

論文の内容の要旨

論文題目 Geomorphological and geoenvironmental approaches for evaluating karst terrain
 in Guizhou Province, China
 (中国貴州省におけるカルスト地域の地形学・地圏環境学的研究)

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Karst areas account for almost 20% of lands in the world and more than a quarter of the world's population depends on water from karst areas. There are several environmental problems related to karst landscape, such as soil erosion, sinkhole collapse, rocky desertification, and shortage of land resources. In order to better understand such problems based on knowledge about geomorphic systems composed of karst landforms, this paper develops a method of semi-automatic landform classification, and conducted morphometric, land-use and soil erosion analyses. The study areas are the western and central parts of Guizhou Province, China, having a typical karst landscape subject to recent desertification and soil erosion.

The semi-automatic approach was employed to classify karst landforms into sinkholes, tower karst hills and cockpit karst hills. The methodology of the landform classification is summarized as follows: 1) identification and digitization of actual sinkholes, tower karst and cockpit karst using aerial imagery, integrated with field validation; 2) sinkhole delineation from a DEM (digital elevation model); 3) exclusion of water area and distinct pseudo-sinkhole artifacts; 4) contour line extraction from the DEM; 5) delineation of hill-area polygons by defining the basal contour line for each hill; and 6) calculation of the number of contour lines and classification of cockpit karst (frequency > 1) and tower karst (frequency = 1). As a result, 423 sinkholes, 439 tower karst hills and 403 cockpit karst hills were identified in the central part of Guizhou province, and 38 sinkholes, 112 tower karst hills and 35 cockpit karst hills were identified in the western part. Comparisons with field observations indicate that the overall accuracy of the classification was higher than 85%.

For understanding the characteristics of karst landforms quantitatively, we analyzed the morphometric characteristics of the classified karst landforms. Fourteen morphometric parameters were measured in terms of horizontal, vertical and overall shapes. The obtained morphometric parameters were compared among different landform types, and the same landform type but in different study areas. It was found that the morphometric characteristics of sinkholes generally follow those of the field-based approach.

Based on the obtained knowledge about landforms, this thesis examined the two most important karst-related environmental issues in the study areas, land-use shortage and soil erosion. Land-use maps were generated from remote sensing data supported by field observations. The result indicated that the study areas were highly cultivated even in the

relatively steep hilly areas. The sinkhole areas are dominated by agricultural land-use with ratios of 51% to 83%, and over 50% of the tower and cockpit karst hills are also developed for agriculture. This situation has resulted in a serious problem of soil erosion and rocky desertification. We also evaluated erosion rates of a selected closed basin using the RUSLE model. The model gave a mean annual erosion rate of $30.24 \text{ Mg ha}^{-1} \text{ y}^{-1}$, which is consistent with the result of a previous study based on an in-situ sedimentation volume measurement in the central depression accumulated during 1980 to 2009. This situation allows us to use the RUSLE for more detailed evaluation of erosion distribution. The estimation of soil loss for different land-use types indicated that erosion from dense forest and grass land is much lower than that from other areas with stronger human impact. This suggests that human disturbance has significantly accelerated soil erosion and rocky desertification in the area.

In summary, this paper has provided important knowledge on geomorphology and geoenvironmental issues in the karst areas subject to recent desertification and erosion. To mitigate these problems, appropriate land-use arrangement and better protection on vegetation are needed to recover forest and grassland especially on the tower and cockpit karst hills where most erosion takes place.