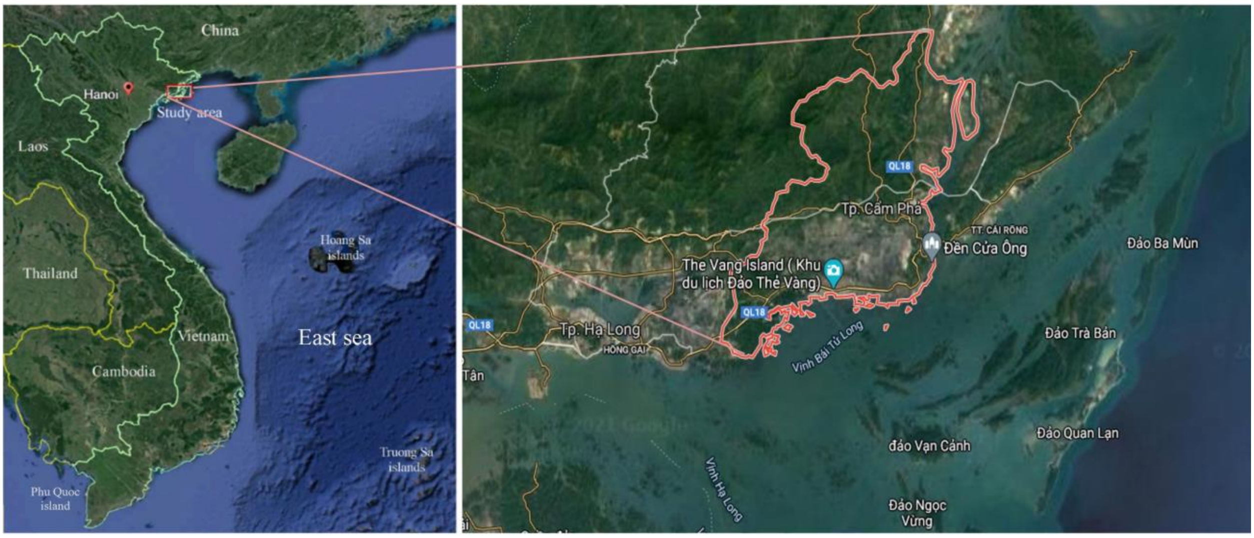

Fig. 1. Location of the study area.

3. Materials and Methods

3.1 Material and data sources

In this study, the satellite images used for extracting land use/land cover maps include: Landsat 5 Thematic Mapper (TM) images acquired in 1990, 2000, 2010 and Landsat 8 Operational Land Image (OLI) image acquired in 2020, which provided by the United States Geological Survey (USGS). Table 1 shows the details of satellite images with acquired time and resolution. Additionally, a topographic map (scale of 1:25,000) established by the Vietnamese Ministry of Natural Resources and Environment (MONRE) in 2020 was used for geocoding satellite images.

Tab. 1. List of Landsat data with acquired time and resolution (Source: USGS).

Sensor	Path/Row	Acquired Date	Local time	Resolution (m)
TM	126/045	26 November 1990	14h36'	30
TM	126/045	05 November 2000	14h56'	30
TM	126/045	03 September 2010	15h07’	30
OLI	126/045	12 November 2020	15h17’	30

3.2 Methodology

Procedure of image pre-processing is to remove distortions, precision and corrected terrain data (Level 1T) into the Universal Transverse Mercator (UTM) projection and WGS 84 datum (Zone 48, North). The images acquired in 1990, 2000 and 2010 were geo-referenced to the 2020 one. Then, the quality of the images was improved by using spectral enhancement tool.

An object-based approach was used to produce LULC map with 5 classes: Built-up, Mine area, Forest, Water body and Bare land. As LULC spatial data became more widely available (either for sale or for free), such data (e.g. LANDSAT satellite images) could be more extensively used in developing countries. Object-based image analysis (OBIA) uses geographic objects as basic units for land cover classification. This approach reduces the within class variation and generally removes salt-and-pepper effects which result from isolated pixels mainly due to misclassification [23, 24, 25, 26]. OBIA has an advantage because it incorporates various sources of information like texture, shape and position as the basis for classification [23, 24]. A number of studies were conducted to compare the performance of object-based and pixel-based classification of Landsat imagery [27, 28]. In most of these studies, OBIA produced higher classification accuracies across various land cover types. Therefore, this paper further explores and demonstrates the capability of object-oriented image analysis software eCognition for landcover classification from Landsat imagery. The combination of complex object description, hierarchical image object network, and fuzzy system makes eCognition a challenge to knowledge-based image interpretation in a range of landcover classification applications.

Figure 3 shows the methodology flowchart adopted for the analysis. In the first step, the imagery was geometrically registered and radiometrically corrected. In the second step, land cover image objects were generated using an image segmentation algorithm. The training samples used for the former classification were carefully chosen after field investigation and reference were made to available ancillary maps. Finally, the accuracy of the classification results derived from this method was assessed using reliable reference data.

For detecting and analyzing the change on earth's surface, the most standard method used for land use land cover change detection is the post classification comparison method, which entails the comparison of independently produced classified images [29]. Post classification method is proved to be the most popular approach in change detection analysis [29, 30, 31, 32, 33]. This method requires the comparison between classification maps achieved from satellite images. The approach of this method is based on the rectification of the independently classified images, then the thematic maps generated is followed by the comparison of corresponding labels to identify the areas inwhich change has occurred. In this case LULC change detection study for opencast coal mining area in Cam Pha region was carried out by using post classification method. In addition, in order to obtain the dynamic changes of each class categories during the study period (i.e., from 1990 to 2020), the ArcMap 10.3 software were used to compute the trend, class total, net change, class change, percent change and rate of each LULC change between the years 1990, 2000, 2010, and 2020.

