A Study on Ecotope Diversity Transition Analysis in the Middle of the Mankyung River, South Korea

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***Abstract*-An ecotope is an environment where an ecological niche and habitat are combined. Ecotopes are the smallest habitat units that are homogeneously classifiable on maps. Since the diversity of classified ecotopes i closely related to biodiversity, analysing ecotope diversity should be useful for indirectly presuming ecological healthiness. In this study, ecotopes in the middle of the Mankyung River were classified by time period (1918~2014), and the changes of their diversity before and after the construction of dikes were analyzed. Based on this analysis, the ecological healthiness of the environments of the Mankyung River was evaluated. The results of this study show that, after the construction of dikes in 1948, riverside lands formed intensive ecological environments, but the ecotope diversity index of protected lowlands declined sharply due to the artificial development of roads, farmlands, houses, and rural villages.**

Keywords- Ecotope; Diversity; Stream Environment; Habitat; Aerialphoto

I. INTRODUCTION

An ecotope is an environment where an ecological niche and habitat are combined(e.g., R H Whittaker and S A Levin[1]). As the smallest units on maps, ecotopes are the elements that can be homogeneously classified according to the status of general components, potential natural vegetation, and potential ecosystem functions. Ecotopes represent ecological land units composed of patches with different seral stages or land usages. 'Ecotope' and 'biotope' are similar in terms of the concept of habitats for specific colonies of animals and plants(e.g., Tian-Xiang Yue, Qi-Quan Li[2]), but biotope is used as some part of a habitat or as the concept of spaces that are habitable for more than one life.

Meanwhile, ecotopes can classify the landscape into patches, and are therefore useful for comparing and analyzing changes over time through quantitative mapping using aerial photographs. Since ecotope diversity is closely related to biodiversity, we presuppose that analyzing ecotope can be used for indirectly presuming ecological diversity.

This study's objectives include: (1) classifying ecotopes in the middle of the Mankyung River, where the construction of dikes in 1948 rapidly altered the stream environment; (2) evaluating the ecotopes' diversity index using aerial photographs; and (3) analyzing their transition over time so as to investigate ecotope diversity and to determine the ecological diversity of river environments.

II. METHOD

A. Study Area

The study area was approximately a 3.5km section from the confluence of the Soyangcheon stream to the Jeonjucheon stream in the middle of the Mankyung River (total length: 80.86km). This is shown in Fig. 1. The 100~500m crossing distance from the main channel was divided at intervals of 100m, and the 500~1,000m crossing distance at intervals of 500m (shown in Fig. 2).

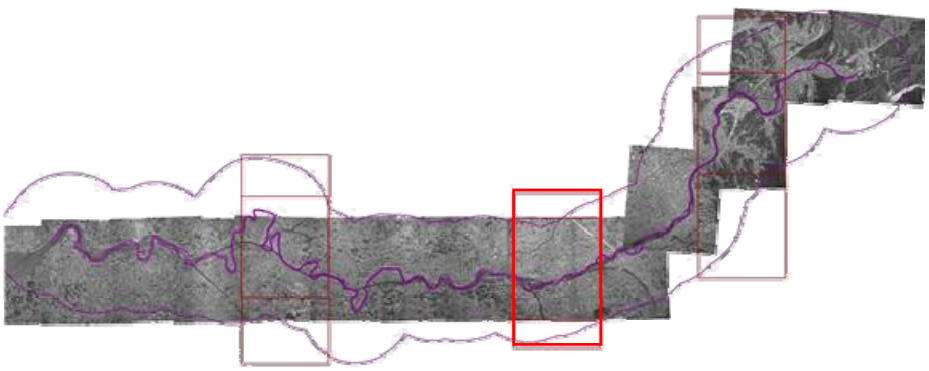

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Fig. 1 The Middle of Mankyung River

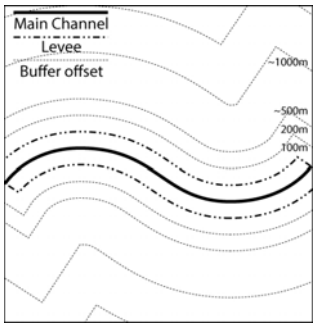

Fig. 2 Conceptual study area

B. Ecotope Diversity Analysis

For mapping ecotopes, this study used an antique 1918 map, drawn before dike construction, as well as aerial photographs of the years 1948, 2003 and 2014 using different scales (1:50,000, 1:20,000, 1:10,000) after dike construction. These maps are collected from the National Geographic Information Institute. The coordinates of all the maps used herein, including the antique map, were corrected using ERDAS Imagine 9.1. Ecotope classification criteria(e.g., D T Van der Molen, N Geilen[3]) are presented by image scale in Table 1. Each classification type was coded and classified using GIS technology.

