APPLICATION OF REMOTE SENSING ON LAND COVER CHANGE IN GONGGA MOUNTAIN GLACIER

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ABSTRACT: Global warming has brought about many severe environmental problems, including a rise in sea level, lack of water resource, global food crisis, ecological environmental change, and increased natural hazards. In many mountainous areas of the world, glaciers are critical sources of fresh water that crucially contribute to the sustainability of socio-economic activities such as hydroelectric power generation, agriculture and tourism. Studies have shown that the mountain glaciers have retreated rapidly likely due to global warming. Thus, glaciers can provide a longer term perspective for the study of climatic variations and environmental changing. Their retreat is considered a key indicator of early detection of global climate changes.

In China, in response to global warming, glaciers on the Tibetan plateau have been retreating since the early 20th century, and the change has begun to accelerate since 1980s. The Hailuogou glacier, a typical monsoonal temperate glacier, is located on the eastern side of Mt. Gongga, in the region of the southeastern part of the Tibetan plateau. It has a profound influence on regional and global atmospheric circulation and is therefore important for understanding the dynamics of global environmental change. This study applies the remote sensing techniques to monitor Hailuogou glacier's surface cover change. Change detection of the glacier retreat during the period of 10 years is performed by utilizing the multi-temporal satellite imagery (SPOT, 1997-2009). The results showed that an annual mean retreat at Hailuogou glacier during 1997 to 2009 was 35.5 m, faster than that of the previous studies of around 29.8 m.

1. INTRODUCTION

Located in the Hengduan Mountain region of the Tibetan Plateau, Mt. Gongga (29 ◦ 20' ~30 ◦ 20'N, 101 ◦ 30' ~102 ◦ 15'E, 7556 m) is one of the most typical and concentrative of monsoonal temperate glaciers. Meanwhile, it is the most typical region where there are many distributions of monsoonal temperate glaciers in the middle-low latitude district of China. These monsoonal temperate glaciers have exhibited an obvious response to global changing and distinct influence on the regional climate fluctuation (Lu, 2009). Thus, it brings about numerous scholars to investigate the glacier's evolution associated with global warming. Since 19th century, the scholars of Anderson, Von Locyz and Heim etc. have been conducting researches in geology, terrain features, glaciers, relics of ancient glaciers around the rim or edge of Mt. Gongga, and thus accomplished something (Su et al., 2002).

The remote sensing technique has the advantages of being quick, effective to access the surface signatures over a large area and thus suitable for monitoring the evolution of the glaciers. Thus, this study is aimed to apply the remote sensing imagery as analytic materials to quantify the glacier retreat and monitor environmental changes over Mt. Gonnga.

2. METHODOLOGY

The flowchart of the study is seen in Fig 1. It contains two major parts. First, the 1997, 1998, 2002, 2008, and 2009 SPOT images are used to locate the Hailuogou glacier tongue and thus its movement is quantified. The 2009 image is used as the reference image for geometric comparison. In order to identify the details of variation on glacier, the images from Google Earth on October 12, and December 14, 2002 are used. Identification on melt, location of the front of edge of the glacier, and snow cover over the glacier are performed based on the representation of images. In addition, the 2008 and 2009 images were used to monitor the environment changes over Hailuogou glacier. The two sets of images with multi-spectrum (XS) are suitable for classification of land use. The classification can be typically divided into categories, supervised classification, unsupervised classification, and Hybrid classification. The images were classified into three major categories, vegetation, bare land, and snow area by supervised classification. Nevertheless, classification of foliage forest, grasslands, or savanna, cannot be classified effectively due to limitation of imagery spatial resolution.

