A RIVER CLASSIFICATION USING GEOMORPHOLOGICAL CRITERIA

CHANJOO LEE [1], DUHAN LEE [2], KYUHO KIM [3] and HYOSEOP WOO [4]

[1] Researcher, [2] Senior Researcher, [3] Research Fellow, [4] Senior Research Fellow, Korea Institute of Construction Technology, 2311 Daewha-Dong, Ilsan-Gu, Goyang, Gyeonggi-Do, 411-712, Korea
(Tel: +82-31-910-0516, Fax: +82-31-910-0251, e-mail: c0gnitum@kict.re.kr)

Abstract

The purpose of this study consists in presenting a newly suggested river classification system based on the geomorphological criteria and applying it to some rivers in Korea.

A geomorphological river classification is a process of grouping a variety of streams into types with the quantitative and qualitative criteria representing the morphology of rivers. The river classification systems developed in other countries are based on different physiographical situation from Korea. We examined the previous systems and suggested a new river classification system reflecting the fluvio-geomorphologic environment of Korea.

In a geomorphological view, as channel processes and forms depend on water and sediment discharges imposed to it, it is pertinent to divide a channel based on the change of water and sediment discharges. Hence, the suggested system uses the channel reach as a basic classifying unit, which is delineated by upstream and downstream tributaries. And it adopts three major basic geomorphological criteria for classification: valley-floor width index, sinuosity and bed material size. The suggested system is composed of 24 stream types(Table-1). Concerning every stream type, valley forms, dominant bedforms and fluvial processes with disturbance elements are briefly presented(Table 2).

Table 1. Suggested river classification system based on the geomorphological criteria

Planform	Valley Confinement (VI)	Large ← BED MATERIAL SIZE (d_{50}) → Small									
		Bedrock(1)		Boulder(2)		Gravel(3)		Sand(4)		Silt-Clay(5)	
				d_{50} > 256mm		256mm > d_{50} > 2mm		2mm > d_{50} > 0.0825mm		0.0825mm > d_{50}	
Straight P < 1.2 (S)	Mountain Type (c) δ > VI	1c	w/d < 20, s > 0.03	2c	w/d < 20, s > 0.01	S3c	w/d > 20, s < 0.01	S4c	w/d > 20, s < 0.005	S5c	w/d < 20, s < 0.001
	Plain Type (u) VI ≥ δ					S3u	w/d > 20, s < 0.01	S4u	w/d > 20, s < 0.005	S5u	w/d < 20, s < 0.001
Sinuous P < 1.5 (N)	Mountain Type (c) δ > VI					N3c	w/d > 20, s < 0.01	N4c	w/d > 20, s < 0.005	N5c	w/d < 20, s < 0.001
	Plain Type (u) VI ≥ δ					N3u	w/d > 20, s < 0.01	N4u	w/d > 20, s < 0.005	N5u	w/d < 20, s < 0.001
Meandering P ≥ 1.5 (M)	Mountain Type (c) δ > VI					M3c	w/d > 20, s < 0.01	M4c	w/d > 20, s < 0.005	M5c	w/d < 20, s < 0.001
	Plain Type (u) VI ≥ δ					M3u	w/d > 20, s < 0.01	M4u	w/d > 20, s < 0.005	M5u	w/d < 20, s < 0.001
Divided (D)				D2	w/d > 20, s > 0.01	D3	w/d > 20, s < 0.02	D4	w/d > 20, s < 0.005	D5	w/d > 20, s < 0.005

Table 2. An outline of valley morphology, bed forms, fluvial processes and disturbance elements according to the stream Types presented in Table 1.

