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Theoretical Consideration of the Plan for Environmental-Friendly Applications of Flood Plain around Dam

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The purpose of this study was attempted to establish concepts of environmental-friendly applications of flood plain and to suggest the application plans.
The results of this study can be summarized as follows;

1. Roles of flood plain as biotop (restoration, preservation, and creation of stream corridor ecosystem) should be considered.
2. Application methods considering environmental and scenic values should be reviewed.
3. Application methods reflecting values as regional ecological resources should be planned.
4. Preservation and application should be considered together, and obtaining a means of living for regional residents and creation of economic profits should be considered together.
5. Land application and approach method by usages (integrated management model) should be applied to utilize and manage flood plain efficiently.
6. Flood plain application programs should be designed reflecting opinions of regional residents.
7. With respect to space planning of flood plain, introduction of facilities focused on ecosystem preservation/ecosystem restoration/experiences/observation/learning/culture/recreation/water purification could be reviewed positively.

Key word : Flood plain, Environmental friendly application, Ecological function

1. Introduction

Flood control policies focused on streams have been regarded as very important throughout the world from the early stage of civilization, and, especially, dam has been closely related to people's life and development as a measures to adjust a natural law related to water artificially[1].

With rapid economic development, large-scale land development including dam construction for expanding social overhead capital(SOC) has been carried out within short period, and consideration for environment has been neglected in actuality.

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In other words, arrangement and preparation of dam and streams have been performed for economic development from the viewpoint of flood control and irrigation and environmental and ecological aspects of streams were not strengthened.

Therefore, the current streams and dams show many problems and have played simple roles such as stream discharge channel, rainwater channel, and water storage together with negative images. Dams and streams do not perform their original roles in actuality.

Especially, flood plain located between normal high water level (NHWA) and flood water level (FWL) is ecotone as a kind of transition zone and is a very important zone ecologically that has both land and stream features. Nevertheless, most flood plain zones around stream and dam have appeared to be bare land and showed

inferior views visually because artificial planting was performed in most artificial channels or turf or surrounding vegetation was removed on account of interruption of flood drainage.

Therefore, application and management of flood plain on the basis of transcendental (traditional) values can cause washed-away status and erosion and flood plain can be degraded as a negative space that cannot perform various ecological functions such as purification of water and obtaining of various living things.

But, today, since 1990's when the Environmentally Sound and Sustainable Development (ESSD) was established to be a new development paradigm as a concretely agreed code, a field of development and construction including dam construction has had more interested in plans for reduction and replacement of bad influences such as damages of natural environment in Korea[1].

And, with respect to dam construction, the field has made efforts for 'environmentally sound and sustainable development' i.e., environmental-friendly dam construction projects instead of projects centered on development and also made efforts to find solutions about regeneration of environmental-friendly space around dam as well as restoration method of natural environment deteriorated by dam construction and development[2].

Meanwhile, restoration of stream corridor space in city and importance of its ecological functions have been regarded as important. Recently, as demand on improvement of the quality of life due to deterioration of urban ecological environment has been strengthened, interests in restoration and regeneration of ecological environment are increased. Especially, foreign natural stream construction methods such as Germany, Swiss, England, and Japan are applied in urban streams that play a great role in the stream corridor environment of urban life. In addition, experimental researches for development of the advanced construction method under the support of the Ministry of Environment have been performed actively[3] .

Considering these current tendencies, with respect to flood plain that have been focused on flood control and flowing function, new approach methods focused on ecological functions should be required considering a kind of ecotone that water areas and land areas are faced.

Especially, though restoration has been carried out in many waterfront areas and riverside highlands due to the movement that urban streams should be rearranged newly into natural streams, there is still no case that considers restoration and environmental ecological application methods of flood plain around dam. Accordingly, this study was attempted to establish concepts of environmental-friendly applications of flood plain and to suggest the application plans.

2. Ecological functions and actual conditions of flood plain

2.1. Notions of flood plain

Flood plain means a site adjacent to streams, lake, bay or sea that experienced flooding in past or are expected to be in flood and generally defined the coast that maintains dry condition in ordinary times.

And, according to environment terms dictionary, flood plain is defined as a level and broad surface of the earth that is formed by sediment of transported earth and sand of streams in the floor of valley.

