Spatial Topographic Changes of Phetchabun basin Using Digital Elevation Model and Interferometric Synthetic Aperture Radar Techniques

Author : Ms. Thitima Wongthibet 640510422
Advisor : Assistant Professor Dr. Pichawut Manopkawee
Department of Geological Sciences, Faculty of Science, Chiang Mai University
Advisor : Assistant Professor Dr. Chanida Suwanprasit
Department of Geography, Faculty of Social sciences, Chiang Mai University

ABSTRACT

Phetchabun province represents a region of fault-block mountains and a large basin in the middle. The evolution of tectonics and the difference in lithology and climate make the region more complicated in terms of the geomorphology of Phetchabun province. This study analyzes the spatial and temporal changes in the Phetchabun Basin using the slope, concavity, channel steepness indices, and the distribution of knickpoints across five major watersheds in Phetchabun. The results show that the highest slope values in the eastern part of the central area and the basin, whereas the northern and southern areas exhibit significantly lower values. The maximum channel steepness index (k_{sn}) is 259.04 $m^{0.9}$ in the eastern part of the northern study area, followed by 238.60 $m^{0.9}$ in the central basin and 202.33 $m^{0.9}$ in the western part of the central zone. The concavity index in the eastern and western parts of the central zone exhibits the most significant variations, similar to the density of knickpoints in the middle of the basin, suggesting that the higher uplift occurs in the middle and western parts of the central area. It is related to surface changes detected using Interferometric Synthetic Aperture Radar (InSAR), which reveals subsidence and uplift in the central part of the basin. The subsidence values range from -0.046 to -0.006 m, while the highest uplift reaches 0.037 m. In the southern study area, the subsidence is more pronounced, with a maximum of -0.221 m, compared to -0.105 m in the central and northern parts of the basin. Regarding lithology, the central area comprises sedimentary rocks from the Korat Group, which exhibit moderate weathering rates. In contrast, the southern part of the study area contains intrusive igneous rocks and limestone with high precipitation, resulting in higher weathering rates and significant subsidence. It is related to surface changes in the southern part of the study area, where subsidence is greater than in the central and northern parts of the basin. These findings highlight the significant role of geological factors in controlling geomorphic evolution. Furthermore, the results are linked to surface changes observed using InSAR techniques.

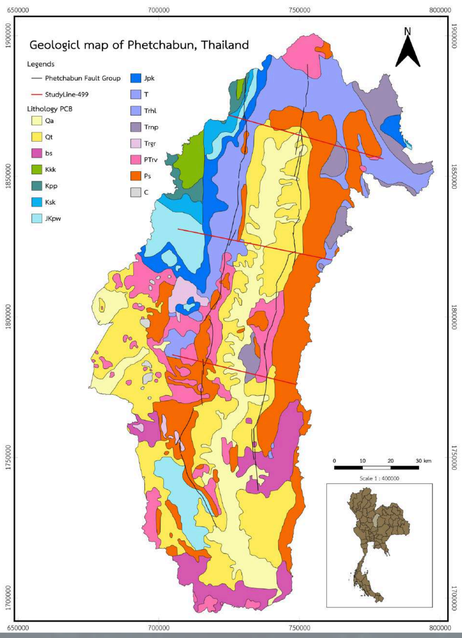
OBJECTIVES

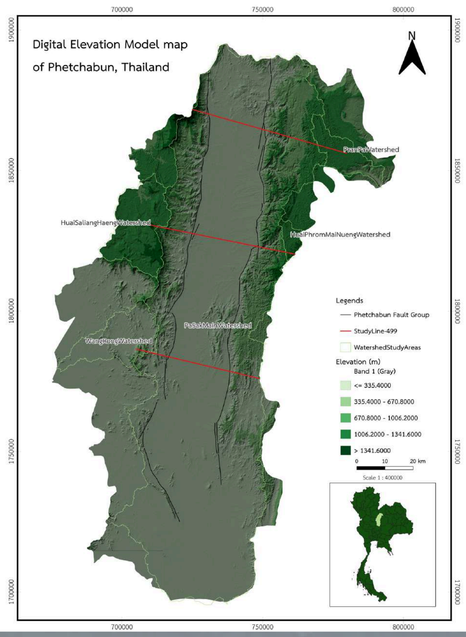
- To study the influence of lithology, climate, and tectonic changes of the Phetchabun Fault Zone on the spatial variation of geomorphic characteristics of first-order streams.
- To model the topographic changes in the Phetchabun Basin using a Digital Elevation Model (DEM) and Interferometric Synthetic Aperture Radar (InSAR) techniques.

