FLUVIAL MORPHOLOGY AND WATER QUANTITY AT THE JUNGCHEON RIVER, UIRYEONG-GUN, KOREA

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ABSTRACT

River morphology is the shape or form of a river along its length and across its width and results from the complex interplay of many geomorphic process that occur in a basin at different spatial and temporal scales. Water of sufficient quality and quantity is critical to all life. Healthy and self-sustaining river systems provide ecological and services of critical importance to human societies everywhere. This study is to investigate the degree of river naturality according to the river morphology and river naturality on the Jungcheon River at Uiryeong-gun, Gyeongsangnam-do in Korea. The vegetation of low water's edge was natural weeds, shrubs, and mixed. The vegetation of flood way was both of natural vegetation and artificial vegetation. Land use in riparian zones was urban, residential mixed. Land use in flood plains beyond river levee was park facilities, playground facilities. The value for index of degree of river naturality according to the environment factors at upper, middle, and low regions were a mean of 2.857, 3.714, and 4.143, respectively. As a result of an analysis about environmental factors for the numbers of animals including fishes in each surveyed sites, the most effective groups were, pH, suspended solids (SS), dissolved oxygen (DO), chemical oxygen demand (COD), total phosphate (T-P), and total nitrate (T-N). However, the Biological Oxygen Demand (BOD) middle and low streams were within unacceptable levels for drinking water.

Keywords: Biological Oxygen Demand (BOD), river morphology, river naturality, Jungcheon River.

INTRODUCTION

Water of sufficient quality and quantity is critical to all life. Healthy and self-sustaining river systems provide ecological and services of critical importance to human societies everywhere (Postel et al., 2003). Rivers provide both a natural transportation network and source of water for irrigation and industry.

River morphology is the shape or form of a river along its length and across its width and results from the complex interplay of many geomorphic process that occur in a basin at different spatial and temporal scales (Ibisate et al., 2011). Fluvial geomorphological processes and channel forms are determined by three main factors: discharge and sediment yield, which are the main drivers, and valley characteristics, which establish the boundary conditions (Newson, 2002). These factors are influenced by other variables within and outside of the catchment and by different human activities that frequently dictate the character of riverine landscapes (Church, 2002).

The restoration and maintenance of healthy river ecosystems have become very important objectives of river management (Karr, 1991, Norris & Thomas, 1999). River health has been described as the ability of a river ecosystem to support and maintain a balanced, integrated and adaptive community of organisms that resembles the natural habitat. In practice, river health is measured using various indicators of environmental disturbance from the healthy state, relative to some benchmark or reference condition. The appropriate agencies are seeking a more rigorous approach to monitoring river health in many countries as well as Korea that reflects all aspects of a river's ecological condition. Under this approach, a nationally consistent program would underpin the monitoring of river conditions, evaluate the impact of management actions, and assist to Priorities Rivers and river catchments for particular management attention. These components are linked through physical, chemical and ecological processes, and a monitoring program may concentrate on one component or a combination.

The objective of this paper is to review the river health on the creation of fluvial morphology and provide illustrations of different examples taken mainly from the Jungcheon Rivers but also from three geographical regions.

METHODOLOGY

Surveyed Regions

This study was carried out on the Jungcheon River (upper region: 35°296′851″N/128°234′679″E, low region: 35°297′285″N/128°259′047″E), located at Uiryeong-gun, Gyeongsangnam-do province in Korea (Fig. 1). The river is located to the eastern region of the city of Uiryeong-gun. The river is approximately 3.08 kilometers in length with a varying width of between 2.5 and 30.5 meters. Lowlands are usually no higher than 100 m (328 ft.), while uplands are somewhere around 130 m (427 ft.) to 160 m (525 ft.). The upper area of the Jungcheon River, including one reservoir per region, used to be covered with pine trees and other species. The relatively level land can be developed either as agricultural fields or sites for habitation or business. Flood plains of this river are usually very fertile agricultural areas and out sides of this river consist of a mosaic of agricultural fields and farming houses. Mean annual temperature ranges from -0.5 (January) to 25.4 °C (August) with 13.0°C, and mean annual precipitation ranges from 15.2 (December) to 294.5 mm (August) with 1275.6 mm.