4. Results and discussion

4.1. Accuracy Assessment

The classification accuracy is achieved by comparing the ground truth data points sampled along roads, focusing on typical land-cover types in the region (Fig. 2) with the classified images. The accuracy of each classified image was provided by eCognition Developer 8.7 software using a stratified random sampling approach with a minimum per-class sample size of 20 points to ensure that classes. The overall accuracy is calculated by dividing the number of correctly classified pixels by the total number of reference and ground pixels [34]. Although it is simple, the overall accuracy has been the most conventional approach in accuracy assessment.

An improvement to the overall accuracy assessment is the Kappa coefficient of agreement which expresses the proportionate reduction in error generated by a classifier compared with the error of a completely random classification. Reference and ground samples were randomly generated, and then the respective informational classes were labeled by referring to the ortho-corrected digital land-use map. For this research, 128 references and ground sites were selected from high resolution Google Earth images, landuse/land cover map and fieldwork in December 2020. Results of accuracy assessment of the classifed images showed that, the overall accuracy and kappa coefficient were found at 80.06% and 0.78 for classified image in 1990, 83.32% and 0.81 for classified image in 2000, 84.69% and 0.82 for classified image in 2010, 87.05% and 0.85 for classified image in 2020, respectively for LULC classified images.

http://doi.org/10.29227/IM-2021-02-44 Received: 12 Jun 2021, Accepted: 18 Sep 2021, Published: 10 Nov 2021

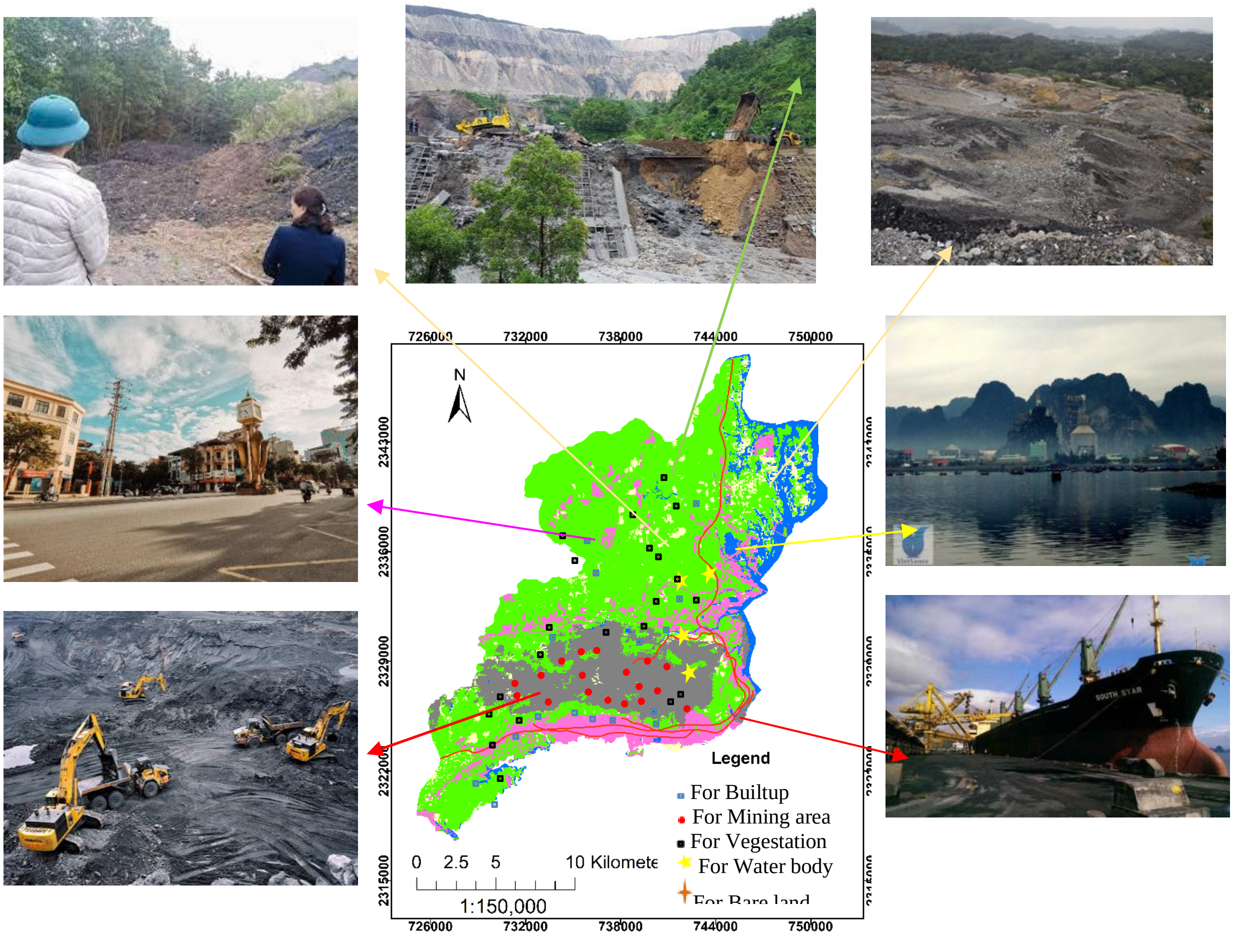

Fig. 2. Distribution of the ground truth points and field survey in the research.