Especially, the riverside highlands, waterfront, and flood plain have been used together in Korea, but their meaning and features are different strictly speaking.

Floodplain has been used in American streams(Note: floodplain is translated as 'Hongsuteo' in Korea, but it should be translated as 'Beomramwon'). But, American streams have little different in forms and location of levee in Korea. As floodplain include flooding area beyond levee in some cases, its meaning and application should be differentiated from the riverside highlands that defines only flooding area on the inside of levee.

Therefore, flood plain in this project is differentiated from floodplain specifying flooded area by overflow of flood beyond levee and is limited to floodplain in channels. With respect to dam construction, it can be considered as a fixed area located between normal high water level(NHWA) and flood water level(FWL) that is not flooded in ordinary times but is

inundated in flood for fixed period.

2.2 Environmental ecological notions of flood plain

Flood plain is related to flood drainage and protection of levee erosion as well as land utilization and ecosystem preservation, and is regarded as important from the viewpoint of hydraulics and hydrology as well as ecology.

But, as shown in the aforesaid, as a result of river conservancy and dam construction focused on flood countermeasures, flood control, and irrigation, flood plain that is important as a kind of ecotone faced with water areas and land areas together has not been regarded as important and neglected. It is not too much to say that these traditional approaches caused many changes in the stream corridor life.

Like waterfront and riverside highlands, flood plain has 2 places with different features - land areas and water areas or freshwater areas- and gives habitats with complex and various variations to living things.

In addition, new ecological phases can be also formed in flood plain by environmental changes such as appearance of natural marsh like back marsh by flooding for the fixed period.

Therefore, preservation of various living thins in stream corridor requires projects for recovery or restoration of marsh or creation of new stream corridor or marsh that the value has been reduced as well as protection of natural stream corridor. In addition, if development is performed, reasonable environment assessment and mitigation should be essential[4].

Under this viewpoint, if we let flood plain alone or do not consider flood plain in view of management so that it passes through natural succession, withering of plants by submergence and opening can cause flood plain to be bare land and result in deterioration of scenes. In addition, inevitable usage conversion of flood plain such as cultivation of flood plain into farmland gradually can occur.

But, above all, we should recognize flood plain with values and function by periodic flooding as ecotone faced with water areas and land areas.

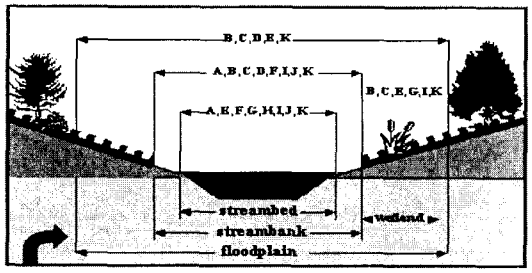

Fig. 1. functional struct of floodplain.
*source: Fedaral Emergency Management Agency

A : stream protection act
B : storm water discharge general permit
C : streamside management zone
D : state floodplain and floodway management act
E : short-term exemption from state's surface water quality standards
F : state natural streambed and land preservation act
G : state land-use license or easement on navigable waters
H : state water use act
I : federal clean water act
J : federal rivers and harbors act
K : other laws that may apply depending upon your location and activity

2.3 Actual condition of flood plain utilization

2.3.1 Case study concerning flood plain

Complex and various groups of plants are formed and many species of animals preying on them exist in a stream corridor[5].

A stream corridor is composed of bar, flood plain, and upland fringe connecting to the surroundings latitudinally. In bar water flows nearly always. Flood plain is submerged only in a flood, so trees grow spontaneously, and damp grounds are formed in several places of flood plain by topographic features. Therefore, various plants inhabit in a stream corridor according to the level of water(changes in submergence frequency and ground water level) and the soil by places. However, flood plain made in a deposit area is plain and wide, so it is used as farm and residential land for man. Specially, in this case, as a stream corridor is narrowed by dike construction for flood control, plants around it are limited within the dike actually[6].