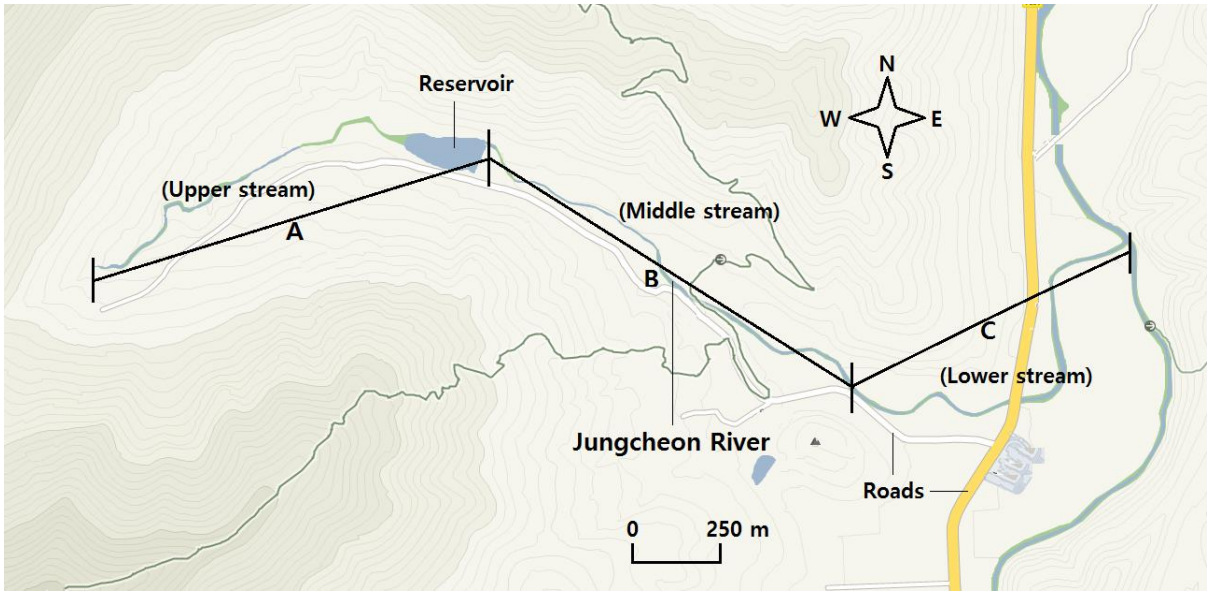

Figure 1: Location of the study area and the three detailed internodes at the Jungcheon River.

Index of degree of river structure

The three regions of Jungcheon River were divided by the geographic location with considering length of the river and river morphology. Index of degree of river naturality according to the environment of river was also analyzed according to Table 1. River terminology was followed by Hutchinson (1975). The test for biochemical oxygen demand (BOD) is a bioassay procedure that measures the oxygen consumed by bacteria from the decomposition of organic matter (Sawyer and McCarty, 1978). The method for BOD was used to a standard method of the American Public Health Association (APHA) and is approved by the U.S. Environmental Protection Agency (USEPA, 2002).

Environmental factors

Laboratories and equipment were used to measure a range of water quality parameters including pH, suspended solids (SS), dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total phosphate (T-P), and total nitrate (T-N). The change in DO concentration is measured over a given period of time in water samples at a specified temperature. The method for BOD was used to a standard method of the American Public Health Association (APHA) and is approved by the U.S. Environmental Protection Agency (USEPA). COD is a widely known parameter used to measure water quality using the 910 colorimeter (YSI Incorporated, Ohio, USA). It is a measure of water pollution resulting from organic matter. Total phosphorus and nitrogen in river were evaluated the use of alkaline peroxodisulfate digestion with low pressure microwave, autoclave or hot water bath heating (Maher et al., 2002). Total suspended solids (SS) were determined by membrane filtration (0.1 um polycarbonate filters).