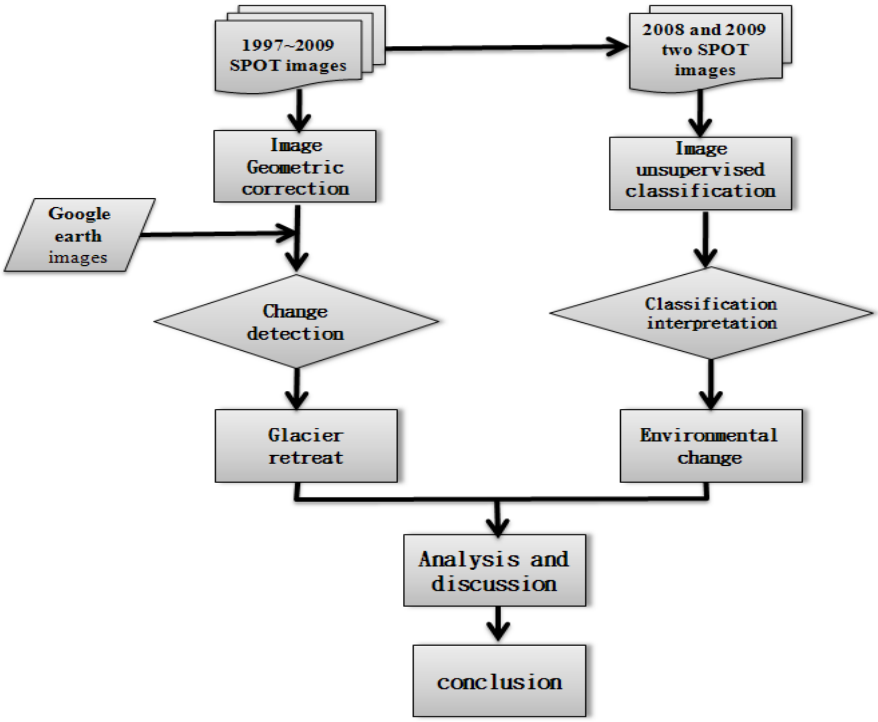

Fig. 1 Flowchart of this study

3. RESULTS AND DISSCUSSION

3.1 The retreat of Hailuogou glacier

In the processing of the SPOT imageries and high resolution imagery of Google Earth for assisting the identification of surface signatures, the Chengmendong was chosen as the reference point for distance measurement, which was labeled on Google Earth. The measurement tool of ERDAS IMAGINE 9.1 is utilized to determine the distance from reference point to the front edge of glacier tongue in the 1997, 1998, 2008, and 2009 SPOT imageries and 2002 Google Earth imagery. The results show that the distances are 1,547 m (1997), 1,579 m (1998), 1,660 m (2002, Google Earth), 1,853 m (2008), and 1,973 m (2009), respectively. The distances are then applied to determine the decrement of glacier's length, which are found to be 32 m between 1997 and 1998; the annual mean decrements during 1997-2002, 1998-2002, 1997-2008, 1998-2008, 1997-2009, and 1998-2009 are 20.2 m to 22.6 m, and 27.4 m to 27.8 m, respectively. The annual mean decrement is 32.1 m from 2002 to 2008 and the annual mean decrements during 1997-2009, 1998-2009, and 2002-2009 are 35.5 m, 35.8 m and 44.7 m, respectively. In contrast, the annual mean decrement reaches 120 m during 2008-2009.

3.2 The classification and retreat of Hailuogou glacier

The images captured on December 8, 2008 and November 7, 2009 were used to classify the land cover of Hailuogou glacier by ERDAS IMAGINE 9.1 as shown in Fig. 2. The results indicated that the areas of bare land, vegetation, and snow cover without change are 12.37 km2, 69.53 km2, and 46.77 km2, respectively. The principal land covers of the glacier are vegetation and snow. The areas of changes from bare land to vegetation and snow are 6.23 km2 and 5.24 km2, respectively, while 13.10 km2 and 2.18 km2 of vegetation covers were converted to bare land and snow, respectively. In addition, 31.09 km2 and 5.38 km2 of snow areas were altered to bare land and vegetation, respectively. Note that the decrement in snow cover is conspicuous.

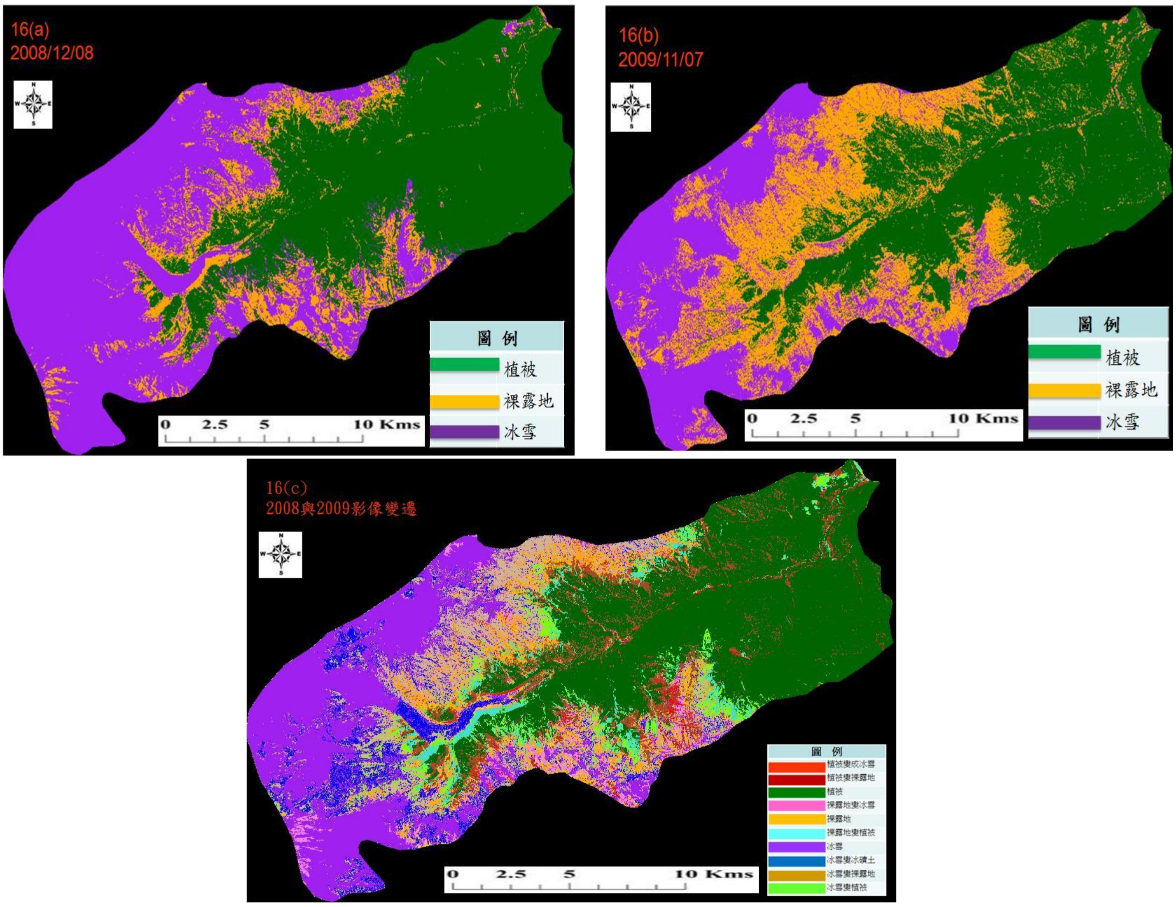

Fig. 2 The classification maps on Hailuogou glacier of Mt. Gongga

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