Ecological Landscape Evaluation for the Planning of River Rehabilitation:
The Upper Areas at the Mangyeong River in Jeollabukdo, Korea

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하천복원계획을 위한 생태경관 평가:
전북 만경강 상류지역을 사례로

이명우

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국문초록

근래에 들어 자연환경의 복원은 우리나라의 하천 관리에서 중요한 계획과제의 하나이다. 계획과정에 있어서 경관의 분석과 평가는 보전 지역 및 개발 지역의 적지선정을 위하여 매우 중요한 단계이다. 이 연구의 목적은 생태경관 단위에 있어서 생태환경분야별 조사 특성을 반영할 수 있는 위계적 방법론의 수립과 이에 기초한 적지분석을 통해서 하천내 보전 지역을 설정하는 데 있다. 경관 평가과정에서 경관 스케일은 광역스케일, 지역스케일, 국지스케일로 구분하여 적용할 필요가 있으며, 이에 따라 환경자료들이 수집, 분석, 종합된다. 이러한 3단계의 단위개념이 도입되어야 하는 것은 하천코리도에서 보전지 설정을 위해 생태 자료들의 다원적 성격을 평가하기 위한 것이다. 위계적 스케일에 따른 평가과정은 3단계로 구분되어 수행되었다. 첫 번째는 장거리 경관 단위로서 광역적 개념에서 하천폭을 기준으로 설정되었다. 두 번째는 각각의 장거리 경관 단위의 지역적 개념에서 경관의 동질성을 기준으로 2 이상의 단위공간으로 구분되었다. 세 번째는 국지적 개념에서 교각, 다리, 보의 위치에 따라 세분적으로 분류되었다. 이 마지막으로 분류된 국지적 단위를 기준으로 하여 생태환경에 대한 자료를 재취합, 분석하기 위한 개념적 적지분석모형의 항목들을 선정하였다. 최종 결과에서는 하천내 습지생태학습공간으로서 집중적으로 관리되어야 할 잠재력이 있는 장소로서 3개소의 보전 지역이 설정되었다. 적지분석과정이 내포하고 있는 많은 가정에도 불구하고, 이러한 방법론적 제안은 우리나라의 하천복원계획에서 다원화된 전문가들과의 공통적 토론을 통해 생태 정보들을 통합하여 실천적

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으로 적용할 수 있는 틀을 제공할 수 있으리라고 기대한다.

키워드: 경관 단위, 하천코리도, 보전용지, 경관스케일, 평가과정, 생태정보통합 개념모형

ABSTRACT

Nature rehabilitation has become a major theme in river management in South Korea. An analysis and evaluation of the landscape is a crucial step to select the suitable tracts for developing or conserving land use in the process of landscape planning. The purpose of this paper is to establish a hierarchical procedure for the setting of the landscape units on the various scales at which field biologists performed their observations and to select the preserves through by a suitability model for synthesizing the ecological empirical, and biophysical data. An evaluation process needs to be performed according to the landscape scales: site, local, and regional scales, at which the environmental data were collected, analyzed, and synthesized. Introducing of three level scales was crucially necessary for evaluating the various multi level ecological data for zoning of preserves in river corridors. The evaluation level at different scales are hierarchically established into three phases. The first evaluation phase can be performed by the long length units defined by the ranges of stream widths at regional scale. Secondly, each of these long units can be divided into two or more segments according to its landscape homogeneity at local level. Finally the segments at the last phase can be designated according to the location of the reservoir weirs and bridges at site level. The conceptual model components are adopted for collecting, evaluating, and interpreting the biological and abiotic data at site level. Three preserves are selected , having high potentials for being intensely managed as the Ecological Education Areas in the river. Despite a lot of assumption the results are expected to facilitate discussion and decision making about which frameworks of evaluation are desirable and adaptable for integrating the ecological data into the rehabilitation design process in South Korea.

Key Words: Landscape Units, River Corridors, Zoning for Preserves, Landscape Scales, Evaluation Process, Conceptual Model for Synthesizing the Ecological Data

I. Introduction

The topic of river rehabilitation has been adopted as a major policy related to sustainable development of natural resources and biodiversity, especially in Western Europe (the Netherlands, Germany, Swiss, etc.) and in Japan. In South Korea, attempts for the river and stream rehabilitation projects have been performed, "planning for naturalizing streams" since 1995 to renew the deteriorated river especially in urban areas mainly by benchmarking Western Europe and Japan.

1. Decreasing Natural Dynamics and River Rehabilitation

The dynamics of flow velocity and discharge are key factors in the determinations of the fluvial system, and are linked to the suitability of the river as a habitat for biota. Various concepts are used to describe this system, e.g. the river continuum (Vannote *et al.*, 1980), the flood pulse (Bayley, 1991), hydraulic stream ecology (Statzner and Higler, 1986), the fluvial hydrosystem (Petts and Amoros, 1996). Flooding is the trigger for some of the most important characteristics of a living fluvial hydrosystem as is summarized by the flood pulse concept (Junk *et al.*, 1989). They adopted the 'design with nature' philosophy of McHarg(1969) and advocated using geomorphological processes for maintaining natural bed forms in river channels that had to be improved. The first handbook to further the conservation of wildlife in rivers was published in the followed by the effects of river dams and channelisation by Brooks(1988), respectively. The physical structure of previously channelized rivers was restored in project of small streams in Germany and Denmark (Brooks, 1987). The first time specific goals were considered for the channel and floodplain morphology of a major trans boundary river in the Rhine Action Programme in 1987 (Van Dijk *et al.*, 1995).