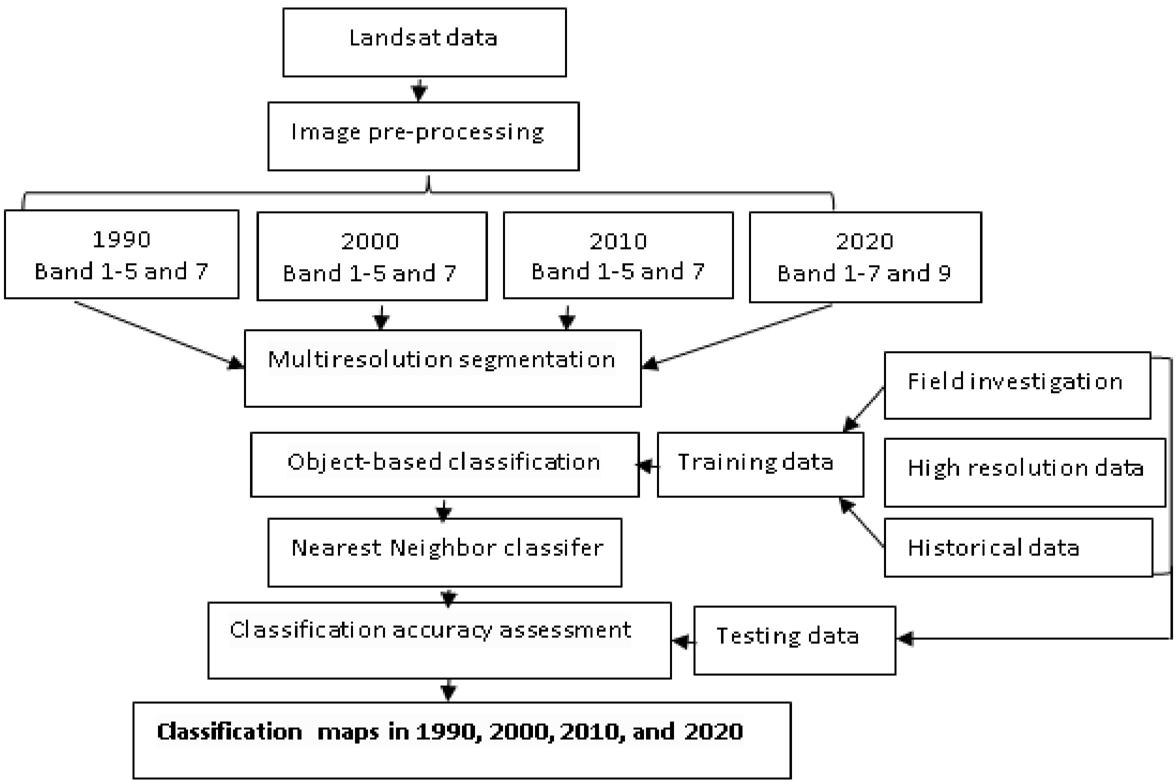

Fig. 3. Flowchart of image processing for land cover classification.