TABLE 1 ECOTOPE TYPES USED TO DEFINE SCALE OF LANDSCAPE UNITS

	Code		Ecotope		Description
			1:20,000	1:10,000	
Natural	MC		Main Channel	Main Channel	
	Bc		Branch Channel	Branch Channel	
	Be	-g	Bed	Gravel Bed	Exposed river bed due to a decrease in the water level of the channel in a dry season
		-s		Sand Bed	
		-c		Clay Bed	
	Ba	-g	Bar	Gravel Bar	Bar raised by sediment deposition
		-s		Sand Bar	
		-c		Clay Bar	
	S	-oc	Swamp	Open Channel Swamp	Floodplain swamps in riverside lands and swamps in the old river channel within protected lowlands
		-cc		Closed Channel Swamp	
		-fl		Floodplain Swamp	
		-et		Swamp etc.	
	SV		Sparse Vegetation	Sparse Vegetation	Sparse vegetation in floodplains (20-year frequency floodplains, coverage: 25% and/or below)
	Hb	-a	Herbaceous	Herbaceous Annual	Herbaceous plants developed in floodplains and swamps (20 to 100-year frequency)
		-p		Herbaceous Perennial	
	Tr	-h	Tree	Hard wood	Woody plants developed in floodplains and swamps (20 to 100-year frequency)
		-m		Mixed	
		-s		Soft wood	Coniferous forests developed in floodplains and swamps (100-year frequency and/or above)
Anthropic			Levee, Paddy, Artificial Facility, Road etc.		Levee, Paddy, Artificial Facility, Road etc.

The Shannon Index (H) was used to evaluate the values of the ecotope diversity index for the ecotopes classified in this study(e.g., A Carbezas, F A Comin[4]). The index was calculated considering the diversity and homogeneity of patches. It used the following equation; $H= -\Sigma Pi*LnPi$ (where pi is the ecotope proportion of type i). The index values of the divided areas of each year were compared through the use of a graphic.

III. RESULTS

According to the results of the classification of ecotopes in the middle of the Mankyung River shown in Table 2, in 1918 the natural type of ecotopes was 30.30%, but it declined by over 10% after 1948 (16.49~19.72). In particular, branch channels (2.31%) in 1918 had gradually changed into swamps (1.44%) after 1948, and the figure was down to 0.42% in 2003. Herbaceous plants accounted for 21.96% in 1918, but the figure declined by over 10% afterwards (7.74% in 1948, 6.6% in 2003, and 10.61% in 2014).

TABLE 2 AREA (%) COVERED BY EACH ECOTOPE IN EACH YEAR

PERCENTAGES ARE CALCULATED FOR THE TOTAL AREA

	Code	Ecotope			
		1918	1948	2003	2014
Natural	MC	5.89	3.37	8.59	8.24

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	Bc		2.31	0.54	0.79	0.33
	Be		-	5.01	0.04	0.01
	Ba		-	1.22	-	-
	S	-cc	-	1.44	0.42	0.39
		-fl				0.01
		-etc				0.03
	SV		-	-	0.03	-
	Hb		21.96	7.74	5.54	9.12
	Tr		0.14		1.06	1.59
Natural			30.30	19.33	16.49	19.72
Anthropic			69.70	80.67	83.51	80.28
Total			100	100	100	100

Using the classified ecotope maps (Fig. 3), values of the ecotope diversity index were calculated depending on the distance from the main channel (Table 3). The main channel's ecotope index value was 1.06 in 1918, but it decreased to 0.68~0.83 as the calculated areas became increasingly more distant from the main channel. This shows a gradual decreasing pattern, as shown in the graph of Fig. 4. After the construction of dikes in 1948, the value of the main channel slightly increased to 1.5, but the value of the protected lowlands declined sharply to 0.23~0.31.

