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Ecological Riverbed Management by Changing Reach Scale Channel Configuration

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1. Introduction

Importance of integrated river management with geomorphic approaches has been accepted and many researchers focus on the linkage between large-scale management activities and local ecosystem conditions. Reach scale channel configuration (RSCC) such as braided, meandering, wandering, or anastomosing and straight channels can be classified by hydraulic -geomorphic parameters such as discharge and slope (Leopold and Wolman, 1957), depth-grain size ratio and width-depth ratio (Muramoto and Fujita, 1977), sediment load and lateral stability (Schumm, 1985). Also, ecological characteristics of streams such as flora and fauna, biodiversity, and productivity are closely related to the reach scale geomorphology (Takemon, 1997). Therefore, if we could investigate the interrelationships among RSCC, ecological functions and hydro-geomorphic conditions, changes in a river ecosystem could be predictable under human impacts.

This study aims at linkage between RSCC was evaluated by ecological function and hydraulic -geomorphic conditions in the Kizu River, and proposes countermeasures for higher biodiversity. According to purpose, RSCC was plotted on various biplot dimension consist of hydraulic – geomorphic parameters, and then, historical changes of RSCC were investigated on the biplot dimension. Finally, the possibility of channel changes in the future was predicted with manipulation of target parameters.

2. Methods

RSCC in the Kizu River (0-26 km) was classified into single, slightly wandering straight and sinuous, quite wandering straight and sinuous, bifurcated wandering straight and sinuous, and braided channels using geomorphic parameters, e.g., number of channels, sinuosity, channel width, slope, ratio of landscape (Choi, 2014). A total of 116 reaches were divided into 8 channel types during 1948-2002. According to Choi (2014), classified channel types were evaluated by habitat diversity and soundness (diversity x total habitat abundance), and bifurcated wandering sinuous channels had maximum habitat diversity and soundness.

The classified RSCC was ranged by biplot dimension of hydraulic-geomorphic parameters such as bankfull discharge and channel slope, depth-grain size ratio (h/d) and width-depth ratio (B/h) (Muramoto and Fujita, 1977), width-depth ratio and specific stream power (Burge, 2004). Specific stream power is pgQaS/w, where p is the density of water, g is the acceleration due to gravity, Qa is the mean annual flood discharge, S is channel slope, and w is the bankfull channel width.

3. Results

All channel types in the Kizu River were plotted on three biplot dimension. The all channel types were plotted within a restricted range of meandering channels in the dimensions of bankfull discharge and channel slope. In the biplot dimension of depth/grain size ratio and width/depth ratio, the channel types were distributed in the alternative bar. Among three biplot dimensions, difference of channel types in the Kizu River was shown in the biplot dimension of width/depth ratio and specific stream power. The channel types were located in the area of meandering and transitional wandering channel (Fig.1a). The range of bifurcated wandering channels (green) was higher values of B/h than single (black), slightly wandering (violet) and quite wandering channels (orange), and braided channels (yellow) showed maximum values of B/h. In terms of specific stream power, the range of slightly wandering and bifurcated wandering channels appeared wider than that of single, quite wandering and braided channels.

Historical changes of channel types were shown

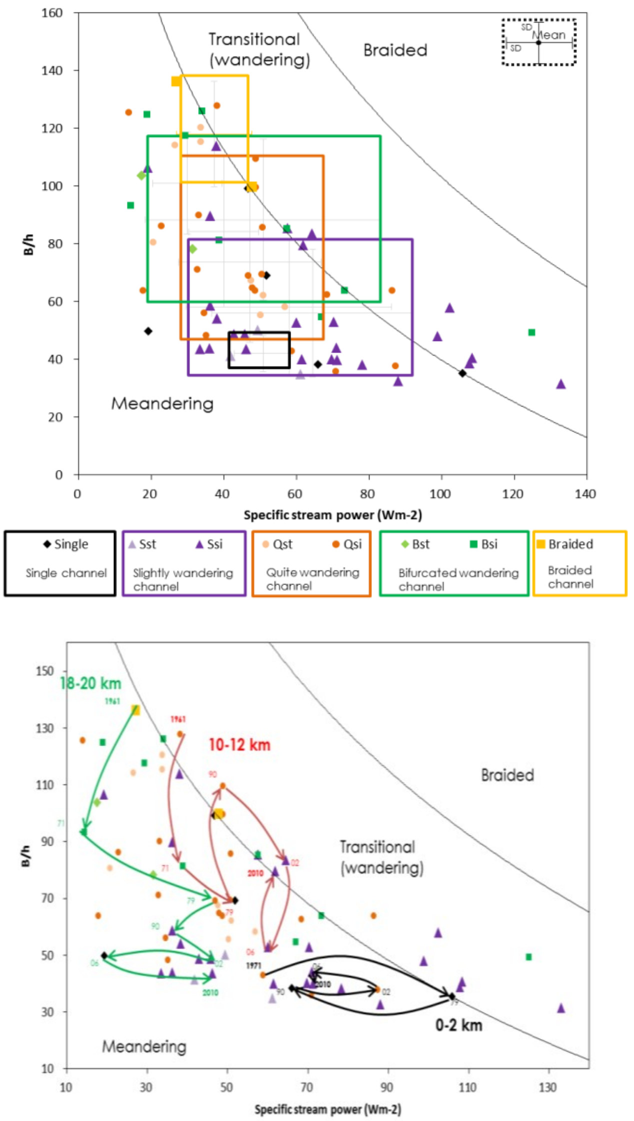

Fig.1 (a) Distribution of each channel type within the biplot dimension of width/depth ratio (B/h) and specific stream power in the Kizu River, and (b) their historical changes in channel types, the plots of 0-2km, 10-12 km and 18-20 km correspond to those in lower, middle and upper reaches of the study area.

in Fig. 1b. The upper site (18-20 km) moved from braided channel having the highest B/h to slightly wandering channel during 45 years with significant decreasing of B/h. The middle site (10-12 km) changed from a quite wandering channel to a slightly wandering channel with changes both in B/h and specific stream power. In contrast, lower site (0-2 km) moved from a quite wandering channel to a slightly wandering channel with significant changes of specific stream power and lowest changes of B/h.

Upper and lower site of channel types in 2010 were distributed in the range of single and slightly wandering channels. Middle site of channels were included in area of target channel types (bifurcated wandering channels) for maximum habitat diversity and soundness. Channel widening (about twice) in upper and lower site have possibility of changing from current channel conditions to bifurcated wandering channels.

4. Conclusion

RSCC variations in the Kizu River could be well explained by width/depth ratio and specific stream power among biplot dimensions of hydraulic -geomorphic parameters. According to the distribution of channel types and their historical changes, we could predict resultant RSCC after manipulation of channel width. And thus, the countermeasure can be evaluated by the resultant RSCC plots in relation to the potential ranges for ecological functions. Channel widening about 1.8-2.0 times in upper and lower site could have high potentials of biodiversity.

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