ABSTRACT

Geoecology combines ecology and geography studies. In line with that, geoecology is an interdisciplinary and multidisciplinary discipline that integrates geology and biology to investigate the many impacts of geological processes on historical and modern biogeographic patterns, as well as the causes and effects of geoedaphics on biota at all temporal and geographical scales. Modeling typically use geographic information to describe spatial locations, characteristics, change over time etc. Its functions give analytical findings in ArcGIS. These frequently produce new data layers and related tabular data in the GIS, allowing users of ArcGIS to model a range of spatial issues and share the outcomes. Moreover, Mount Merapi National Park (MMNP), one of the active volcanos in Indonesia, has past volcano eruption history since 1911 up to date. Specifically, Plawangan Hill, a part of the MMNP, has periodically experienced volcanic eruptions. This study aims to construct the geoecological model for conservation of Plawangan Hill. The primary goal was divided into three main objectives. The first objective is to analyze the nutrient levels in the soil and the vegetation development in regions directly and indirectly impacted by a volcanic eruption. Additionally, the aim is to determine the optimal time for commencing planting activities on Plawangan Hill after the eruption. The second objective is to develop a geo-ecological model by creating a micro-zonation for vegetation on Plawangan Hill for conservation. The third objective is to examine the alterations in land cover and carbon storage on Plawangan Hill before and after the eruption of Merapi Mountain for four years (2009, 2013, 2017, and 2023).

Plawangan Hill was classified into two regions, namely directly impacted, and indirectly affected, based on its geological features related to its eruption history. A field study was done to collect soil samples and record the growth of vegetation in the surrounding area, specifically in terms of Dbh (cm) and height (m). The soil samples were taken to the laboratory of the agricultural department at Universitas Gadjah Mada for analysis to acquire the outcome. Furthermore, the DEMNAS data was obtained to generate maps based on the digital elevation model (DEM), digital terrain model (DTM), and digital slope model (DSM). The micro-zonation of vegetation was developed by using the criteria and sub-criteria derived from other objectives, as documented in the literature of previous studies. This study employed the K-means clustering algorithm to discern variations in the criterion. The Analytical Hierarchy Process (AHP) analytical technique was utilized to estimate the weight and score of criteria that were vital for producing the micro-zonation of vegetation. Hence, the data collection procedure entailed conducting comprehensive interviews and manually completing questionnaires with experts. A total of four experts participated, including professionals from Mount Merapi National Park (MMNP) and the forestry department of Universitas Gadjah Mada. The spatial evaluation was conducted using ArcMap 10.4 software following the processing of the Analytic Hierarchy Process (AHP) utilizing an Excel sheet. Moreover, the research location has been designated as a conservation

area that has experienced intermittent effects from volcanic eruptions, both via direct and indirect means. Data was collected using the imagery from Landsat 7 and 8. The forest canopy density (FCD Mapper) model examined land cover changes and quantified the research site's carbon storage.

The DEM and DSM of Plawangan Hill were classified from very low to very high classes and flat to extremely steep slopes, respectively. Results showed that soil pH was usually 5.93–6.54. The soil had low to medium nitrogen but very low phosphorus and potassium. Organic C varied from low to medium (1.44% to 3.22%), while the carbon-nitrogen ratio was medium. Erupted material age increased soil N, K, organic matter, carbon, and C-N ratios. It was also shown that plant growth was excellent under indirect (IA) and directly influenced (DA) circumstances, as measured by Dbh and H. In indirectly impacted (IA) and directly affected (DA) regions, soil parameters are correlated with plant growth differently. The study concluded that volcanic debris had a substantial impact on the soil properties and plant growth of Plawangan Hill. The findings also indicated that, after a volcanic eruption, the soil required a minimum of four years to recuperate and enable the establishment of plants.

The results showed that the AHP analysis of the micro-zonation of vegetation resulted in the highest weight (0.197) for the history of volcanic eruptions. Following this were the vegetation characteristics based on altitude (0.128), land cover (0.117), MMNP zone (0.096), elevation (0.092), slope (0.082), intensity of rainfall (0.073), and soil nutrients (0.056). The micro-zonation of vegetation further resulted in five clusters and five priorities. Cluster 3 became priority 1 and had an area of 33.56 hectares, or 24%, followed by Cluster 1, which became second priority and had an area of 26.55 hectares, or 19%. Cluster 5 became the third priority and had an area of 36.08 hectares, or 26%, while Cluster 4 became the fourth priority and had an area of 35.15 hectares, or 25%. The last zone was cluster 2, which became the fifth priority and had an area of 6.88 hectares, or 5%. The findings then proposed activities that could be greatly beneficial to apply to Plawangan Hill as a conservation area. The Plawangan Hill wilderness zone comprised nearly 70% of the area that was designated as a priority zone. All clusters, except for cluster 4, exhibited attributes associated with the utilization and wilderness zones of research areas. The MMNP's managerial team shall prioritize and take significant measures to conserve the land, which is designated as a utilization zone. It is imperative to reforest and restore certain regions of Plawangan Hill with indigenous vegetation that is well-suited to the ecosystems of the Low Land Tropical Forest and the Low Mountain Tropical Forest.

The study revealed fluctuations in land cover transformations from 2009 to 2023. The land cover of Plawangan Hill has seen a decrease in density from 2009 to 2023. Moreover, alterations in land cover directly influenced variations in carbon storage. The primary factors contributing to these alterations were the trees' age, vegetation types, succession stage, and history of eruptions.

Keywords: geoecology; vegetation characteristics; K-mean cluster; AHP; land cover; carbon storage; Mountain Merapi; Model; Plawangan Hill