U.S. has made efforts to protect the damp grounds and utilize them effectively by introducing 'No Net Loss of Policy' under the

goal that she would not lose any damp grounds after suffering ecological and socioeconomic losses from the damage to them by unreasonable development. But no single Act exists for protecting the riverside damp grounds. The damp grounds have been protected pursuant to the land use related acts under the Coastal Zone Management Act[7] and by this, flood plain is being controlled also.

The Department of Geology of University of Cambridge described flood plain of forest areas is a key zone for variety and plenty of species concerning flood plain control in a forest area and asserted that people have to protect the resources. In addition, they insisted that it has 1) the natural value, 2) the biological value including plenty of species, and 3) social society and other values of scenic variety and recreation.

Japan has exerted their efforts to restore trees around the stream corridors through shore protection works or erosion control works in a mountain stream or riverside[8], form restorable BIOTOPE in a tideland, swampy place around a village or reservoir, river and dam reservoir and make environmental-friendly woodlands in cities[4].

Recently, as interests in stream corridor restoration have been increased, it ultimately means river restoration covering the bar, flood plain, bank, and surroundings with scenical and ecological continuity in river. This, to begin with, starts from the recognition of factors of interference with natural restoration of naturally or artificially damaged river, which must spoil the structure and function of a river ecosystem[9]. It means that the subject of river restoration is stream corridor including bar, flood plain, bank, and dike, and effort to return the structure and function of the ecosystem in a damaged habitat as near as the original condition is required for this.

On the basis of findings of previous studies, the researcher can recognize that a ultimate purpose of restoration of stream corridor are restoration and recovery of ecological habitat, and interests in stream have been converted into restoration of habitat of living things and water-friendly features. With respect to flood plain around dam, approaches should be planned under this viewpoint.

2.3.2 Similar related cases

(1) Domestic cases

As a movement for preparation of natural stream in Korea, application of flood plains such as waterfront and riverside highlands was attempted to plan in the environmental-friendly viewpoint.

① Hangang River waterfront (upper stream of Gwangnaru)

Cosmos ecological study place was prepared in Hangang River waterfront and flower zone (herbaceous flowers, cosmos garden, seasonal roses garden, and crops zone such as buckwheat and foxtail millet) was prepared in the ecological study place. Various programs such as drawing environmental pictures, writing contest, and taking photos were introduced[10].

② Geumhogang River waterfront

For the waterfront park project to prepare comfortable recreational place for people, ideas were collected publicly and selected.

The city established plans to supply a place for meeting and recreation for people by preparing flower road, flower garden, and grass space in the waterfront.

③ Tancheon waterfront

With waterfront filled with turf and grass, the plan was to supply habitat environment by plating rye, wheat, and buckwheat by season so that winter migrants and butterflies can visit.

④ Nakdonggang River waterfront

For the purpose of the event park project in Nakdonggang River waterfront that passes through Gyeongbuk Andong downtown, standing performance stage, lighting tower, and various convenient facilities were planned. In addition, lighting tower and large public rest-room instead of movable rest-room were constructed and drinking water fountain and formatives suitable for images of park were constructed.

⑤ Taewhagang River waterfront (Ecological Park Preparation Project)

Considering features of Taewhagang River, the purpose is to prepare an environmental-friendly natural ecological park, to supply a comfort recreational place for people, to gain ecological tourist attractions, and ultimately to prepare a recreational place downtown that

everyone can visit pleasantly.

Various facilities including nature study place, streamlets, stepping stones, ecological observation way, bridge of mountain, birds observation deck, Bamboo Park, flower garden, orchestra fountain, and artificial waterfalls were introduced.

⑥ Preparation of Namgang riverside ecological park (proposition)

Basic direction and purpose of preparation of Namgang riverside ecological park are to restore an ecosystem, to maintain healthy ecosystem, to supply nature study places, and to create individual places. For these purposes, major places were divided into vegetation district, observation district, wet vegetation district, management and study district, and parking district in a large way.

As shown in the aforesaid, improvement of environmental functions of stream such as flood plain including waterfront and riverside highlands has been attempted instead of stream arrangement focused on flood control, centered on some local self-governing bodies, in Korea.

But, though approaches related to the improvement of environmental function of streams have concepts of nature-friendly stream preparation, they are far from ultimate concepts of stream restoration that is indented to restore ecological vegetation environment of stream. In this point, the Zoning plan for preparation of ecological park in the riverside of Namgang River is greatly significant.