Many rehabilitation projects on both small streams and large alluvial rivers have followed. River rehabilitation seeks to improve the natural functioning of the river and the riverine landscape as a diverse network of habitats, including its corridor function for the catchment. Boon(1997) describes five appropriate strategies for river conservation, in accordance with the state of the river: preservation of natural system, limitation of catchment development, mitigation of low quality of the river landscape, rehabilitation for the degraded environment, and dereliction for the worst case scenario. When rivers are degraded to a point that natural hydrodynamics are hardly recognizable and only scattered and small remnants of population persist, there the emphasis shifts toward river rehabilitation. With the help of well chosen rehabilitation techniques and nature development projects, more suitable habitats need to be created, enhancing the recovery of the remaining populations and the establishment of new ones.

The natural features of the river stretch are the result of physical and biotic processes and management activities. In a natural fluvial landscape, the abiotic processes, especially morphological and hydrological processes determine the type of natural systems occurring at the scale of the river section. Therefore to restore a natural situation in a certain river stretch, rehabilitation of morphological and hydrological processes is a prerequisite: e.g. the flooding frequency of the actual floodplains can be increased by removing protection levees or weirs or dams or the sediment layer that covers the original relief structures.

The solution to many problems can be found in a careful and integrated planning process, in which the various river and land use claims are assigned to the most suitable parts of the river systems. Scientists supporting the planning process will generally raise the following four questions where it concerns about nature.

- Are there reference situations for nature rehabilitation ?
- What conditions should be fulfilled to realize situations?
- Which areas are suitable for successful rehabilitation?
- What measures should be included in the spatial layout?

Reference situations are descriptions of past situations or the relatively pristine river systems elsewhere, revealing the existence of more natural landscapes and biologically more diverse ecosystems. The inspiration of river rehabilitation is usually derived from such situations. Besides, comparison of the reference situations with the river system to be rehabilitated make it possible to investigate which phenomena and processes have been degraded and consequently to identify the direction of change that has to be pursued. Process conditions that have to be fulfilled must be identified to set the rehabilitation targets that are likely to be sustainable solutions at minimal costs for future management. Comparison with characteristics of the various parts of the river systems allows areas to be selected where these process requirements are met. This forms the basis for the design of measures that will create the new situation or trigger the required process dynamics.

From the above discussion, it is evident that biodiversity in the rivers and riverine landscapes depends largely on the unhampered hydrological and morphological dynamics of the river, functioning as a complex of the fluvial hydrosystem. Fluxes of water, transported components and organisms between distinct environment and spatial units result in a mosaic of independent habitats each with characteristic hydraulic conditions, suitable for different species and communities. Any attempt to manage and restore rivers in favour of biodiversity, should focus on these preconditions.

2. Selecting the Preserves and Greenway Suitability Analysis

In USA, the suitability analysis method has been widely applied to the greenway development including stream corridors. The stream corridor (stream and its immediate shore land environment) is an area of critical environmental significance which includes the streams, their natural and cultural resources as the most important zone for concentrating the waterway conservation and management efforts. Generally for conservation and management purposes, a stream corridor may be classified according to its relationships to land use as reflected in either of the following: The Urban Stream Corridor, The Suburban Stream Corridor, and The Natural Stream Corridor (New York DEC, 1985). Greenways, sometimes referred to as environmental corridors, landscape linkages, wildlife corridors, or riparian buffers, are defined as connected systems of protected lands that are managed for multiple uses: nature preservation, recreation, agriculture, and cultural landscape protection. Greenways can be used to create interconnected networks of open space that include more traditional non-linear park and natural areas. They can help to maintain ecological integrity in human dominated landscapes, especially with regard to sustaining high water quality and preserving biological diversity (Miller *et al.*, 1993).

Because of the multifunctional nature and emphasis on connectivity, greenways require an ecological landscape planning approach which should be multidisciplinary. The key challenges for greenway planning are to first establish the importance of landscape connectivity and to demonstrate alternative ways of combining compatible uses, and of separating incompatible uses. Greenway planning should be integral to a comprehensive landscape planning effort, including consideration of development suitability, open space resources, wild life species protection, and scenic resource management. In this larger context greenway may be seen as the connecting elements in a network which links protected lands. Greenway planning needs to perpetuate ecological processes and to conserve wildlife populations while affording continued human interaction with the natural landscape.

Miller *et al.*(1998) established three functions for greenway suitability analysis for Prescott Valley, AZ, USA. The functions were:

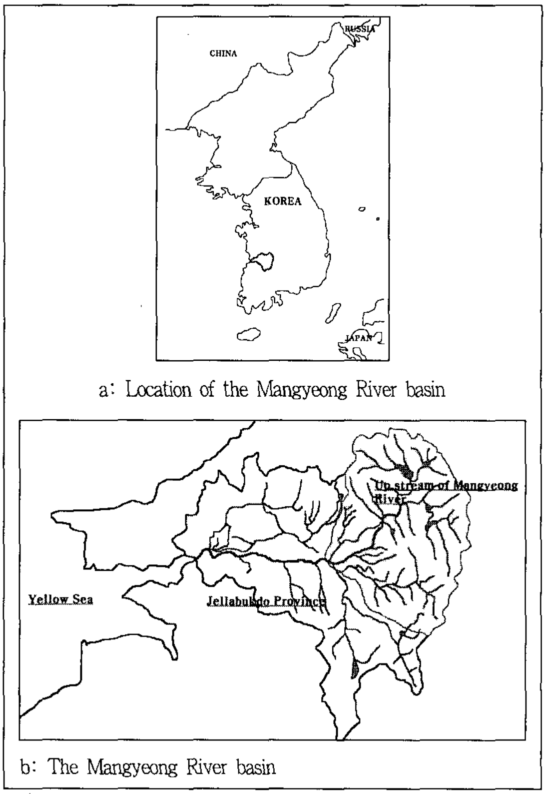
1) Protection of natural riparian corridors and their associated functions towards groundwater recharge and surface water runoff.
2) Preservation of open spaces for wildlife habitat and more specifically the protection of sensitive antelope habitat areas and travel corridors.
3) Provision of multi-use recreation areas and amenities to increase the general public's exposure to the natural environment.

