Geologic effects on distribution of fluvial knickzones of mountain rivers in Japan

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A riverbed segment of which gradient is steeper than the adjacent segments, referred to as a knickzone, is a primary agent of bedrock erosion in mountain rivers. Since knickzones not only cause rapid erosion of bedrocks but also accelerate riverside slope failures, knickzones have often been pointed out as the fundamental topography in fluvial landforms. Although a manual extraction of knickzones is often difficult especially in broad areas because of the lack of objective criteria and the difficulty in obtaining a large amount of river longitudinal profiles, the utilization of a DEM and GIS enables an objective and semi-automated methodology to identify knickzones (Hayakawa and Oguchi, 2006). This study applies the method to bedrock rivers in all mountainous areas in Japan to discuss the distribution of knickzones and geological effects on the knickzones.

Using 50-m DEMs, ca. 66,000-km long reaches of major bedrock rivers, defined as the river reaches not flowing on unconsolidated Quaternary sediments, were examined. Using the river gradients with measurement lengths from 320 to 1,720 m, the decrease rate of the gradient with increasing measurement length was calculated, and it was used to determine knickzones based on a threshold value of the gradient decrease rate, 1.42x10^-5 /m. Many (ca. 5,800) knickzones were identified throughout the study area, and their frequency and density are 0.09 /km and 3.2%, respectively. The average forms of the knickzones are 45 m in height, 290 m in length, and 0.147 m/m in gradient.

The correlation analysis revealed that the knickzone abundance is strongly influenced by the river trend gradient. Relief structures also have good correlation with the knickzone frequency. The percentage of riverbed length for each rock type, on the other hand, generally shows a very weak correlation with the knickzone abundance, except for some positive correlations for volcanic rocks. Moreover rock variety does not correlate with the knickzone abundance. Although differences in the knickzone frequency summarized for each rock type of river reaches are observable, where knickzones are the most abundant in volcanic rocks and the least abundant in sedimentary rocks, the knickzone frequency plotted against the river trend gradient does not show significant differences, indicating that the local lithologic properties exert only a weak influence on knickzone abundance.