(2) Foreign countries

① Horton Brook Flood Plain Restoration

DEC work crews removed more than 500 feet of berms or levees, and approximately 1,500 cubic yards of fill from the flood plains and streambanks along Horton Brook.

This will allow flood waters to spread out in the stream' s flood plain, slowing the water down and reducing the force and severity of flooding at the mouth of the river.

② Bolsachica coastal marsh

Along the Pacific coast about 3km from Huntington Beach in the south of Los Angeles in State of California, U.S., Bolsachica marsh called as 'A Textbook of Marsh Ecosystem Restoration' in U.S. is spread. Since a dam was constructed for hunting freshwater duck in 1895, natural marsh began to be damaged on a full scale. Accordingly, restoration plans for this area were carried out since 1973.

Especially, the marsh restoration project supervised EDAW Landscape Company and Cal Poly 606 Studio. As reciprocal demands of preservation and development on the target place were opposed sharply, application and management scenarios and plans made by each party were integrated and a strategic plan was established significantly to abstract optimal application and preservation plans to adjust an interest of various stakeholders relating to the target place. 5 suggested scenarios were as follows.

First, preparation of a regional park including area for preservation of low and swampy place

Second, preservation of low and swampy place as well as development of residential districts in some regions around low and swampy place

Third, preparation of small boat anchorages between residential district and low and swampy place

Fourth, preparation of a large landing place and passage by digging the inside channels so that large boats can run

Fifth, minimization of scale of low and swampy place, and development of the surroundings for various usages such as residential district, boat landing place, and commercial district[11].

③ Francis Creek in Ferndale city and Humboltrns (U.S)

Green belt was formed in flood plain, bypass waterway, and underflow plain plans, transfer of flood-proof structures, and land utilization project.

Basic methods for protection of properties from flood and erosion of bank are not to build permanent structures in the vicinity of bank or flood plain as possible but to utilize it for park, recreation lot, wildlife habitat or shelter, riding bicycle or hiking, and nature study center in ordinary times so that flood water can overflow and bypass in flood. This program gives technical instruction and financial supports to regions that would like to utilize flood plain under this purpose. In addition, for preparation of flood, this program supports flood-proof

countermeasures and recommends that people do not reside in flood plain.

④ Rhein River in Germany

Auen Research Institute under the support of 'World Wildlife Fund(WWF)' of a private environmental institute that played an active part in improving the quality of Rhein River insisted that natural branches and marshes would be formed and vegetation environment should be prepared suitable for aquatic life by destroying the constructed levee and opening an irrigation gate for artificial management of Rhein River. The German government accepted this insistence, and performed the ecosystem restoration project privately and publicly.

In Germany, stream arrangement has been performed by dividing streams into rivers with active water transportation owing to gentle inclination of riverbed such as Rhein River, Moselle River, Elbe River, and Donau River and branches where multipurpose dams are constructed. A new type of stream arrangement construction methods were applied to construction fields of 6 multipurpose dams that had been constructed in Reppe city in states of southern Germany such as Deutsche Alpes area and St. of Bayern. Basic concepts in building a dam in a stream of Reppe city are as follows; First, gaining of low water areas and harmony with natural scenes in stream corridor were regarded as important. Second, sufficient fundamental surveys relating to stream engineering, scenes, and natural ecology were performed in water-front and low waterway in view of preservation. Third, technological responses to preservation and restoration of natural space were suggested.

⑤ Floodplain management plans(NSW)

Floodplain management plans are being developed by the Department of Land and Water Conservation in conjunction with local communities for many floodplain areas, especially in areas of intensive agriculture and development. The main aim of these plans is to assess the impact of existing and proposed structural works on the floodplain and develop management options. Floodplain plans also have a conservation aim, attempting to balance the natural state of the floodplain and the function it performs with development.

⑥ Gachgawa dam

It is located in Nakata Prefecture of Japan, and plays a role of flood control and generation of electricity partially. Mountain streams, turf space, shelter, and walkway were prepared in dam surroundings i.e., a kind of flood plain. Beautiful surrounding scenes have attracted people for appreciation and tourists also visit it owing to surrounding hot springs.