4.2 Land use/land cover maps in Campha city, Quang Ninh province, Viet Nam from 1990 to 2020

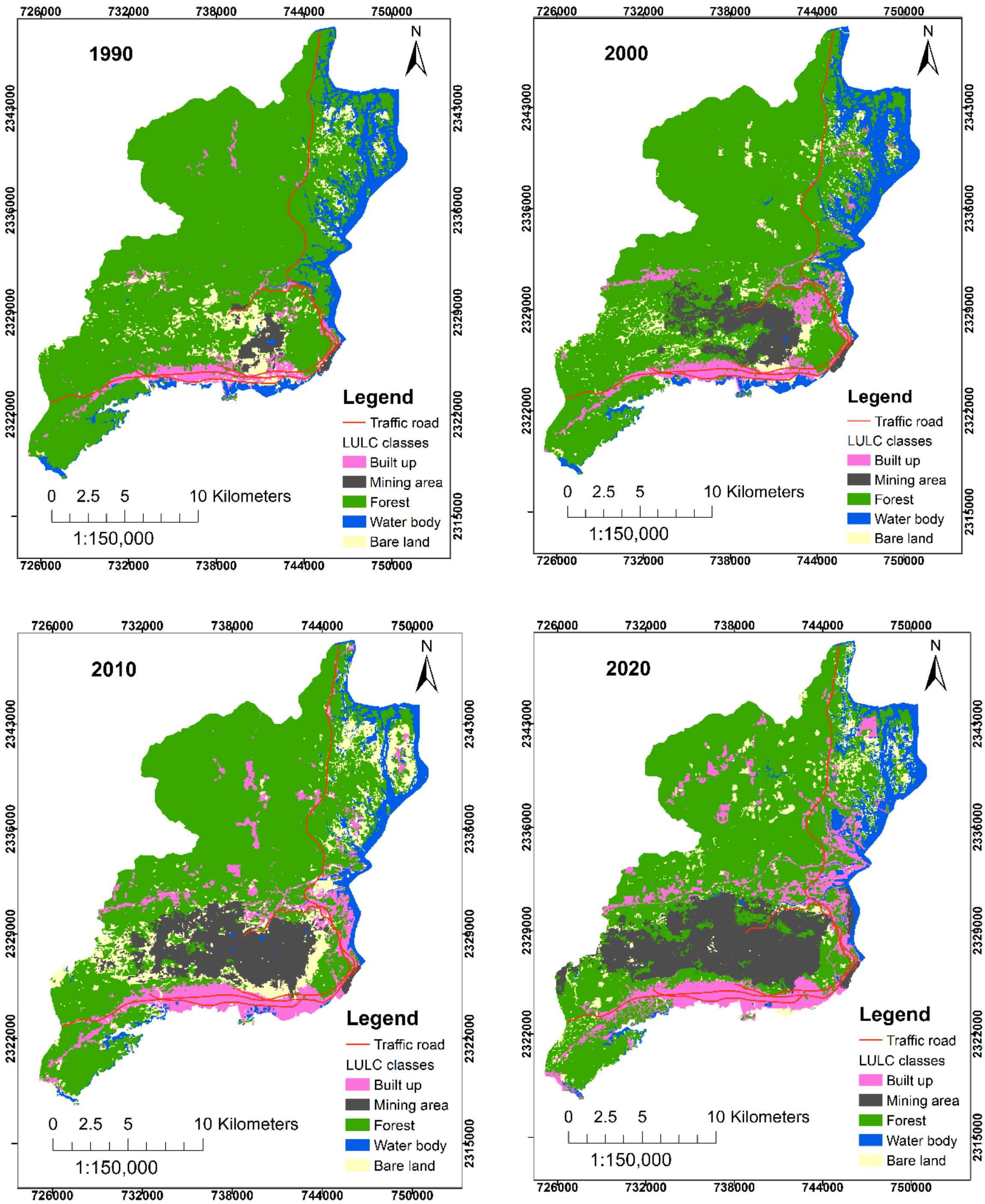

Fig. 4. Land use/land cover maps in Cam Pha city, Quang Ninh province, Viet Nam in 1990, 2000, 2010, and 2020.

The results on various land cover extents and their changes are presented in Figures 4, 5, and Table 2. Five major LULC classes: built up, forest, water body, mining area, and bare land were regconized in the study area. The LULC maps of the study area for four different years are presented in Fig. 4. Spatial distribution and area statistics of five LULC categories and the change of the area covered by each LULC category for each years are also shown in Table 2. Table 2 depicts the magnitude of change in different land use/ land cover categories in 4 period span from 1990 to 2000, 2000 to 2010, 2010 to 2020, and 1990 to 2020. Table 2 also shows the statistics of change detection analysis for the study period 1990-2020 for each class categories.

Figure 4 shows that coal mines area as a main part of the study was distributed mostly in the central or Cam Pha city. The forest areal is the most biggest in the study area, and shows decreasing trend from 1990-2020. Forest cover land contains 29322.72 ha (78.41%) in the year 1990, however decreased to 21339.27 ha (57.06 %) in the year 2020.

The water body comprises the second largest class of the study area and forms an important land cover class. The rate of the water body is with area of 3494.34 ha (9.34%) in 1990, 3997.62 ha (10.69%) in 2000, and 2781.27 ha (7.43%) in 2020.

The coal mining area that had spread over 719.55 ha in 1990 (1.92%), increased to 2491.47 ha (6.66%) in 2000, and again increased to 6313.95 ha (16.89%) in 2020. The mining area comprises the opencast coal mines and overburden dumps showed constant increase in their aerial extents during the study period. The most mining extraction process and new mine coal pits are situated in forest land area.

On the other hand it can be observed from the data that there was a shrunken in the area of all of the land cover from 1990 to 2020, excepted mine and built up cover area (Tab. 2 and Fig. 5).

Tab. 2. Area of Land use/ land cover classes and its change from 1990 to 2020 in the Cam Pha coal mines area.

LULC classes	1990 (Ha)	2000 (Ha)	2010 (Ha)	2020 (Ha)	Changed 1990 -2000 (Ha)	Changed 2000 - 2010 (Ha)	Changed 2010 - 2020 (Ha)	Changed 1990 - 2020 (Ha)
Mining area	719.55	2491.47	4534.38	6313.95	+1771.92	+2042.91	+1779.57	+5594.4
Built up	1693.80	2415.78	4073.40	4842.18	+721.98	+1657.62	+768.78	+3148.20
Forest	29322.72	26708.49	22765.50	21339.27	-2614.41	-3942.99	-1426.23	-7983.45
Water body	3494.34	3997.62	2253.33	2781.27	+503.46	-1744.29	527.94	-712.89
Bare land	2165.67	1782.72	3769.47	2119.41	-382.95	+1986.75	-1650.06	-46.26
Total	37396.08	37396.08	37396.08	37396.08	0	0	0	0

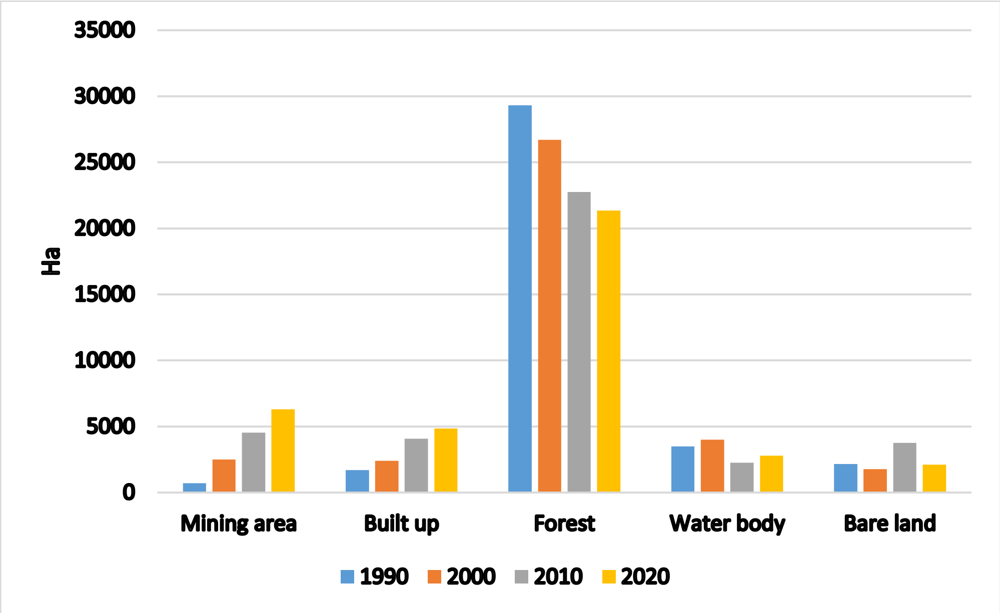

Fig. 5. Change in area under land use/land cover.

