Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

HDS022-06 Room: 201B Time: May 26 12:00-12:15

Formation analysis of debris-covered glaciers in the Bhutan Himalaya using ASTER data

Hiroto Nagai[1*], Koji Fujita[1], Takayuki Nuimura[1]

[1]Nagoya University

In Himalaya there are many debris-covered glaciers which have ablation areas covered by supra-glacial debris, and their glacier lakes sometimes cause glacier lake outburst floods (GLOFs). Debris effectively absorbs the solar radiation due to its low albedo comparing with ice and snow, therefore a thin layer of debris accelerates melting of a glacier. On the other hand, thick debris cover decreases the rate of the glacier ablation by its insulation effect.
Debris is mainly provided by rock falls originating from the exposed rock face in the altitudinal range where frequent frost-shattering occurs. Such rock face has a various altitudinal distribution for each glacier, thus quantitative relationships between debris-source slopes and debris-covered areas at the terminus of a glacier remain to be clarified. The purpose of this study is to identify the relationships between the altitudinal distribution of steep slopes and the altitude of effective freeze-thaw cycles around the glaciers in the Bhutan Himalaya. Understanding the formation of debris-covered glaciers is important for studies on glacier response to climate change.
For nearly 300 glaciers along the border between the northern part of Bhutan and China, Visible Near Infrared (VNIR) images and Global Digital Elevation Model (GDEM) data acquired by Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER - multi-spectral sensor onboard the Terra satellite), were analyzed with the data of both air temperature and precipitation.
The glaciers were classified as D-type (Debris-covered), S-type (Semi debris-covered), and C-type (Clean-type) according to the difference of debris-covered area along the terminal edges. Additionally, a new index, Debris Productivity Index (DPI), was introduced to estimate the altitudinal distribution and quantity of the steep slopes which provide most of debris.
As a result of the analysis, many steep slopes at altitudes with frequent freeze-thaw cycles were recognized with the D-type glaciers, secondly the S-type, and thirdly the C-type glaciers. For D-type glacier, DPI showed higher values around the altitude of 5600 m. A regional difference was found between southern and northern sides of the main Himalayan range. More debris is considered to be provided onto the glaciers at the southern side of the range.

Keywords: debris-covered glacier, ASTER, Bhutan Himalaya, Glacier lake