As shown in the aforesaid, reasonable plans have been attempted variously for suitable utilization, preservation, and management of stream corridor space including flood plain in foreign countries.

Especially, consideration of a natural ecosystem is strengthened such as natural restoration of riverbed in stream corridor spaces including flood plain.

3. A plan for environmental-friendly application of flood plain

River environment is an integration of stream and the surroundings - commonly called as both natural and artificial environment composed of the volume of water, water quality and river space. Before 1990s, river had been controlled mainly focused on the irrigation and flood control function, recently, however, it has been controlled centered on its environmental functions such as water-friendliness, a habitat of animals and plants, scenic function etc., as interests in environment have been increased.

Flood plain has been controlled focused on drainage capacities including irrigation and flood control in the same way as general river environment. However, for example, the Ministry

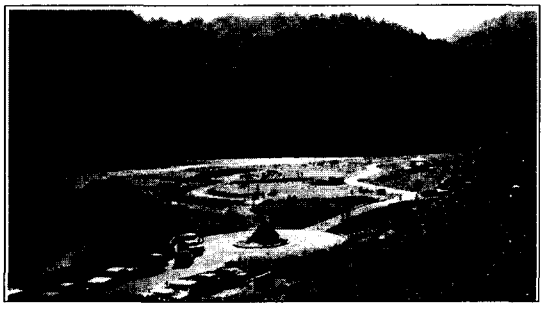

Fig. 2. Application of Flood plain in gachgawa dam.

of Construction & Transportation laid down a guide for expanding space of stream channels and preserving a bar, riverside, flood plain and damp ground of natural river as near as the original condition to help flood drainage and retention and secure ecological space in promoting the natural-friendly river arrangement project, recently.

That is, in the past flood plain had been developed and controlled mainly in the stability aspect such as flood drainage and control, while today the ecological approaches concerning ecological stability are being applied to it.

Though the different functions and importance of flood plain from existing ones are being highlighted like this, the conceptual and theoretical approaches to environmental-friendly application plans on flood plain are insufficient in Korea.

The current river environment considered, it is desirable that flood plain sites around a dam shall be selected in the environmental-friendly aspect.

However, in flood plain to appear by dam construction a damp ground may exist already, or a natural damp ground appears after a flood as it is not flooded with water always but temporarily in a flood due to increase in the water level as mentioned above. Also, as a zone requiring partial restoration in the ecological aspect may appear, such points shall be fully examined before establishment of an application and control plan for flood plain <See Table 1>.

Lots of dams have been built in home and overseas, and apart from the merits and demerits of dam construction<See Fig. 3>, nowadays many efforts are being made for environmental-friendly dam construction.

Considering the negative effects by dam construction such as reduction in the variety of species, deterioration in the water quality, submergence of natural resources, damage to the residents, it is thought that one of plans to minimize such bad effects and maximize environmentally positive functions is environmental-friendly application of flood plain.

Specially, contrary to U.S. or Europe building a dam in the river where fixed amount of water continuously flows throughout the year, in case of Korea, flood plain of relatively wide area appears unavoidably due to difference in the water level in the flood season and the dry season.

Owing to the difference, flood plain has different environmental conditions by zones, so it is being used diversely as natural river, farm land or commercial site. Therefore, the zone of flood plain shall be utilized effectively with decrease in the flood damage by maintaining flood drainage capacities in the river space and finding a flood plain application plan suitable for the surrounding conditions and the need for land use simultaneously.

However, although it is a well-known fact that, first of all, the ecological function of flood plain shall be considered in the application plan, a sense of relative deprivation of the residents and negative public opinion caused by dam construction shall be examined additionally.

Therefore, in consideration of the special conditions by dam construction, reasonable application plans capable of contributing to activation of the surrounding economy as well as the ecological functions in utilization of dam

Table 1. Provision personality model of preservation, restoration, creation to flood plain

classification	character of site	evaluation of preservation value
Reference Site	least disturbed habitats	preservation
Impaired Site	extremely impaired habitats	creation
Reversible Habitat Alterations	most alterable habitats	restoration

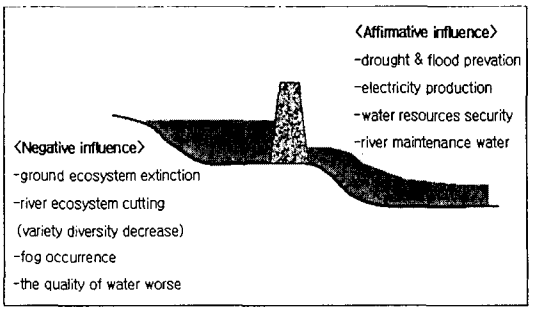

Fig. 3. Influence and improvement plan to environmental in dam construction[12].