http://doi.org/10.29227/IM-2021-02-44 Received: 12 Jun 2021, Accepted: 18 Sep 2021, Published: 10 Nov 2021

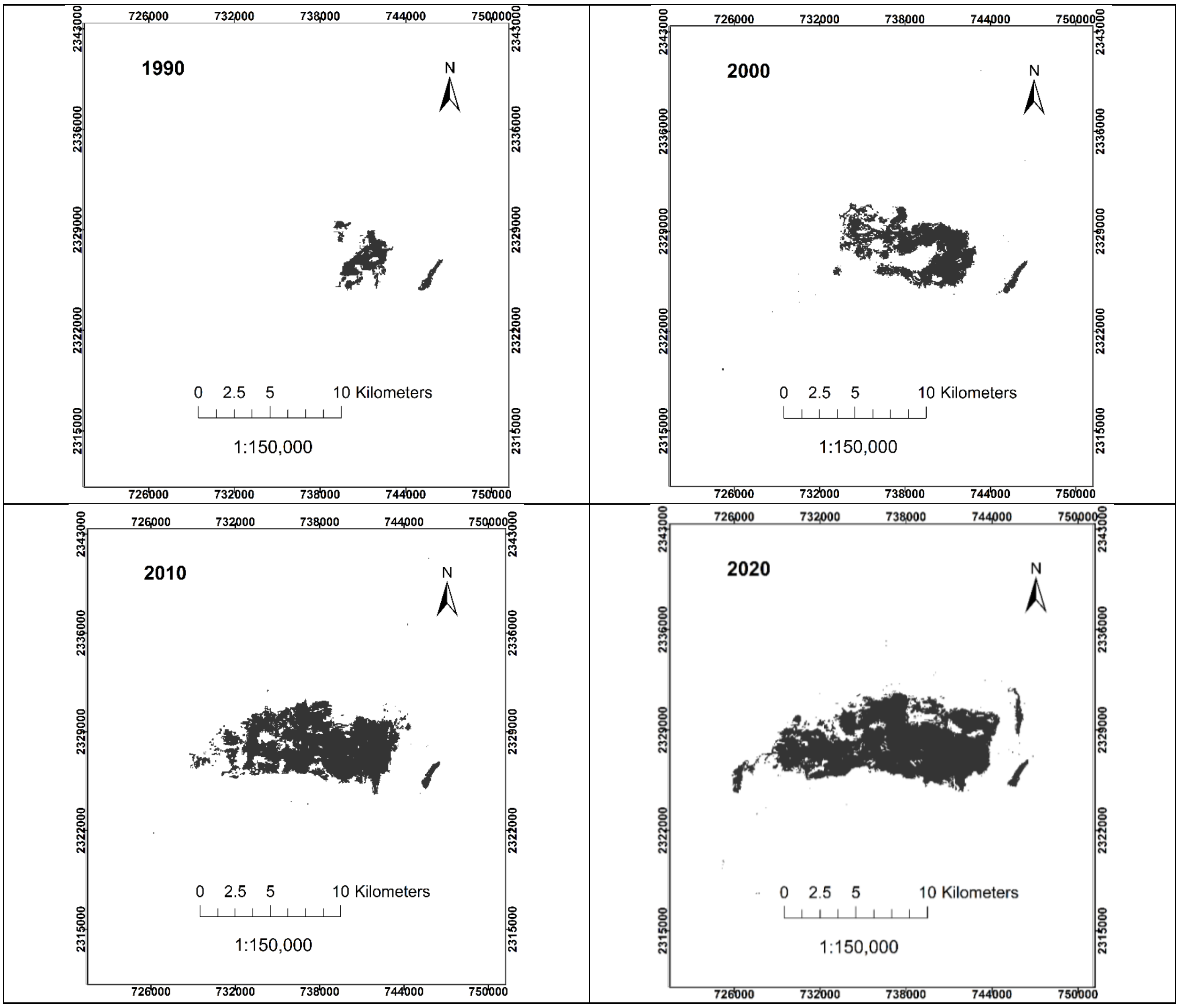

Fig. 6. The expansion of opencast coal mining areas in Cam Pha city from 1990 to 2020.