The factors for wildlife habitat function are macro habitat type, slope, distance to water, and distance to population, and those for riparian corridor function are surface water quality, ground water recharge, vegetative cover, erosion control and channel morphology. The factors for recreation are existing land use, development pressure, greenbelt component, extending public parcels, and population density.

The most important part of river conservation planning is to conserve potentially valuable natural habitats with finding and selecting the preserve·in the stream as the main task. The preserve zone can be defined as the area which should be carefully protected for high ecological sensitivity and diversity. The data on ecological environment is usually investigated and evaluated, however there are some limitations to integrate the scale specific ecological information and apply this to the corridor planning process.

The purpose of this paper is to establish a hierarchical procedure for the setting of the landscape units on the various scales at which field biologists performed their observations and to select the preserves through by a suitability model for synthesizing the ecological empirical, and biophysical data. This approach is based on the assumption of the rules of combination method as presented by Hopkins (1977) which has been underlined on McHargian suitability analysis to handle the independent factors in terms of verbal logic. In applying a suitability analysis to river rehabilitation, conservation planners are increasingly trying to understand the actual ecological phenomena on the selected site in their ease of interpretation. This paper addresses the procedure and the model of the preserves suitability analysis for designers to easily understand the biophysical background at the sites.

II. Study Area and the River Rehabilitation Project



a: Location of the Mangyeong River basin

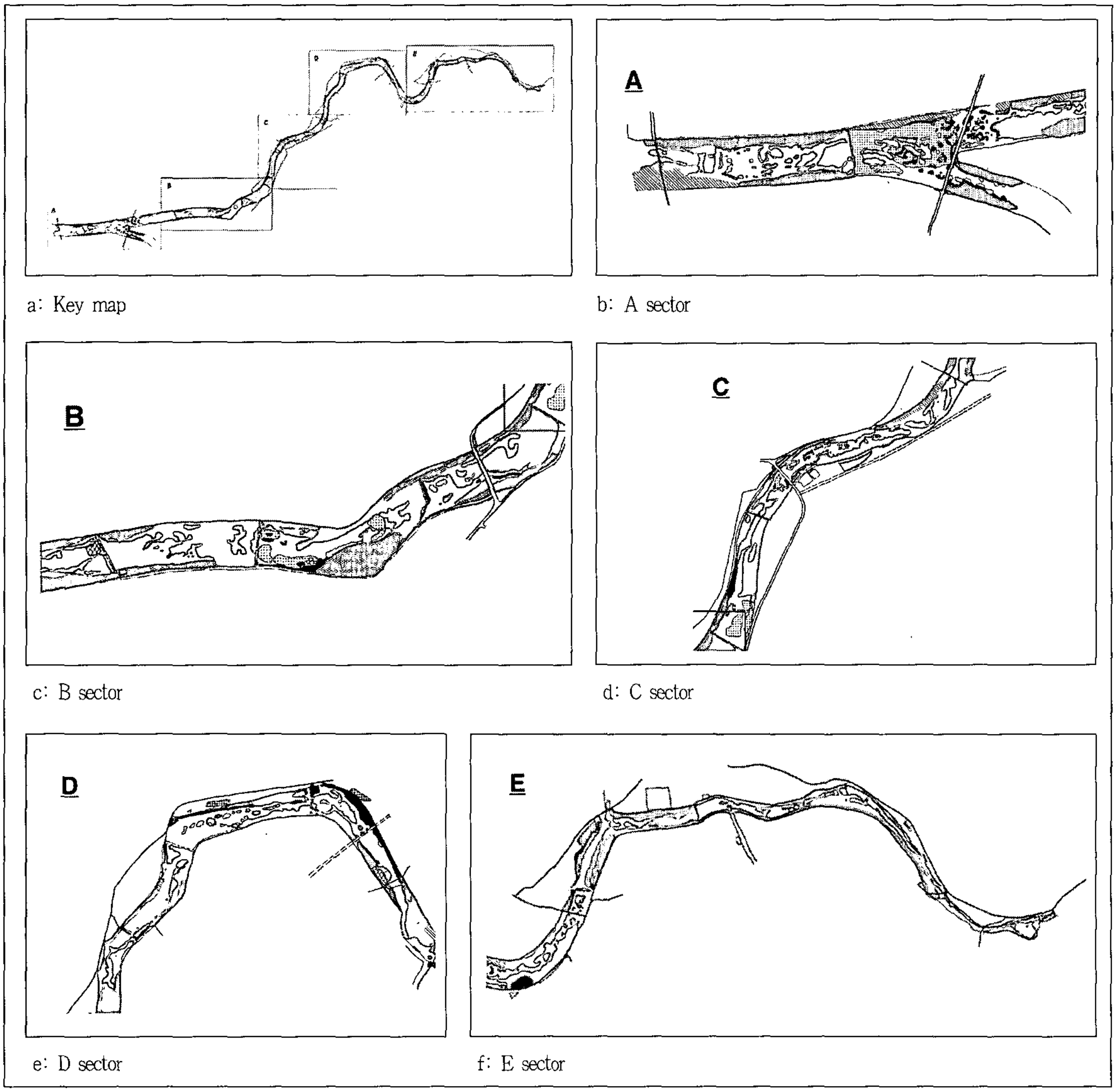
b: The Mangyeong River basin

Figure. 1. Location of the site.

The River Mangyeong (54km long, 1km~100m wide) is located in Wanjukun (35°55′ N, 127°8′ E), Jeollabukdo, draining the most intensively agricultural area in southwest Korea (Figure. 1).