Type	Valley Morphology	Main Bedforms	Major Fluvial Processes	Distubance Elements
1c	Upstream & bedrock exposed valley	Cascade, Waterfall, Erosion pit	Transport exceeds sediment supply Erosion of bedrock. Forming local pit, Removal of mass movement materials	Artificial cutting of mountain slopes, Supply of slope debris
2c	Upstream valley, Steep valley slope, Transition from high to mild slope	Step-pool, Rapids	Vertical energy dissipation(step) and storage(pool), Sorting of slope-supplied materials High energy by steep channel gradient	Artificial cutting of mountain slopes, Supply of slope debris, Input of Large woody debris
S3c N3c	Mountain, Straight structural valley, Valleys on granite geology, Fringed by river terrace	Rapids, Riffle-pool, Plane-bed, Armoring, Alternate bars Mid-channel bars Point bars	Undulating bed, Restricted lateral migration, Downward incision, Sorting of gravel and sand, Development of bars, cluster bedforms, Energy dissipation by meandering, Forming of deep pool at outer of bend apices	Artificial cutting of mountain slopes, Supply of slope debris, Excavation of bed material
M3c	Valleys on metamorphic and sedimentary geology, Valley meander, Fringed by river terrace			
S3u N3u	Plain, Front of mountain area, Basin in mountain area, Valley floor plain	Riffle-pool, Plane-bed, Mid-channel bars, Armoring, Alternate bars, Point bars	Undulating bed, Active lateral migration, Sorting of gravel and sand, Development of bars, cluster bedforms and floodplains Active development of bars and islands. Channel widening by bank erosion	Bank collapse, Excavation of bed material, Roughness increase and channel widening by vegetation on bars
M3u				
S4c	Mountin area, Straight structural valley, Granitic weathering basin	Ripple, Sand dune, Alternating bars, Mid-channel bars, Point bars, Development of apparent banks and islands	Undulating bed, restricted lateral migration, Energy dissipation by bed form resistance Development of mid-channel bar, chute and braiding Forming of deep pool at outer bank of bend apices	Abundant supply of sand from upstream catchment, Artificial cutting of side mountain slopes, Input of debris, Bank collapse, Excavation of bed material
N4c	Mountain area, Granitic basin			
M4c	Metamorphic and sedimentary mountain, Valley meander			
S4u N4u	Plain, Front of mountain area, Granitic weathering basin,	Ripple, Sand dune, Alternating bars, Mid-	Undulating bed, Active lateral migration, Development of	Abundant supply of sand from upstream

M4u	Valley floor plain, East Coastal plain	channel bars, Point bars, Development of apparent banks and islands	bars, cluster bedforms and floodplains. Energy dissipation by bed form resistance, Development of mid-channel bar, chute and braiding. Channel widening by bank erosion	catchment, Bank collapse, Roughness increase and channel widening by vegetation on bars, Excavation of bed material. Confinement by artificial levees
S5c **N5c** **M5c**	Mountain, Narrow valley with fine sediment supply, Tidally effected coastal mountain area	Alternating bars, Mid-channel bars, Point bars, Development of apparent banks	Undulating bed, Restricted lateral migration, Maintenance of steep bank due to cohesiveness	Artificial cutting of mountain side slope, Input of debris, Bank collapse
S5u	Wide alluvial plain, Floodplain of large rivers	Development of apparent banks	Maintenance of steep bank due to cohesiveness Backwater by flood level increase of large rivers. Development of wide floodplain, backswamp	Bank collapse, Effects of tide, Confinement by artificial levees
N5u **M5u**		Mid-channel bars, Point bars Development of apparent banks and islands	Undulating bed, Active lateral migration, Maintenance of steep bank due to cohesiveness.	
D2 **D3** **D4** **D5**	Channel reach with exceeded supply of sediment, Confluence	Mid-channel bars(braiding), Islands	Anastomosing of flow. Development and growth of islands by overbank flow	Bank collapse, Roughness increase and channel widening by vegetation on bars, Excavation of bed material.

For the evaluation of applicability, the Chungmi-chun and the Imjin River are classified using both the suggested and the Rosgen systems. In case of the Chungmi-chun, the present system classifies most reaches as the stream Type S4u, and other reaches are included in N4u, N3u, S3u, N4c, M4c Types. But according to the Rosgen system, most reaches of the Chungmi-chun except only two reaches are classified as C5, C4, and Reach 8 and 22 as B4, B5, respectively. In case of the Imjin River, fifteen unit reaches of it are confined gravel-bed streams and classified as Type S3c, N3c, M3, and the others as Type N3u, S4c, N4c. Reach including the Chopyung Island is classified as D3. Based on the Rosgen system, most reaches (18 of 20) fall into Type F4, B4, and Reach 19 and 20 into Type B5. By applying both systems to the Chungmi-chun and the Imjin River, we found that though valley confinement and bed material characteristics are properly and similarly classified by the suggested and the Rosgen systems, the suggested system which adopts sinuosity as a main criteria, classifies channel planform property in more detail and realistically.

Keywords : River classification system; Geomorphological criteria