[Research Note]

Snail Density Estimation for Schistosomiasis Control by Integrating Field Survey and Multiscale Satellite Images

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I. INTRODUCTION

In a mountainous region of Sichuan Province, China, snails live along the edges of ditches in crop fields. People are infected through contact with the contaminated waters of natural rivers and irrigation systems. Infected human and animal stools are used as fertilizers in the crop fields, from which the disease can also be transmitted. Snail population is crucial for more refined analysis of schistosomiasis transmission and for the development of a control model. We focus on five land-use and land-cover categories to which the snail habitat and the water exposure activities of humans may be closely related. These are lowland crop, upland crop, terraced crop field, riverbed and residential area.

Surrounding Qionghai Lake at the southern edge of Xichang City, Sichuan Province, our study site resides in the valley of a mountainous area of western China with an elevation range of 1500-2500 m. A multispectral IKONOS image of the study site was acquired in December 2000, covering an area of 137 km^2 (Figure 1). The spatial resolution of the image is 4 m (Space Imaging, 1999). The study site consists of approximately 200 residential groups organized into 4 townships. The climate there is subtropical with an annual average temperature of 17 °C and an annual rainfall of about 1000 mm, over 90% of which falls between the beginning of June and the end of October. The main agricultural products are rice, corn, wheat, bean, garlic, rape, eggplant and tomatoes (Spear, et al., 1998). Most people are farmers, and secondarily, raisers of livestock and fish. People get infected when they come into contact with infected water. They might be growing crops and vegetables in the lowland, the upland fields or terraced areas, washing their feet and working utensils along the ditches where the irrigation system runs or playing in the riparian zones along riverbeds.

II. DATA PREPROCESSING

The IKONOS image is georeferenced to UTM projection based on the 1984 World Geodetic System. We then treat the geometrically corrected IKONOS scene as the master image, and four other satellite images are geo-matched accordingly. The four registered images include Landsat TM data taken in March 1998 and November 1998, EO-1 ALI and Hyperion data taken in January 2002.

We apply regression analysis to the reference data for the five land-use categories. On the one hand, we want to assess the capability of the Landsat Thematic Mapper (TM), EO-1 Advanced Land Imager (ALI) and Hyperion to extend local-scale knowledge to large-scale monitoring of the disease transmission. However, land parcel size in this study area is often smaller than the 30m by 30m pixel of the Landsat or EO-1 data. Extracting land surface cover information at sub pixel levels thus becomes important. We use classification results from the multispectral IKONOS imagery as "ground truth" data. Landsat and EO-1 data are used as regressors after geometric registration of these satellite images. The proportions of those land surface covers are subsequently estimated.

III. LAND COVER CLASSIFICATION WITH IKONOS AND ELEVATION DATA DERIVED FROM ASTER DATA

Elevation in this mountainous schistosomiasis endemic area is important, as prevalence in the upland regions is higher than in the lower floodplains. People may grow very different agricultural products in the lower and upper lands. Therefore, upland and lowland crop and terraced area are distinct land surface categories. The land-cover classification map is made by extracting the lake separately and including elevation data in the classification of IKONOS multispectral imagery. The lake delineation was achieved by processing the near-infrared (NIR) channel (band 4) of the IKONOS imagery. The first step of the processing procedure is applying a Sobel filter to the NIR image to enhance the contrast between water and land. A Sobel filter is an edge-enhancement technique that calculates from a 3 X 3 neighborhood the vertical and horizontal gradients and takes the square root of their sum of squares (Jensen, 1996). A 5 X 5 average filter was applied to the edge-enhanced

1082-4006/03/0901~2-97$5.00