The upper reach project for the River Mangyeong, 2001~2002, was based on "selecting and preserving the ecologically potential core areas for environmental research and education" because of relatively good nature conditions on the River Mangyeong. Several field biologists had seasonally investigated the biotic information of riparian vegetation, fisheries and birds and water quality. Plant species were surveyed at 21 stations and were mapped as plant communities through mapping the vegetation communities seasonally (Figure 2). The composition and abundance of fish species were surveyed at 10 stations through counting the number of species on catched fishes at three random positions. The water quality data were collected every fishes-counting point. The species and number of bird were at 7 stations through observing method on random stations. The field biologists professionally identified and described the peculiar values of the rare or endangered species. The critical point of this research of the biotic data was the number of species to be observed at some area. As a planner, I adapted the results from the professional surveying analyses.

But the location and number of surveying stations were incongruous and it was difficult to spatially interpret the data for synthesizing the results. The



a: Key map b: A sector c: B sector d: C sector e: D sector f: E sector

Figure. 2. Map of riverine vegetation communities.

Legend:
- Submerged and floating-leaved plants comm.
- Emergent plants comm. 1(*Typha orientalis*. *Zizania latifolia*
- Emergent plants comm. 2(*Phragmites japonica*)
- Wetland plants comm.
- Upland plants comm.
- Riparian tree & shrubs
- Gravelly field
- ricd field
- Field

issue was how to incorporate the data into the planning process for selecting the preserves with adequate interpretation at different scales.

III. Procedure and Conceptual Model for the Case Study

1. Hierarchical Landscape Scals: Site, Local and Regional Level

In general, three levels of landscape scale are distinguished in landscape planning: site, local and regional level. The element at site level, called eco-elements or ecotopes, are areas less than a few hectares. An ecotope is the smallest, relatively homogeneous landscape element which can be mapped at scales of 1:5000 to 1:25,000. The regional level contains eco-regions or regional natural units. The landscape mosaic might corresponds with the regional scale which can be the strategic planning level where landscape planners are looking for opportunities and constraints to find the current land use patterns, to link possible landscape interventions with costs and benefits to people and nature, as well as to configure land use change over time (Langevelde, 1994). This study had adopted this hierarchical landscape scales concept.

In this study, the landscape scales for evaluation were hierarchically categorized into three types for interpreting the whole ecosystem. Classification criteria was judged on the field situation especially by river width and around land use.

The first type is the long length type (LU) at regional scale, which is defined by the stream width. The upper stream area is classified as A sector, the width of which is below 200m, the mid into B sector (200m~300m width) and the lower into C sector (300~600m width). I generally interpreted the naturalness and human interruption to each 5~8km long LUs. The avian information in this project could be interpreted in these LUs. Secondly, each of three LUs were reclassified into two to five tracts according to their landscape homogeneity (the medium length type: MU) totaling 10 parts at local scales (A1~C3). I could adequately explain the riparian ecological function and structure to each 2~5km long MUs. Fishes information was interpreted in these MUs. Thirdly, each of these MUs were site-specifically classified according to the location of the reservoir dams and bridges (the small length unit: SU) totaling 28 units at site scales (A11~C34). I could evaluate by selecting the core preserve to each 200m~2km SUs. Vegetation information was mapped and evaluated in these SUs (Figure. 4).

2. Landscape Evaluation for River Planning

There was contrasting approach at different scales, inter-state and regional level. At inter-state level, the target vegetation and final vegetation concept was considered to select the proper scenario. Each potential

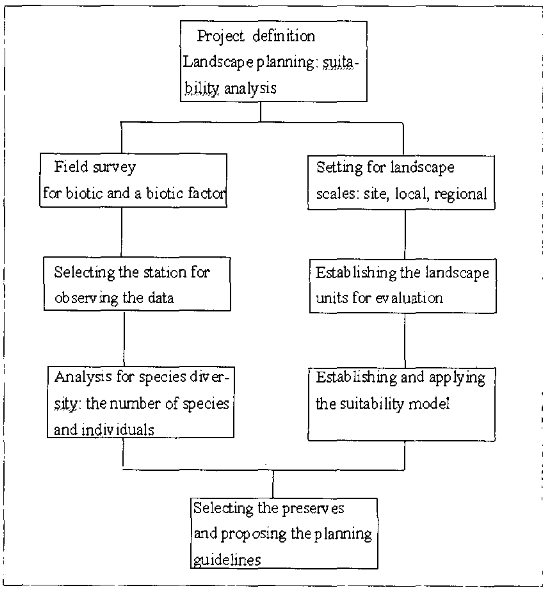


Figure. 3. Flow chart for the planning process.