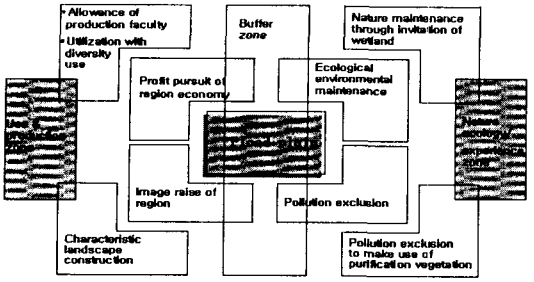

Fig. 4. Example of application concept in floodplain.

flood plain shall be examined, and further an actual beneficial plan to the residents shall be prepared.

Ultimately, the concept of environmental-friendly flood plain the researcher is to emphasize is for restoration and recreation of a river ecosystem, including resident-friendly one considering the ecological aspect.

4. Conclusion and Suggestion

Many dams have been being constructed and has been constructed throughout the world. Dam construction functions positively and negatively and it is different to evaluate environmental profits and losses of the dam construction easily.

Negative influences caused by dam include changes in ecosystem, submerged beautiful scenes, and psychology of direct and indirect damage of regional residents.

As a countermeasure to minimize these negative effects and to increase environmental positive functions caused by dam construction, environmental-friendly application methods of flood plain should be reviewed positively.

Flood plain is ecotone faced with land areas and water areas and is regarded as important ecologically. And we should consider it as today approach methods on flood plain are focused on effects of restoration and creation from the viewpoint of environmental ecology instead of irrigation and flood control plan traditionally.

Currently, though conversion of direction for functions and applications of flood plain has been considered, basic concepts and theoretical frame are not still established on application plans in the environmental-friendly aspects of flood plain in Korea.

Accordingly, many-sided tries are carried out to break from stream arrangement focused on flood control and to improve environmental functions of streams in Korea. But, those plans are far from ultimate concept of stream restoration to restore the ecologically vegetative environment of streams or are focused on programs, so that reasonable application methods are not prepared suitably to meet with features and function of flood plain.

Especially, flood plain is located between normal high water level(NHWA) and flood water level(FWL) that is not flooded always but is inundated with water temporarily. Therefore, this point should be reflected in planning applications of flood plain.

Of course, intervention cannot be required for natural succession through naturalization itself from the viewpoint of environmental ecology, but it can cause artificial land utilization such as cultivation of flood plain into farmland and these points should be reviewed.

In conclusion, environmental-friendly application plans of flood plain should be focused on environmental ecological aspects of flood plain and considered scenic ecological aspects and regional residents in the integrated views.

Therefore, environmental-friendly application plans of flood plain can be suggested to find plans for reasonable utilization and preservation of flood plain as follows.

First, roles of flood plain as biotope (restoration, preservation, and creation of stream corridor ecosystem) should be considered.

Second, flood plain can play a role of water impact part or a kind of ecotone and is expected to reduce ecological threats and ecological diversity.

Third, application methods considering environmental and scenic values should be reviewed.

Fourth, application methods reflecting values as regional ecological resources should be planned.

Fifth, preservation and application should be considered together, and obtaining a means of living for regional residents and creation of economic profits should be considered together.

Sixth, land application and approach method by usages (integrated management model) should be applied to utilize and manage flood plain efficiently.

Seventh, flood plain application programs should be designed reflecting opinions of regional residents.

Eighth, an opportunity factor affecting positive images in dam construction should be reflected.

Ninth, with respect to space planning of flood plain, introduction of facilities focused on ecosystem preservation/ecosystem restoration/experiences/observation/learning/culture/recreation/water purification could be reviewed positively.

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