STUDY AREA

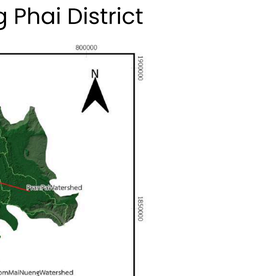
Study area covering 6 Districts

- Study line 1 covers Lom Kao, Lom Sak District
- Study line 2 covers Mueang District
- Study line 3 covers Nong Phai District





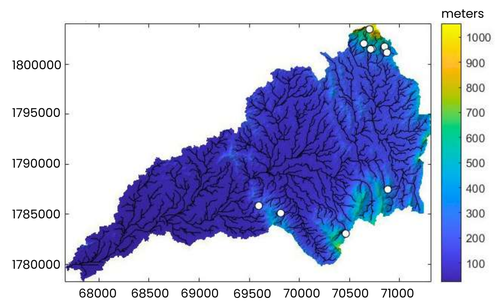
METHODOLOGY



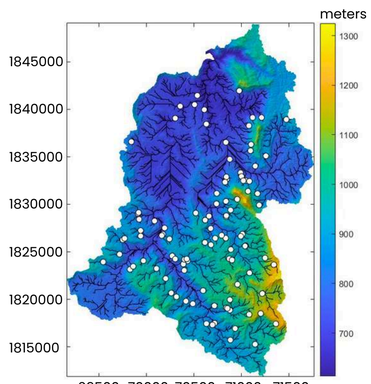
- Using Geomorphic-related factors to assess tectonic activity
  - Slope grafient and concavity index
  - Normalized Channel Steepness Index, k_{sn}
  - Gradient basin-averaged k_{sn} values
  - Knickpoint
- Using Interferometric Synthetic Aperture Radar (InSAR) to assess land subsidence or tectonic plate movements.
  - Result displacement area and value
- Using averaged rainfall in 55 year (Thai Meteorological Department)
- Using lithology in study area to analyze the weathering rate.
- Using rate movement from active fault (Phetchabun fault zone) (Department of Mineral Resources, 2020)
- Fieldwork to assess the tectonic activity from geomorphology along the fault.

RESULTS

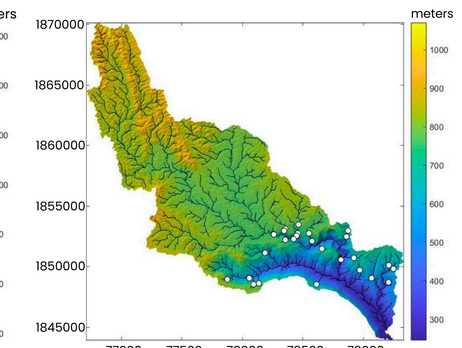
- Channel steepness and concavity index with Knickpoint