RESULTS
Region A

The mean river width at this region is about 1.7 m. The riparian areas of both the river banks are dominated by mixed sediment and the vegetation is composed of herbs, shrub, trees,

climbers and macrophytes (Table 2). The vegetation of low water's edge was natural formed various vegetation communities by natural erosion (sediment exposure) were absent. The vegetation of flood way was both of natural vegetation and artificial vegetation. Land use in riparian zones was about 1/2 urban, residential mixed. Land use in flood plains beyond river levee was about 1/2 park facilities, playground facilities. Transverse direction of artificial structures was bypass reservoir or slope waterway reservoir. The average value of BOD was 2.86 mg/l. The oxygen-demand parameter BOD at upper region was relative clear. The ratio of sleep width/river width was 5-10%. The value for index of degree of river naturality according to the environment factors was a mean of 2.857. As a result of an analysis about environmental factors for the numbers of animals including fishes in each surveyed sites, the most effective groups were, pH, BOD, COD, DO, SS, T-N, and T-P (Table 3).

Region B

The mean river width at the region is about 3.1 m. The vegetation of low water's edge was natural weeds, shrubs, and mixed (Table 2). The flood way vegetation was artificial vegetation with parks, lawns, and so on. Land uses in riparian zones within river levee were 1/2 or more urban, residential mixed. Land use in flood plains beyond river levee was impervious man-made structures, parking, etc. Transverse direction of artificial structures was one fish migration reservoir. Biological Oxygen Demand (BOD) is an indication of water contamination by organic materials and bacteria, especially from sewage water. The average value of BOD was 4.52 mg/l. The oxygen-demand parameter BOD was not clear. The ratio of sleep width/river width was 5-10%. The value for index of degree of river naturality according to the environment factors was a mean of 3.714. As a result of an analysis about environmental factors for the numbers of fishes in each surveyed sites, the most effective groups were, pH, COD, DO, SS, T-N, and T-P excluding BOD (Table 3). In particular, SS (Suspended solids) has a significant influence on the two points (St. C and St. D). Suspended solids are important as pollutants in water system. Although SS and phosphorus did not exceed the threshold, the amount of both values solids increased significantly. Phosphorus is caused by the use of fertilizer in the surrounding croplands. Stone dust was carried on the surface of particles and stone powders might cover the gills of the fish. It could be affected as one indicator of mortality of fishes.

Region C

The mean river width at the region was about 4.5 m. The vegetation of low water's edge was blocked by stonework etc. (Table 2). The flood way vegetation was artificial vegetation with parks, lawns, and so on. Land uses in riparian zones within river levee were 1/2 or more urban, residential mixed. Land use in flood plains beyond river levee was impervious man-made structures, parking, etc. Transverse direction of artificial structures was fish migration difficulty with reservoirs. The average value of BOD was 6.18 mg/l. The oxygen-demand parameter BOD was within unacceptable levels. Mean BOD values varied between 4.6 mg/l in mid-February and the highest value (7.68 mg/l) found in those samples collected close to phosphate fertilizer discharges of the sewage water. The ratio of sleep width/river width was 5-10%. The value for index of degree of river naturality according to the environment factors was a mean of 4.143. As a result of an analysis about environmental factors for the numbers of fishes in each surveyed sites, the most effective groups were, pH, COD, DO, SS, T-N excluding BOD and T-P (Table 3). In particular, SS (Suspended solids) has a significant influence on the two points (St. B and St. C). BOD and total phosphate (T-P) are important as pollutants in water system. Thus both stations remained in suspension in water.