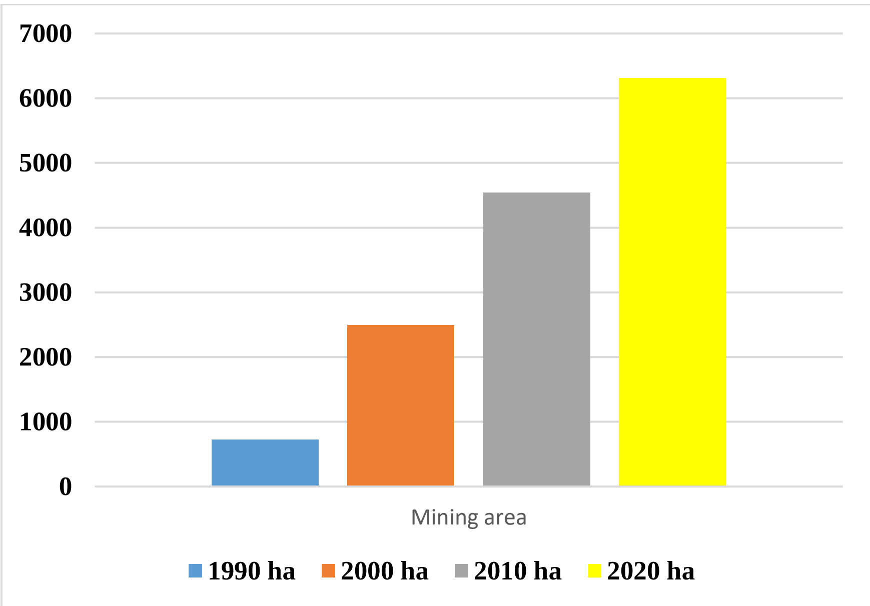

Fig. 7. Mining areal from 1990 to 2020 in Campha city, Quangninh province.

4.3. Impact of open-cast coal mines on land use/land cover change in Cam Pha city, Quang Ninh province, Viet Nam between 1990 and 2020

Land use dynamics were categorized in to five classes i.e., forest to mining, bare land to mining, water body to mining, no change and others were considered (Fig. 9). The result from the change analysis shows that there was impact of mining to different land uses/land cover, which were directly related to forest, bare land, and water body. About 43 km^2 of the forest of the study area was changed to the mining area from 1990 to 2020 and more than 10 km^2 area of bare land was converted into mining area during that period. The changes of about 3 percent of the total water body area revealed that much stress was on to the landscape during 30 years of time (Fig. 8).

The results of study revealed that from 1990 to 2020 maximum positive change is observed in the mining area, whereas maximum negative change recorded in forest land cover (Fig. 9 and Tab. 2). The mining activities in the area is a significant driver to decrease in LULC categories, and change their rates during the period from 1990 to 2020 (Fig. 8). The classified results of the forest area were the most victimized due to increasing in mining activity (from 719.55 ha in 1990 to 6313.95 ha in 2020). There was a loss 4321.620 ha of the forest area from 1990-2020 (approximate about 15%), meanwhile the water body conveted 94.95 ha (about 3%) to mining area during 30 years (Fig. 8).

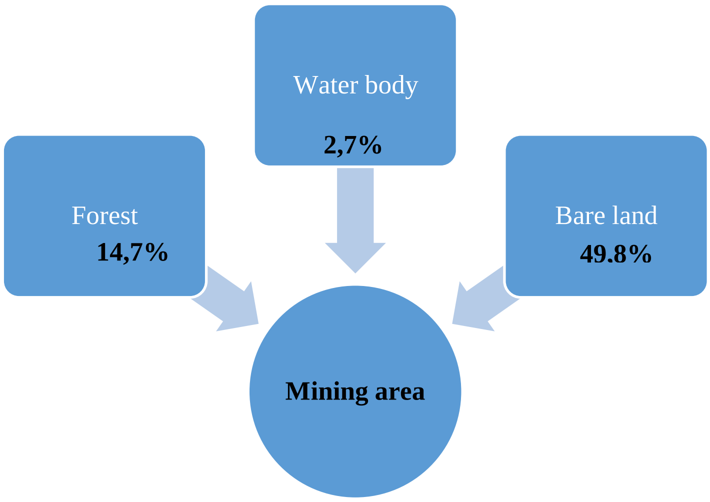

Fig. 8. The percentage of change (in %) of three LULC class converted to Mining area in the Cam Pha coalfield over time periods.

5. Conclusions

This study has revealed that considerable land use/land cover changes have taken place in Cam Pha city and around mines coal field from 1990 to 2020. Coal mining operation on large scale has significantly changed the mining environment. The mining area shows the increase of 5594.4 ha during 30 years due to the rapid increase in the coal production, meanwhile forest areas are decreasing but the plantations at overburden dumps under reclamation schemes have also been going on. It may be concluded that the land use/land cover change in the coal field has taken place due to the rapid expansion of mining and industrial activity the period of 1990 - 2020. This has resulted in the drastic changes in the land cover dynamics of the study area.

The use of multitemporal satellite data in the area has clearly demonstrated the potential of remote sensing imagery and its techniques in measuring the change pattern of LULC in the area characterized by the influx of mining. The use of remote sensing techniques can monitor the effect of opencast mining at local to regional scales due to the availability of past data, thereby helping us in reconstructing the effect of mining in the past few decades. A series of LULC maps generated by using multispectral and multitemporal remote sensing images acquired between 1990 and 2020 provides an understanding about how the LULC of an area evolved with time to its current form.

