

INTISARI

Busur vulkanik Pulau Sumatra terbentuk akibat subduksi *oblique* antara Lempeng Indo-Australia dan Lempeng Eurasia, yang menghasilkan jajaran gunung api Kuartar sepanjang Bukit Barisan. Proses konvergensi miring ini memicu terbentuknya sistem Sesar Sumatra yang sejajar dengan zona subduksi dan berperan sebagai struktur tektonik utama di wilayah tersebut. Penelitian ini bertujuan untuk mengidentifikasi karakteristik morfologi gunung api serta menganalisis pengaruh kontrol tektonik terhadap perkembangan *edifice* vulkanik di daerah penelitian. Untuk memperoleh informasi tersebut, dilakukan analisis penginderaan jauh untuk mengekstraksi data parameter morfometri berupa tinggi basal dan tinggi kawah, luas basal dan luas kawah, rasio eliptisitas basal dan kawah, serta arah orientasi elongasi basal dan arah terbukanya kawah. Data morfometri kemudian dikorelasikan dengan parameter tektonik berupa jarak pusat gunung api terhadap sesar, panjang sesar serta parameter geometri lempeng subduksi/*slab* yaitu *slab depth*, *slab dip*, menggunakan menggunakan *Principal Component Analysis* (PCA) dan *Random Forest*. Berdasarkan hasil analisis data, di temukan bahwa karakteristik morfologi gunung api monogenetik memiliki basal dengan luas $\sim 2,52$ km², tinggi $\sim 0,27$ km, dan rasio eliptisitas $\sim 0,79$, serta kawah dengan luas $\sim 0,055$ km², tinggi $\sim 0,054$ km, dan rasio eliptisitas $\sim 0,91$. Stratovulkanik memiliki basal dengan luas $\sim 40,79$ km², tinggi $\sim 1,49$ km, dan rasio eliptisitas $\sim 0,62$, serta kawah dengan luas $\sim 0,885$ km², tinggi $\sim 0,141$ km, dan rasio eliptisitas $\sim 0,76$. Kaldera memiliki basal dengan luas $\sim 277,48$ km², tinggi $\sim 0,90$ km, dan rasio eliptisitas $\sim 0,66$, serta kawah dengan luas $\sim 32,67$ km², tinggi $\sim 0,657$ km, dan rasio eliptisitas $\sim 0,685$. Selain itu, melalui korelasi menggunakan *machine learning*, dapat dijelaskan bahwa variasi morfometri dikontrol oleh faktor struktur yaitu jarak gunung api terhadap sesar dan panjang sesar mayor serta faktor geometri lempeng subduksi yaitu *slab depth* dan *slab dip*.

Kata kunci: *Principial Component Analysis*, *Random Forest*, morfometri gunung api, Sesar Sumatra

ABSTRACT

The volcanic arc of Sumatra Island was formed due to oblique subduction between the Indo-Australian Plate and the Eurasian Plate, resulting in a chain of Quaternary volcanoes along the Barisan Mountains. This oblique convergence also triggered the formation of the Sumatran Fault system, which runs parallel to the subduction zone and acts as a major tectonic structure in the region. This study aims to identify the morphological characteristics of volcanoes and analyze the influence of tectonic control on the development of volcanic edifices in the study area. To obtain this information, remote sensing analysis was conducted to extract morphometric parameters, including basal and crater height, basal and crater area, basal and crater ellipticity ratios, as well as the orientation of basal elongation and crater opening. The morphometric data were then correlated with tectonic parameters, including the distance of the volcano center to the nearest fault, fault length, and subduction slab geometry parameters (slab depth and slab dip), using PCA and Random Forest. Based on the data analysis, the morphological characteristics of volcanoes were found to be as follows: monogenetic volcanoes have a basal area of $\sim 2.52 \text{ km}^2$, height of $\sim 0.27 \text{ km}$, and ellipticity ratio of ~ 0.79 , with a crater area of $\sim 0.055 \text{ km}^2$, height of $\sim 0.054 \text{ km}$, and ellipticity ratio of ~ 0.91 ; stratovolcanoes have a basal area of $\sim 40.79 \text{ km}^2$, height of $\sim 1.49 \text{ km}$, and ellipticity ratio of ~ 0.62 , with a crater area of $\sim 0.885 \text{ km}^2$, height of $\sim 0.141 \text{ km}$, and ellipticity ratio of ~ 0.76 ; calderas have a basal area of $\sim 277.48 \text{ km}^2$, height of $\sim 0.90 \text{ km}$, and ellipticity ratio of ~ 0.66 , with a crater area of $\sim 32.67 \text{ km}^2$, height of $\sim 0.657 \text{ km}$, and ellipticity ratio of ~ 0.685 . Furthermore, correlation analysis using machine learning indicated that morphometric variations are controlled by structural factors, namely the distance of the volcano to the fault and the length of the major fault, as well as subduction slab geometry factors, including slab depth and slab dip.

Keywords: *Pricipal Component Analysis, Random Forest, volcanic morphometry, Sumatra Fault*