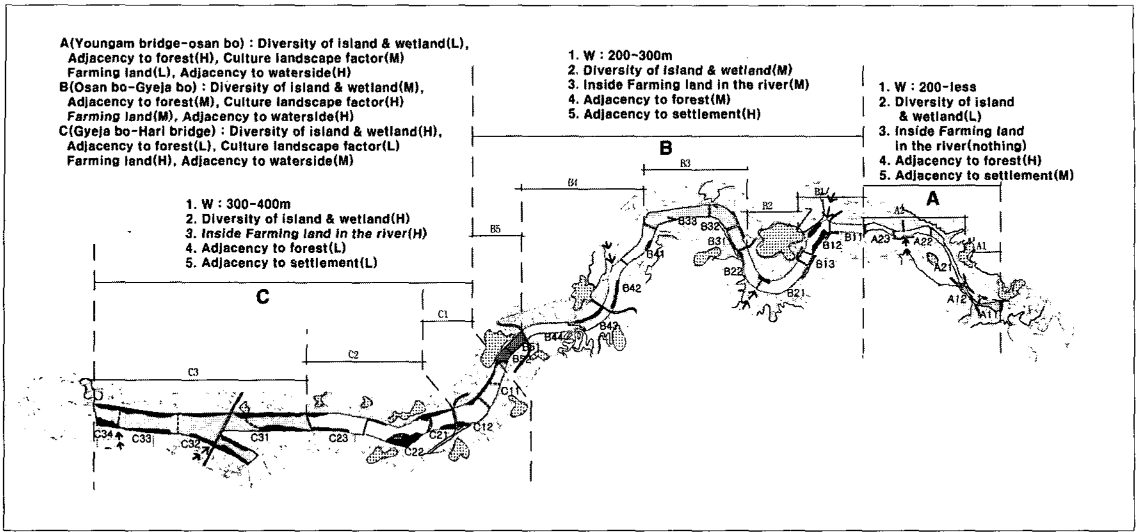


Figure. 4. Hierarchical evaluation units.

habitat for Marsh-harrier and for beaver was estimated after 30 years each at regional level (Harms and Wolfert, 1998).

On project for the Kadowaki and Yamanaki River Hirosima prefecture Japan, conservation site selection was performed by evaluating the vegetation and avian habitat. The existing vegetation is evaluated for rare and recovery potentials and used for selecting the preserved. The forest patch and its layer structure and distance between the large forest and patch were analyzed for regression the relationship between birds and forest (Nakagoshi *et al.*, 2002). This is a kind of index species approach but not eco systematic approach.

In Netherland, case studies on lowland fluvial systems for river rehabilitation had been done on the geomorphological changes. This research is based on long term investigation and interpreting (Wolfert, 2001), and is not adequate to Korean river' project which should be done in one or two year.

There are two river evaluation stages in Japan construction authorities of northeast region. The first stage is general, while the second is detailed evaluation. The general evaluation is performed for zoning the area as natural, semi-natural, and interrupted area by preliminary survey and existing data of land use, channel characteristics, vegetation, and water quality. The detailed evaluation is performed at specific concerned site on the information of biotic species, individual, their location, and the abiotic factors (Cho, 1997).

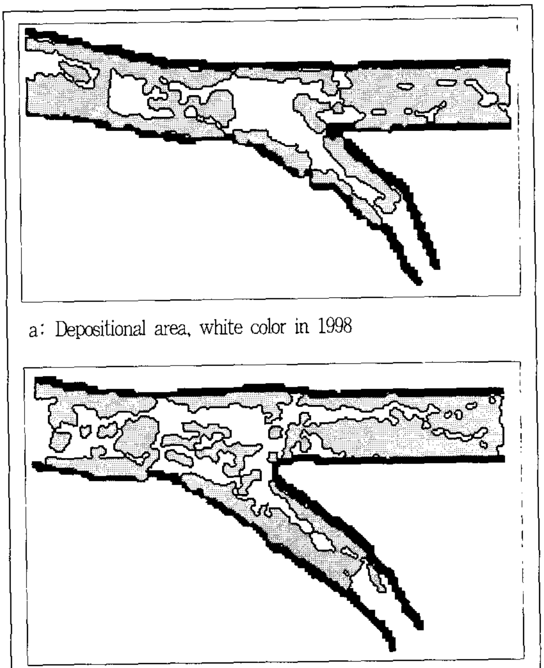
I differentiate two types of river evaluation according to the planning phases: concept plan making phase and site related zoning phase. For concept plan making, the general evaluation information over all areas at regional scale is needed, which includes land use types, land cover types, and general physical factors. I defined this kind of data as "general naturalness evaluation". And the specific information at site scale is needed, which includes biotic species-diversity and physio-diversity for site related zoning and designing which is related to selecting and delineating the preserve. I defined that as "biotope diversity evaluation". These evaluation procedures are sort of overlaying paradigm by summing the assigned values of items. This simple summing overlay method to major item was usually used for the ecological suitability analysis. And the Biotic Diversity evaluation was based on the species abundance. This planning approach could not be scientifically verified but broadly accepted as planning tool.

1) General Naturalness Evaluation

This evaluation was performed at regional and local scale. The evaluation components at regional scales LUs were the proximity of forest and village, riverine agriculture activity and water related recreation activity in riverbank and diversity of depositional area in stream. All the items were evaluated as high, medium and low relatively to the situation. The evaluation components at local scales MUs were the land use around the riverbank and stream physical structure width, water surface area ratio, sedimentation types, stream bed types and water quality. This evaluation was used for describing and interpreting the naturalness.

2) Biotope Diversity Evaluation

This evaluation was performed at site scale SUs. The components of bioptope diversity evaluation were composed of fishes, avian, vegetation as biotic factor and water as abiotic factors. The biotic factors attributes for evaluation were species number and diversity. The abiotic water factors were the water surface area ratio and water quality. The biotic information was gathered seasonally. The Arirang remote sensing data (2002) was used for mapping the water surface area and depositional pattern change (Figure. 5). Each biotic species numbers to be investigated seasonally was summed and relatively graded to 3 levels (A, B, C). The level A was marked as point 3, B' as 2, and C' as 1. All points of three biotic factors at site (SU) were resumed and reclassified as high (total sum 7, 8 and 9) potentials, medium (total sum 5, 6) and low (total sum 3, 4). The deserved areas were selected at high potentials. The water surface ratio (%) was used to explain the site's potentials (Figure. 6).



a: Depositional area, white color in 1998

b: Fractured depositional area, white color in 2001

Figure. 5. Depositional pattern change plotted from the Arirang remote sensing data.