(A) Wang Rong Watershed

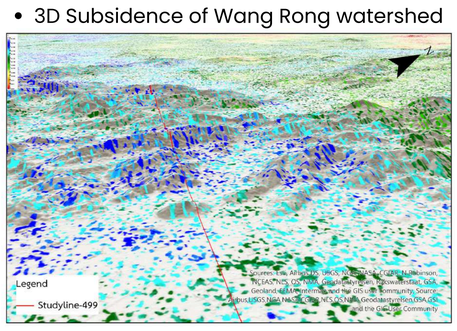


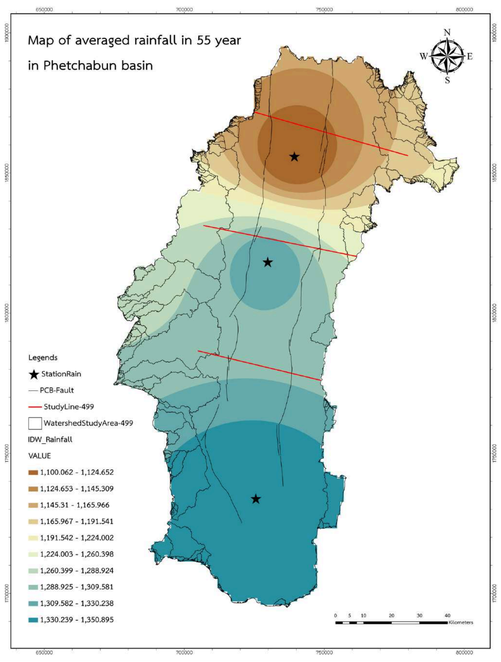
(B) Huai Saliang Haeng Watershed



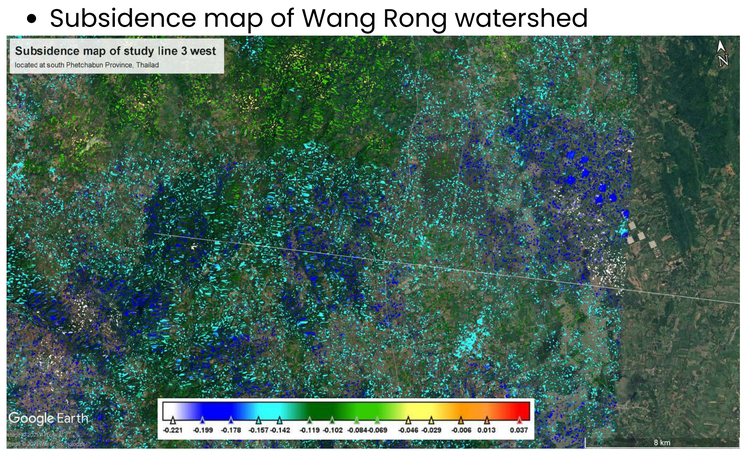
(C) Pran Pa Watershed

- 3D Subsidence of Wang Rong watershed

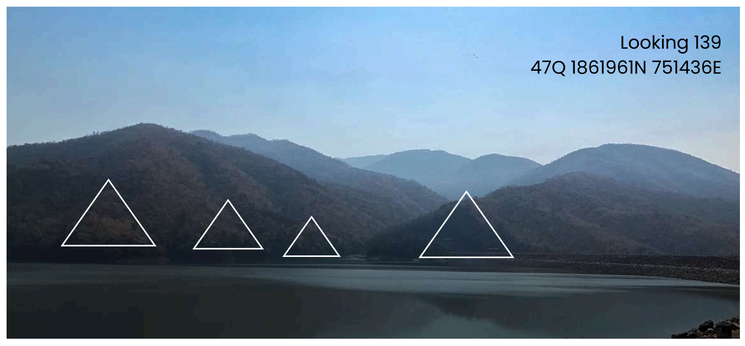




- Subsidence map of Wang Rong watershed



- Triangular facets at Huai Khon Kaen Reservior, Lom Sak District, Phetchabun, Thailand



CONCLUSION

The study indicates that high stream gradient index values in the central and upper regions, along with numerous knickpoints, suggest vertical uplift or subsidence, influencing erosion patterns. Lithology and 55 years of rainfall data also play a key role in geomorphic changes, with limestone in the south contributing to karst topography, while the central and upper regions show lower weathering rates. InSAR analysis confirms significant subsidence in the south. These findings highlight the impact of geological factors on landscape evolution in Phetchabun, with Sentinel-1 SAR imagery enhancing spatial and temporal change detection.

REFERENCE

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