別紙様式８

研 究 主 論 文 抄 録

論文題目

リモートセンシング，地球統計学，地形生態学の統合による2008年四川大地震（中国）震央付近の植生形態と断裂帯との関係の解明

Clarification of the relationship between vegetation pattern and fracture zones around the 2008 Sichuan Earthquake epicenter (China) by integrating remote sensing, geostatistics and landscape ecology

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主論文要旨
《本文》

This dissertation aims to clarify spatial-temporal vegetation pattern associated with fracture zone by combining techniques of remote sensing, geographic information system (GIS), geostatistics and landscape ecology.

Vegetation pattern appears different characteristics across different scale. Factors that influence the pattern are scale dependence. At a global scale, vegetation pattern is dependent on solar radiation, climate and temperature. At a local scale, small scale, topography becomes a dominant factor controlling vegetation distribution because it can reallocate locally water and solar radiation. However, fracture zones including faults, gauges and continuous joints may influence the vegetation pattern more strongly than topography by changing hydraulic conductivity and other soil properties around the fracture zone. In particular, vegetation patterns such as alignment of the same vegetation

type may be formed by fracture zones that control groundwater flow and produce various soil types by strong weathering processes. Accordingly, the distribution of vegetation is expected to correlate with the fracture zone, which is the main focus of this dissertation.

A suitable study area, situated near the epicenter of the Wenchuan earthquake, was selected for the purposes of this study. Initially, a segment tracing algorithm (STA) method was applied for identifying the regional fracture system through lineament extractions from a shaded digital elevation model with 25 m mesh. Additionally, a lineament density map was produced to characterize the heterogeneity of lineament distribution by counting the number of centers of lineaments per km^2. Three major fracture zones were detected from the dense zones of the interpreted fractures, which corresponded with Pitiaohe, Gengda and Yingxiu Faults from northwest to southeast, by referring to a geological structure map of Sichuan province and literature from state forestry administration, R.R. China. The strikes of these three fracture zones are N30-50°E.

The destruction of vegetation caused by the Wenchuan earthquake was revealed from change of NDVI values of ETM+ images before and after the earthquake. The ruined distribution of vegetations was clarified to be generally consistent with the fracture zones by comparing ruined distribution map with the lineament density map.
To examine the distribution of vegetation types and its relationship to fracture zones, vegetation cover map was firstly made by applying a hybrid unsupervised-supervised approach to advanced land observing satellite (ALOS) image. Seven categories of the main vegetation types were defined: evergreen broad-leaved forest; deciduous broad-leaved forest; deciduous and evergreen broad-leaved forest; coniferous forest; meadow; farmland; shrub and the other class, such as snow, ice, and water body, which was unrelated to vegetation. Distribution areas of each vegetation type were combined with the graded lineament density which was defined based on the quartile of cumulative distribution to examine the positional relationship between the vegetation pattern and the fracture zones. Moreover, anisotropy of NDVI semivariogram was used to examine whether the fracture zones affected the vegetation trend. According to the results, forests persisted in the less fractured areas, while farmlands relatively tend to persist in fractured areas with high level. On the other hand, anisotropy results revealed that vegetation pattern tend to be more continuous along the strikes of fracture zones, which indicated that fracture zones have certain impacts on forming vegetation pattern.

Previous work focused on vegetation distribution and its change pattern associated with fracture zones. A further research aims at quantifying the special heterogeneity change of vegetation pattern, because we not only have to detect change, but also have to determine the magnitude and rate of change. Geostatistics and landscape metrics

were employed to quantify the spatial heterogeneity of vegetation pattern in numerical and categorical map, respectively. NDVI semivariogram reveals the variability and structure change of vegetation pattern. Landscape metrics depicts the composition and configuration changes of vegetation pattern.

Remote sensing, GIS, geostatistics techniques were well applied in this dissertation. Remote sensing and GIS have been wide used in landscape ecology, however, the application of geostatistics in ecology have been not penetrated deeply. The combination of remote sensing and geostatistics for characterizing vegetation pattern associated with fracture zones is a new research in vegetation ecology, which is bound to be brand view in this field.