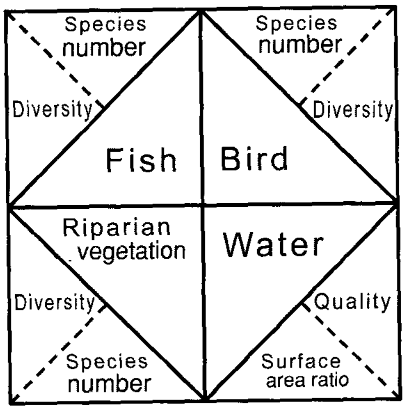


Figure. 6. Biodiversity evaluation model.

IV. Results

1. General Naturalness Evaluation

1) Evaluation at Regional Scale

Along the upper stream sector A, there are com

Table 1. Evaluation at regional scale

	Proximity to forest	Proximity to village	Riyerine agricultural activity	Water related recreation activity	Diversity of depositional area in stream
A sector upper stream (below 200m width)	Medium	Medium	Seldom	Medium	Simple
B sector mid stream (200m~300m width)	High	High	Medium	Much	Medium
C sector lower stream (300m~400m width)	Low	Low	Low	Seldom	Diverse

paratively small forest patches within 50m distance and several agricultural facilities and houses (Table 1). There are seldom riverine agricultural activities and comparatively medium water related recreation activities. The configuration of depositional area in stream is simple. Along the mid stream sector B, there are comparatively large forest patches on the hills 20 ~30m high within 50m distance and comparatively large residential villages. There are relatively little riverine agricultural activities and comparatively high water related recreation activities. Diversity of the depositional area configuration in stream is comparatively medium. Along the lower stream sector C, there are no forest patches distance and no houses within 50m. There are relatively much riverine agricultural activities and seldom water related recreation activities. Diversity of the depositional area is comparatively high.

2) Evaluation at Local Scale

The land use pattern shows different patterns at left and right side to down stream (Table 2). There are large forest or monumental trees left A1, right B1, left B2. Farm land and scattered house with big tree and forest is main feature B2, B3, B4, B5, and C1. The terraced floodplain area is left as mostly natural situation with partly agricultural land use sector B. But it is extensively used as agricultural land, sector C. The width of stream ranges from 100 to 140m at A, 210~260m at B, and 300~380m at C. The water surface area ratio is below 50% except B3. Depositional feature's number is mostly 2 to 3, but at B1 and C3 is 4. Special stream bed number is mostly 3 to 4, but at B1, B2 and C3 is 5. BOD level is mostly below 1.0 mg/l except at C.

These descriptions partly explain the evaluation at regional scale. And I can know that ecological potentials are relatively high at B1 and B2 according to the outside forest proximity and diversity of stream bed and depositional area. But this evaluation has no biotic information. So this result can only be applied to make plan including line corridor and spot. The biotic information should be analyzed for selecting the preserved core area.

2. Biotope Diversity Evaluation and Rehabilitaion Planning

1) Selecting the Preserves

The evaluation criteria (Table 3) is established through discussion with surveying ecologists. Level A for wild bird is determined at more than 20 spp., for riverine vegetation more than 90 spp., and for fishes at 30 spp. (Figure. 7). Though I cannot exactly induct the functional relationship between these biotopes and the species number, I concluded this approach would be proper for selecting the preserved.

The evaluation results (Table 4) reveal that the

Table 2. Evaluation at local scale

		From the banks to the farm land[a]		Terraced flood plain area between banks channel's struture, water quality[b]		Channel's structure and water quality				
		Left side to down stream	Right side to down stream	Left	Right	Width (m)	Water surface ratio(%)	Depositional area's diversity (No of items)[c]	Special stream bed form (No of items)[d]	Water quality BOD(mg/l)
A sector	A1	5	2	A	A	100	45	2	3	0.5
	A2	3	2	A	A	140	38	3	4	0.7
B sector	B1	3	4(2)	A	C	260	41	4	5	0.7
	B2	5(3)[e]	3	A	B	220	32	3	5	0.8
	B3	3	3	A	A	240	53	3	4	0.7
	B4	3(5)	3	B	A	210	29	3	3	0.6
	B5	3(5)	3(4)	A	B	210	22	3	4	1.2
C sector	C1	3	2(4)	A	B	330	33	2	4	1.2
	C2	3	3	B	B	330	38	3	5	1.1
	C3	3	3	B	C	380	41	4	3	1.0

[a]: Land use pattern of terraced floodplain area 1. Apartments, urban residential area, industrial area; 2. Farm land, facilities for livestock, motel; 3. Scattered farm land and residential facilities; 4. Monumental big tree, cultural asset; 5. Almost forest, partly farm land.

[b]: Land use pattern outside from the banks: A. Naturalistic; B. below 50% of farm land; C. Above 50% of farm land.

[c]: Straight riverline sands, curvilinear riverline sands, depositional island, reaches joint areas sand.

[d]: Bogs, shoals and rapids, above double deep areas of average water depth, a shallow pool.

[e]: parenthesis means second type of land use.

Table 3. Evaluation criteria of biotope diversity evaluation

No of species	A(point 3)	B(point 2)	C(point 1)
Wild birds	More than 20 spp.	10~20 spp.	Less than 9 spp.
Reverine vegetation	More than 90 spp.	80~90 spp.	Less than 70 spp.
Fishes	More than 30 spp.	20~90 spp.	Less than 20 spp.

number of high potential ranking is nine. Therefore I finally selected three areas of high water surface ratio as the preserved cores among nine high ranking areas. And the adjacent areas to be needed rehabilitation were involved for supporting the preserved. The average length of the preserved being 1.5 km.