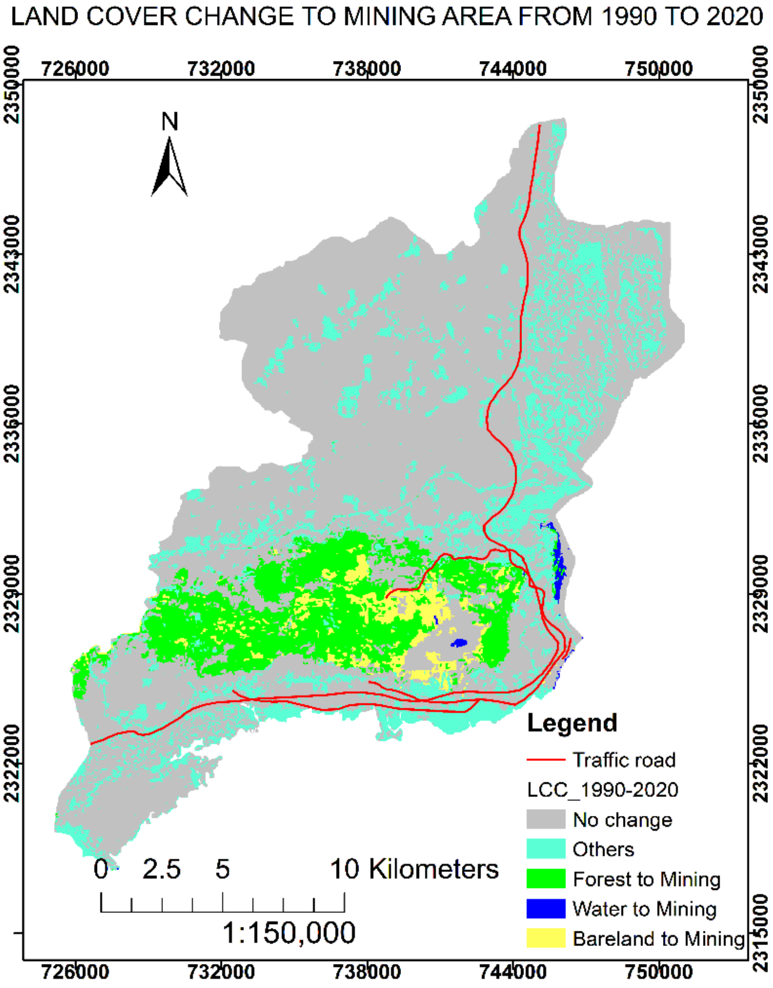

Fig. 9. Land use/land cover categories converted into mining area in Cam Pha city between 1990 and 2020.

6. Acknowledgements

The paper was presented during the 6th VIET - POL International Conference on Scientific-Research Cooperation between Vietnam and Poland, 10-14.11.2021, HUMG, Hanoi, Vietnam.

7. References

1. Sarma, K., Kushwaha, S.P.S., 2005. Coal mining impact on land use/land cover in Jaintia Hills district of Meghalaya, India using remote sensing and GIS technique. Conference Proceeding of National Conference on Geospatial Technologies, Geomatrix, 9(2005): 28-43.
2. Joshi, P.K., Kumar, M., Midha, N., Vijayanand and A. Paliwal, 2006. Assessing areas deforested by coal mining activities through satellite remote sensing images and gis in parts of Korba, Chattisgarh. Journal of the Indian Society of Remote Sensing, 34(4), Doi: 10.1007/BF02990926.
3. Prosper Laari Basommi, Qingfeng Guan, and Dandan Cheng, 2015. Exploring Land use and Land cover change in the mining areas of Wa East District, Ghana using Satellite Imagery. Open Geosci. 1(2015): 618–626, Doi: 10.1515/geo-2015-0058.
4. Chen, W., Li, X., He, H., Wang, L., 2018. A Review of Fine-Scale Land Use and Land Cover Classification in Open-Pit Mining Areas by Remote Sensing Techniques. Remote Sensing, 1(10): 15-20.
5. Prakash, A., Gupta, R.P., 1998. Land-use mapping and change detection in a coal mining area - A case study in the Jharia coalfield, India. International Journal of Remote Sensing, 3(19): 391-410, DOI: 10.1080/014311698216053.

6. Turner, M.G., Ruscher, C.L., 2004. Change in landscape patterns in Georgia. USA Land. Ecol., 4(2004): 251-421.
7. Singh, P. K., Singh, R., Singh, G., 2010. Impact of coal mining and industrial activities on land use pattern in Angul-Talcher region of Orissa, India. International Journal of Engineering Science and Technology, 2(12), 7771-7784.
8. Bocco, G., Mendoza, M., Velazquez, A., 2001. Remote sensing and GIS-based regional geomorphological mapping- a tool for land use planning in developing countries. Geomorphology, 39(3-4): 211–219.
9. Laskar, A., 2003. Integrating GIS and Multicriteria Decision Making Techniques for Land Resource Planning Master's thesis. International Institute for GeoInformation Science and Earth Observation, Enschede, Netherlands.
10. Turner, II, B.L., Lambin, E.F., Reenberg, A., 2007. The emergence of land change science for global environmental change and sustainability. Proc. Natl. Acad. Sci. U.S.A. 104(52): 20666–207671. Doi: 10.1073/pnas.0704119104.
11. Yuan, F., Sawaya, K.E, Loeffelhoz, B.C., Bauer, M.E., 2005. Land cover classifcation and change analysis of the twin cities (Minnesota) Metropolitan Area by multitemporal Landsat remote sensing, Remote Sensing of Environment, 98(2005): 317-328.
12. Charou, E., Stefouli, M., Dimitrakopoulos, D., 2010. Using Remote Sensing to Assess Impact of Mining Activities on Land and Water Resources, Mine Water Environ, 29(1): 45–52.
13. Elsayed, A., El. Gammal, Salem M. Salem, Alaa Eldin A. El Gammal, 2010. Change detection studies on the world's biggest artificial lake (Lake Nasser, Egypt), The Egyptian Journal of Remote Sensing and Space Science, 13(2): 89-99.
14. Coppin, P., Jonckheere, I., Nackaerts, K., Muys, B., Lambin, E., 2004. Digital change detection methods in ecosystem monitoring: a review, International Journal of Remote Sensing, 25(9): 1565-1596.
15. Lu, D.S., Mausel, P., Brondízio, E.S., Moran, E., 2004. Change detection techniques, International Journal of Remote Sensing, 25(12): 2365-2407.
16. Ha Thu Thi Le, Nhat Dac Doan, Lam Thi Huynh, Thuy Thanh Thi Nguyen, Hiep Ngoc Thi Nguyen, Thuy Thanh Thi Luu, Chinh Cong Thi Vo, 2020. The influences of land cover structure on surface urban heat islands by using remote sensing and GIS, Journal of Mining and Earth Sciences, 61(2): 76-85.
17. Jensen, J.R., 2000. Remote Sensing of the Environment: An Earth Resource Perspective, 2nd Ed. Prentice-Hall, Inc.; Upper Saddle River, 544.
18. Mi, J., Yang, Y., Zhang, S., An, S., Hou, H., Hua, Y., Chen, F., 2019. Tracking the Land Use/Land Cover Change in an Area with Underground Mining and Reforestation via Continuous Landsat Classification. *Remote Sensing*, 11(14), 1719.
19. Meshesha, T.W., Tripathi, S.K., Khare, D., 2016. Analyses of land use and land cover change dynamics using GIS and remote sensing during 1984 and 2015 in the Beressa Watershed Northern Central Highland of Ethiopia. Model. Earth Syst. Environ., 2, (168), DOI 10.1007/s40808-016-0233-4.
20. Waldemar, M., 2018. Coal Mining and Coal Preparation in Vietnam. Journal of the Polish Mineral Engineering Society, 275-286, http://doi.org/10.29227/IM-2018-01-40.
21. Dung, L.V., 1994. Problems of beneficiation in coal preparation plants in Vietnam. New Trends in Coal Preparation Technologies and Equipment. Proceedings 5. of the 12th International Coal Preparation Congress, Cracow, Poland, 553-555. 6. ISBN 2-88449-139-2.
22. Mustafin, M.G., Tran Thanh-Son, Tran Manh-Hung, 2019. Comprehensive impact assessment development of the Coal field Campha in Vietnam to the coastal territory, IOP Conf. Series: Materials Science and Engineering 698, doi:10.1088/1757-899X/698/5/055014.