Table 1: Index of degree of river naturality according to the environmental factors

Item	Estimated index and scores				
	1	2	3	4	5
The low water's edge vegetation	Naturally formed a variety of vegetation communities	Naturally formed various vegetation communities by natural erosion (sediment exposure) were absent	Natural weeds, shrubs, and mixed	Artificial vegetation composition	Vegetation blocked by stonework etc.
Flood way vegetation	Naturally formed a variety of vegetation communities	Naturally formed various vegetation communities by natural erosion (sand bar) were absent	Both of natural vegetation and artificial vegetation	Artificial vegetation with Parks, lawns, and so on	Remove vegetation artificially
Land use in riparian zones within river levee	Bush or grassland as natural floodplain	Arable land (paddy fields, orchards)	Arable land, urban, residential mixed	About 1/2 urban, residential mixed	1/2 or more urban, residential
Land use in flood plains beyond river levee	State of nature without artificial vegetation, manmade structures	Arable land or artificial vegetation	Artificial vegetation or natural vegetation mixed	About 1/2 park facilities, playground facilities	Impervious man-made structures, parking, etc.
Transverse direction of artificial structures	Absent	Bypass reservoir or slope waterway reservoir	Fish migration reservoir	Reservoir of height 0.3-0.4 m, fish migration difficulty	Fish move completely blocked
Water quality (BOD)	Class 1 (crystal clear)	Class 2 (clear relatively)	Class 3 (tan, the bottom green algae)	Class 4 (blackish brown, the floor is not looked)	Class 5 (an ink color, odor)
Sleep width /river width ratio	20% or more	20 ~ 10%	10 ~ 5%	5 ~ 1 %	Less than 1%

Table 2: The degrees of river naturality according to the environmental factors at the Jungcheon River

Region	The low water's edge vegetation	Flood way vegetation	Land use in riparian zones within river levee	Land use in flood plains beyond river levee	Transverse direction of artificial structures	Water quality (BOD)	Sleep width /river width ratio	Mean
A	2	3	4	4	2	2	3	2.857
B	3	4	5	5	3	3	3	3.714
C	5	4	5	5	4	3	3	4.143

Table 3: Water quality for three regions at the Jungcheon River in Korea. The values are mean of four seasons at each station and standard deviation

Item	St. A	St. B	St. C
pH	7.13±0.33	7.19±0.26	7.33±0.16
BOD (㎎/L)	2.30±0.28	3.52±0.90	4.14±0.28
SS (㎎/L)	14.52±2.27	17.83±2.00	19.73±2.74
DO (㎎/L)	5.95±0.42	6.13±0.15	5.52±0.19
COD (㎎/L)	2.99±0.53	3.86±0.44	4.57±0.39
T-N (㎎/L)	1.96±0.13	2.45±0.14	2.98±0.23
T-P (㎎/L)	0.06±0.02	0.15±0.02	0.24±0.05

DISCUSSION

Vegetated riparian areas are efficient and cost-effective tools for pollution control. Many contaminants from urban and rural areas bind to sediments that, when washed into waterways, constitute large masses of pollutant loadings. These contaminants include most forms of nitrogen and phosphorus, hydrocarbons, PCBs, most metals, and pesticides.

The use of fertilizers and pesticides in agriculture has worsened water quality in the Jungcheon River. For example, the oxygen-demand parameter BOD was not good at low region (Table 3). T-P and T-N are also important parameters as pollutants in water system. Their concentrations are increasing from the upper stream through the middle stream to the downstream (Table 3). Fertilizer supplies of N and P for agriculture are the most important impacts on water quality in this areas (Fig. 1). Because N and P are frequently the nutrient most limiting biological productivity in estuaries (Vitousek et al. 1997), inputs of soil and fertilizer N from agricultural fields can be a major contributor to N-induced eutrophication.

Natural disturbances play a central role for the survival of typical riparian plants and the reservation of the typical riparian vegetation as the examples have shown. But also for the preservation of typical wildlife in flood plains the importance of natural disturbances is proven (Plachter, 1996; Reich, 1991). This strategy should also embrace a longer term strategy to cover the situation where the Jungcheon River subsequently regrades post the avulsion to a condition not dissimilar to that presently being experienced. In this paper it is opined that such considerations will need to consider the long term viability of the plan, Water Quality Protection at its present location and could be incorporated into similar studies associated with the consequences of the next movement on the Nakdong River (very large size river in Korea) as well as Nam River (middle size river).

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