2) Corridor and Core Planning

I defined the themes of the preserved core areas based on the above evaluation items. The design theme of B22 is the riparian vegetation wetland biotope, that of C21 is the avian and wild plant wetland

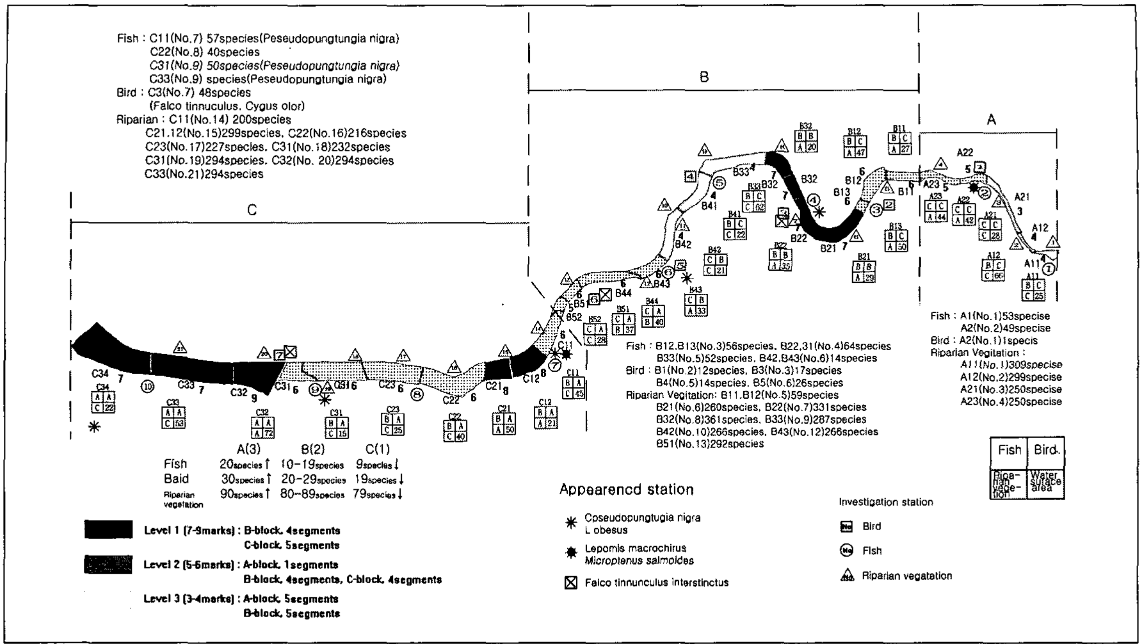


Figure. 7. Evaluation for biotope diversity.

biotope, of C32 is the birds, fishes, and vegetation wetland biotope. These wetland biotope areas with adjacent enhancement area are functioned as ecological cores. The linear wetland biotope corridor was planned along the water side with excavation and reshaping the stream bed. Preserving the existing monumental big tree and forestation of river familiar tree at disturbed area was planed to support the ecological corridor function. The vegetated wet land at the exit of reaches designed as the ecological spot area (Figure. 8).

V. Discussion and Conclusion

In South Korea, ecological experts usually perform their own specified survey in early stage separately

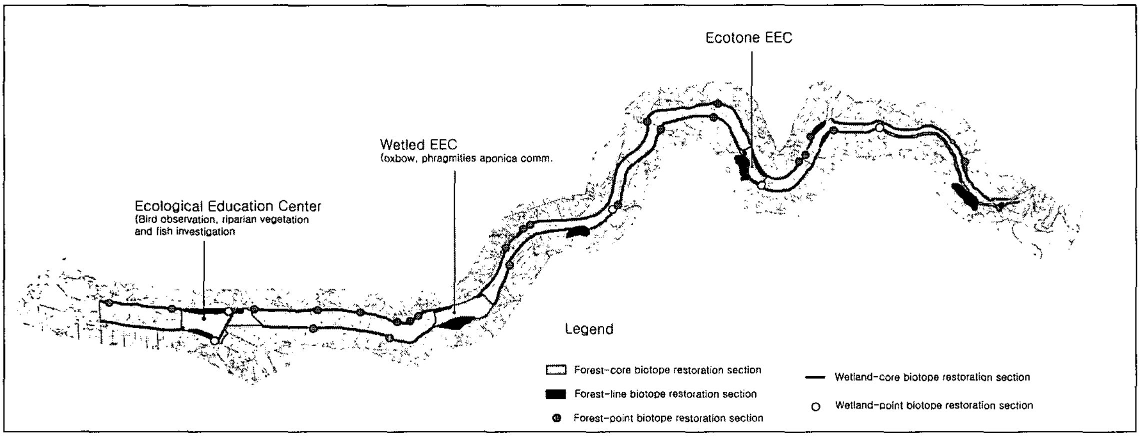


Figure. 8. Planning of the stream corridors.

Table 4. Evaluation result of biotope diversity

			Level of vegetation diversity	Level of fishes diversity	Level of birds diversity	Potentials ranking	Water surfaces area ratio(%)	Final selection of the preserved
Sector A	A1	A11	C	B	C	3	25	
		A12	C	B	C	3	66	
	A2	A21	C	C	C	3	28	
		A22	A	C	C	2	42	
		A23	A	D	C	2	44	
Setor B	B1	B11	A	B	C	2	27	
		B12	A	B	C	2	47	
		B13	A	B	C	2	50	
	B2	B21	A	B	B	1	29	
		B22	A	B	B	1	35	
	B3	B31	A	B	B	1	35	Adjacent
		B32	A	B	B	1	77	0
		B33	C	B	B	3	62	
	B4	B41	C	B	C	3	22	
		B42	C	C	B	3	21	
		B43	A	C	B	2	33	
		B44	B	C	A	2	40	
	B5	B51	B	C	A	2	37	
		B52	C	C	A	2	28	
Sector C	C1	C11	C	B	A	2	45	
		C12	A	B	A	1	21	Adjacent
	C2	C21	A	B	A	1	50	0
		C22	C	B	A	2	40	
		C23	C	B	A	2	25	
	C3	C31	C	B	A	2	15	Adjacent
		C32	A	A	A	1	72	0
		C33	C	A	A	1	53	
		C34	C	A	A	1	22	

from whole design process (Busan city, 2001; Jeollabukdo, 2000). Koreanlandscape studies about the river evaluation mostly focused to physical environmen- - tal analysis and partly general vegetation information referred to the Germany Rhine-land pfalz action(Cho, 1997; *Ahn, et al.*, 1997; Kim *et al.*, 2000; *Jeong et al.*, 1998). But it lacks other critical biotic information for practical implication.