23. Hua Zhang, Yue Sun, Wenzhong Shi, Dizhou Guo & Nanshan Zheng, 2021. An object-based spatiotemporal fusion model for remote sensing images., European Journal of Remote Sensing, 54(1): 86-101, DOI: 10.1080/22797254.2021.1879683.
24. Sunil Bhaskaran, Shanka Paramananda, Maria Ramnarayan, 2010. Per-pixel and object-oriented classification methods for mapping urban features using Ikonos satellite data. Applied Geography, 30: 650 – 665, doi:10.1016/j.apgeog.2010.01.009.
25. Desheng Liu & Fan Xia, 2010. Assessing object-based classification: advantages and limitations. Remote Sensing Letters, 1(4): 187-194, Doi: 10.1080/01431161003743173.
26. Ha Thu Thi Le, Long Van Hoang, Trung Van Nguyen, 2021. Object-oriented classification for landcover of North Thang Long Industrial area using Worldview-2 data, Journal of Mining and Earth Sciences, 62(1): 10 -18.
27. Jing Qian, Qiming Zhoua, Quan Houa, 2007. Comparison of pixel-based and object-oriented classification methods for extracting built-up areas in aridzone, ISPRS Workshop on Updating Geo-spatial Databases with Imagery & The 5th ISPRS Workshop on DMGIS.
28. Sarmadian, F., 2007. Comparisons of Object-Oriented and Pixel-Based Classification of Land Use/Land Cover Types Based on Lansadsat7 ETM + Spectral Bands (Case Study: Arid Region of Iran). American-Eurasian J. Agric. & Environ. Sci., 2(4): 448-456.
29. Anil, Z.C, Chitade, S.K., 2010. Impact analysis of open cast coal mines on land use/ land cover using remote sensing and GIS technique: a case study. International Journal of Engineering Science and Technology, 2(12): 7171-7176.
30. Giriraj, A., Babar, S., Reddy, C.S., 2008. Monitoring of Forest Cover Change in Pranahita Wildlife Sanctuary,Andhra Pradesh, India Using Remote Sensing and GIS. Journal of Environmental Science and Technology, 1: 73-79.
31. Al-shateri Hoshmand Ahmed Azeez1, Shuchrat Mukhitdinov, 2020. Land use land cover change detection in the mining areas of V. D. Yalevsky coal mine Russia. International Scientific Conference "Problems of Complex Development of Georesources", 192, https://doi.org/10.1051/e3sconf/202019204021.
32. Anderson, P.R., Vinicius, A.S., Alex, M.S., Ana, C.F.X., Otto, C.R.F., Jorge, A.M., 2020. Impact of mining activities on areas of environmental protection in the southwest of the Amazon: A GIS- and remote sensing-based assessment. Journal of Environmental Management, 263, 110392.
33. Le Thi Thu Ha, Le Thi Van Anh, Pham Thi Lan, Nguyen Van Trung, 2018. Impact of urbanization on land surface temperature using remote sensing and GIS: A case of Tay Ho district, Hanoi city, Vietnam. Journal of Mining and Earth Sciences, 59(6): 64 -73.
34. Congalton, R.A., 1991. Review of assessing the accuracy of classifcations of remotely sensed data, Remote Sensing of Environment, 37(1): 35 - 46, https://doi.org/10.1016/0034-4257(91)90048-B.

http://doi.org/10.29227/IM-2021-02-44 Received: 12 Jun 2021, Accepted: 18 Sep 2021, Published: 10 Nov 2021