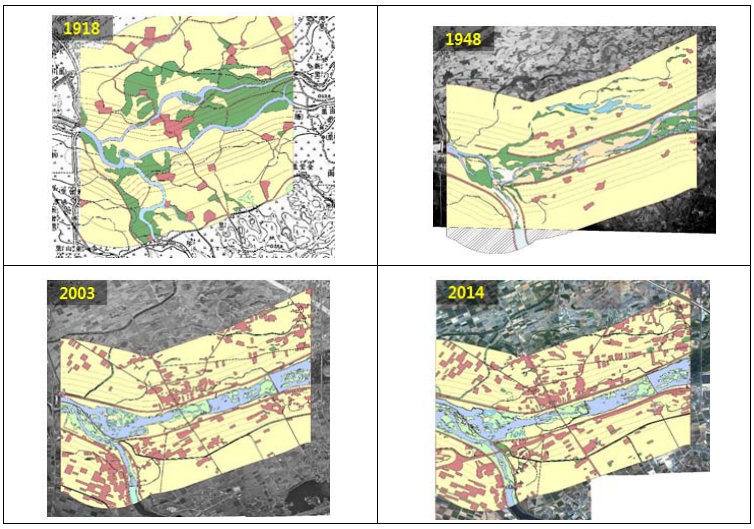

Fig. 3 Ecotope maps for the representative middle of the Mankyung River

TABLE 3 ECOTOPE DIVERSITY TABLE IN THE MIDDLE OF THE MANKYUNG RIVER

Ecotope	Channel	100m	200m	300m	400m	500m	1,000m
2014	1.23	0.38	0.33	0.31	0.3	0.32	0.26
2003	1.23	0.28	0.18	0.19	0.2	0.23	0.23
1948	1.5	0.23	0.23	0.23	0.25	0.29	0.31
1918	1.06	0.77	0.83	0.79	0.75	0.78	0.68

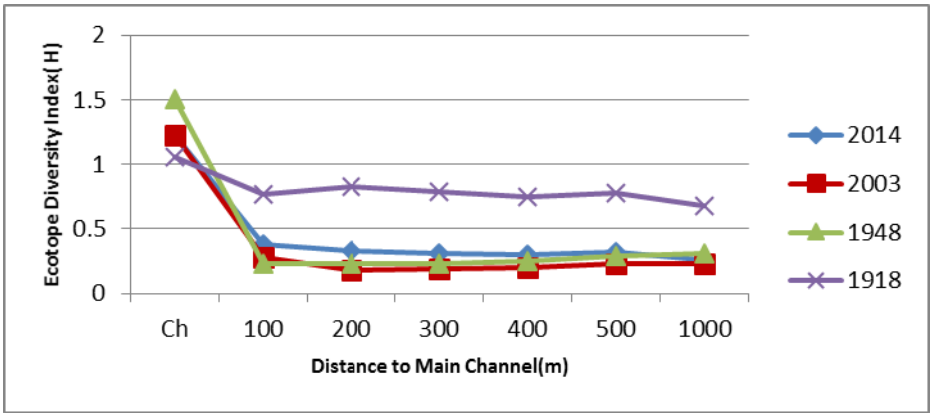

Fig. 4 Ecotope diversity as a function of distance to the river channel

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IV. CONCLUSIONS

In 1918, no dikes had been constructed in the Mankyung River, but there were many branch channels with floodplains covering large areas. Ecotopes mixed with farmlands were observed and the ecotope diversity index values were evenly distributed from 0.68 to 0.83, depending on the distance from the main channel. After the construction of dikes in 1948, farmlands were developed within the protected lowlands through a land readjustment process. Branch channels were closed, resulting in an increase in swamp areas. Additionally, in 2003, the areas were developed more actively into roads, irrigation canals, rural villages, and so forth. In the riverside channel, low water channels increased and intensive ecological environments were developed due to the construction of dikes. Because of this, the main channel's ecotope diversity index increased from 1.23 to 1.5 after 1948. Those of the protected lowlands, on the other hand, decreased from 0.19 to 0.38, showing the extreme difference between opposite sides of the dike.

Against this backdrop, this paper proposes that ecotope diversity is an effective index to analyze the transition of ecotopes. We found that artificial disturbances after the construction of dikes directly result in a decrease in ecotope diversity. Therefore, it is reasonable to infer that the decrease in ecotope diversity after 1948 is correlated with a decrease in ecological healthiness.

ACKNOWLEDGMENTS

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