Ecological landscape planners need to integrate various biotic evaluations to the planning process for practical purpose. The evaluation level at different scales are hierarchically established into three phases. The first evaluation phase can be performed by the long length units defined by the ranges of stream widths at regional scale. Secondly, each of these long units can be divided into two or more segments according to its landscape homogeneity at local level. Finally the segments at the last phase can be designated according to the location of the reservoir weirs and bridges at site level. The conceptual model components are adopted for collecting, evaluating, and interpreting the biological and abiotic data at site level.

At strategic forming planning stage, the regional level evaluation can be used. At system networking stage, the local level evaluation can be used and the site level evaluation can be used for establishing the themes and designing the site. Planners need to perform the planning and design with interlocking the ecological information which should be easily understood and ascertained.

This hierarchical evaluation method developed are applicable to other planning project of river rehabilitation focused on vegetation, birds, and fishes species and diversity related to design. However, it is left to future studies to develop the method of the total eco-system and watershed interpretation.

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References

1. Ahn, H., T. Amada, and K. Ichibara(1997) A study of the analysis of the riparian vegetation naturality and viewscape in upstream. Journal of the Korean Institute of Landscape Architecture 25(3): 222-233.
2. Bayley, P. B.(1991) The flood pulse advantage and the rehabilitation of river floodplain systems. Regul. Rivers Res. Man. 6: 75-86.
3. Boon, P. J.(1997) Trends and dimensions in river restoration: a conference summary. In H. O. Hansen and B. L. Madsen, eds., River Restoration 96-Plenary Lectures: International Conference Arranged by the European Centre for River Restoration. Silkeborg: National Environmental Research Institute. pp. 113-125.
4. Brookes, A.(1987) Restoring the sinuosity of artificially straightened stream channels. Environmental geology and Water Science 10: 33-41.
5. Busan City(2001) Master Plan for Eulsuk Island Eco-park.
6. Cho, Y.(1997) Development of an Evaluation Method of Stream Naturalness for Ecological Restoration of Stream Corridors. Ph. D. Dissertation. Seoul National University
7. Harms, W. B. and H. P. Wolfert(1998) Nature rehabilitation for the river Rhine: a scenario approach at different scales. In P. H. Nienhuis, R. S. E. W. Leuven, and A. M. J. Ragas, eds., New Concepts for Sustainable Management of River Basins. Leiden, The Netherlands: Backbuys Publishers. pp. 95-113.
8. Hopkins, L. D.(1977) Methods for generating land suitability maps: a comparative evaluation. J. of the American Institute of Planners 43(4): 386-400.
9. Jeollabukdo(2000) Master Planing and Design for the Lower Mangyeong River.
10. Jeong, J. and S. Lee(1998) A study of pro-environmental potential of streams in Sunchon City. Journal of the Korean Institute of Landscape Architecture 26(1): 96-112.
11. Junk, W. J., P. B. Bayley, and R. E. Sparks(1989) The flood fulse concept in river floodplain systems. Spec. Publ. Canadian Journal of Fish and Aquatic Science 106: 110-127.
12. Kim, D., J. Lee, and I. Park(2000) An evaluation of stream naturalness close to nature stream restoration. Journal of the Korean Institute of Landscape Architecture 27(5): 138-149.
13. Langevelde, F. V.(1994) Conceptual integration of landscape planning and landscape ecology with a focus on the Netherlands. In E. A. Cook and J. N. vanLier, eds., Landscape Planning and Ecological Networks. Amsterdam: Elsevier. pp. 27-69.
14. McHarg, I. L.(1969) Design with Nature. New York: The Natural History Press.
15. Miller, W., M. G. Collins, F. L. Steiner, and E. Cook(1998) An approach for green way suitability. Landscape and Urban

Planning 42: 91-105.
16. Nakagoshi, N. and T. Kondo(2002) Ecological land evaluation for nature redevelopment in river area. Landscape Ecology 17: 83-93.
17. New York DEC(1985) Stream Corridor Management. pp. 36-47.
18. Nunnally, N. R. and E. Keller(1979) Use of Fluvial Processes to Minimize Adverse Effects of Stream Channelization. Report to Water Resources Research Institute.
19. Petts, G. E. and C. Amoros(1996) The Fluvial Hydrosystem. London: Chapman and Hall.
20. Statzner, B. and B. Highgler(1986) Stream hydraulics as a major determinant of benthic invertebrate zonation patterns. Freshwater Biology 16: 127-139.
21. Van Dijk, G. M., E. C. L Marteijn, S. W. Leidig(1995) Ecological rehabilitation of the River Rhine plans, progress and perspectives. Regulated Rivers: Research and Management 11: 377-388.
22. Vannote, R. L., G. W. Minshall, K. W. Commins, J. R. Sedell, and C. E. Cushing(1980) The river continuum concept. Canadian Journal of Fish and Aqatic Science 37: 130-137.
23. Wolfert, H. P.(2001) Geomorphological Change and River Rehabilitation Case Studies on Lowland Fluvial Systems in the Netherlands. Wageningen: Altera Green World Research.

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