Neotectonic characteristics along both flanks of the Ou Backbone Range, Tohoku Region, Japan, from fluvial geomorphic analyses

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The islands of Japan are located at the boundaries between the Eurasian, Philippine Sea, and Pacific plates, with frequent earthquakes and numerous active structures. In the Tohoku Region, for example, the Ou Backbone Range is bounded on its both sides by two major active structural systems: the Eastern Marginal Fault Zone of the Yokote Basin in the west and the Western Marginal Fault Zone of the Kitakami Lowland in the east. However, the relative activeness and characteristics of these two systems are still not clear. As fluvial systems are capable of recording variations of topography caused by tectonic, climatic, lithologic, and anthropogenic influences, we hope to further understand these two structural systems using fluvial geomorphology of the Ou Backbone Range area.
In this study, we analyzed river profiles to obtain the geomorphic index χ and the river steepness index (k_{sn}). The results show that the steepness index of river channels along the two flanks of the Ou Backbone Range are different, likely indicating different tectonic activities. However, we also found a number of knickpoints along several river networks. We investigated these knickpoints with satellite imagery and field surveys. Our results show that these knickpoints are mostly produced by local resistant rock layers or check dams, instead of reflecting different states of tectonic activity.
Therefore, we were able to exclude the influence of the knickpoints and to focus only on the results of river steepness index. The results show that rivers along the western flank of the Ou Backbone Range generally have steeper channels than those along the eastern flank. This suggests that the uplift rate of the range’s western flank is higher, and the structures in the west may have higher activity. The results are consistent with the vertical slip rate estimates of the faults; ~1 mm/yr for the western flank and 0.2-0.4 mm/yr for the eastern flank. Moreover, the northern segment of the range’s western flank has the steepest river channels. This result appears to correspond with the surface ruptures of the Senya fault, Ota fault, and other related faults during the 1896 Rikuu earthquake. As a result, we propose that the northern segment of the Eastern Marginal Fault Zone of the Yokote Basin may be the primary structural system in the region, producing the faster uplift of the range and rapid subsidence of the basin, and steeper channels along the western flank of the Ou Backbone Range.

Keywords: Neotectonic activity, river steepness index, fluvial geomorphic index χ, Ou Backbone Range, Japan

