

Classification and formation environment of glacial valleys inferred from morphometric analyses

NARUSE, Kosuke¹, OGUCHI, Takashi^{2*}

¹Grad. Sch. Frontier Sci., Univ. Tokyo, ²CSIS, Univ. Tokyo

Glacial valleys are a type of glacial landforms, and some researchers investigated the form of transverse sections of glacial valleys. The objectives of this research are: 1) analyze and compare the forms of glacial valleys using up-to-date elevation data; and 2) classify glacial valleys based on forms of transverse sections. The study areas are the Swiss Alps, the Himalayan Range, Yosemite, the New Zealand Southern Alps and Patagonia which contain typical glacial valleys of the world. Four to six valleys were selected from each area. Transverse and vertical longitudinal sections were obtained from DEMs, and the aspect/form ratio (*FR*) of each transverse section and slope of each small segment of the section were calculated. From frequency distributions of slope, statistical moments including kurtosis, skewness, and standard deviation were computed. Forms of glacial valleys were evaluated using these three parameters and *FR*.

For all glacial valleys, *FR* converged into about 0.28 with increase in valley size. The value may correspond to the balance of vertical and lateral glacial erosion as well as a threshold slope angle for slope failure after the melting of glaciers.

Correlations between any two of the four parameters were investigated. Based on the correlations and actual forms of the transverse sections, the sections were classified into four types; 1) U-shaped, 2) V-shaped, 3) plain, and 4) others. Then the characteristics of glacial valleys were compared based on the classification, and the correlation between the area of each transverse section and the equilibrium line altitude was investigated. Comparisons among the glacial valleys in the five regions revealed that the most common valley-form type is U-shaped in New Zealand, V-shaped in the Himalayas, and plain in Yosemite and the Swiss Alps. In New Zealand, highly abundant snowfall let glaciers create typical U-shaped valleys. In the Himalayas both V-shaped and U-shaped valleys are abundant with high *FR* values, indicating that both active glacial erosion and mass movements after glacial melting contributed to valley formation. The high proportion of the plain type may reflect limited snowfall and a low uplift rate in Yosemite, and glacial re-advances in the Swiss Alps. Average *FR* of valleys in Patagonia is small because of active lateral erosion by ice sheets. Consequently, the form of glacial valleys are controlled by the mode and intensity of erosion, regional climate and tectonics.

In each region, *FR* tends to change according to elevation, and *FR* reaches the maximum in an intermediate elevation in areas around Mt. Cook in New Zealand and in the Swiss Alps. The elevation approximately corresponds to the equilibrium line altitude at the Last Glacial Maximum, suggesting a possibility of estimating the past equilibrium line from *FR*.

Keywords: glacial valley, transverse section, DEM, formation environment