

ORIGINAL ARTICLE

The Tidal Flat Environments and Experiential Learning Program of Southwest Coast, Korea

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ABSTRACT

Ecosystems of the southwestern tidal flats in Korean peninsula have been seriously injured by human activities. The results are mainly due to the lack of public recognition and education on tidal flats. In particular, thoughtless visitors in tidal flats are giving rise up damages because of non-systematic experience programs to tidal flat ecosystems. Therefore, experience programs friendly to natural tidal flats are necessary as a plan to reserve tidal flats and to enhance the effects of environment education on the flats. Experience learning programs on tidal flats can divide into direct experience, indirect experience and local society works. Direct experience work must undergo tidal flats directly and consider on forming the flats with natural refinement functions. Indirect experience includes deeper knowledge on role, circumstance and ecosystems of the flats on the bases of direct experience on the flats. In addition, local society learning must have the feeling and understanding on socio-cultural characteristics of local society itself through above two works. Experience activity would be a kind of injuring one to tidal flats. However, appropriately planned experience and education works on tidal flats could be sustainable development to attract desirable human activity on coastal ecosystems.

Key words : tidal flats, experiential learning program, environmental education, direct experience, indirect experience, learning communities, sustainable development

1. INTRODUCTION

Tidal flats are coastal flatten areas which are submerged in high tide and exposed in low tide, as intertidal zones by repetitive sea level changes due to tides (Robert & Julia, 1987; Klein, 1977; Oh et al., 2013). In addition, the flats are the ecotones between land and marine ecosystems and possess important functions of buffers connecting and relieving direct conflicts be-

tween above two ecosystems, with a kind of control (Hong et al., 2010; Youn et al., 2011). In tidal flats, sedimentary environments and bottom ecosystems changes rapidly, interrelated with environmental factors as rainfalls, winds, typhoons, tides, wave etc. However, a number of organisms flourish and their diversity and bio-productivity are very high in the flats (Korea Ocean Research and Development Institute, 2001; 2002; Park & Lee, 2004).

Received 18 November, 2015; Revised 15 December, 2015; Accepted 18 December, 2015

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Tidal flats are very important for marine products, contamination relief, environmental preservation, disaster prevention and values for experience learning. The flats possess functions with high biomass as an ecotone, refinement to contamination, relief to natural disaster likely to typhoon or flood, increase of fishery people incomes through nourishing shellfishes or seaweeds etc. Together with those functions, tidal flats supply comfortable places to humans as beautiful landscapes and joyful experience works, then, effectiveness of the flats are enhancing (Park & Lee, 2004; Gwak et al., 2008).

Korean tidal flat ranks a flat among worldwide famous five ones (Koh, 2001). However, 1980's, thoughtless developments including establishments of factories and houses have added to the flats. Then, residences in tidal flats have been destroyed and contaminated. Their habitat areas have been profoundly dangerous ones with respect to human influences.

Korean tidal flats have 2,393km² in area, then, the flats are assigned to 2.4% of the peninsula in area. Of the flats, western ones charge 83%, 1,980 km, of tidal flat area of the peninsula, and southern margin areas occupy rest ones. Jeonnam occupies 1,036 km, 40% of Korean tidal flat area (Jeollanamdo Province, 2010; 2011). These areas are mainly concentrated into Shin-an, Muan and Yeongkwang guns (636 km²).

This study is focused to develop tidal flat experience learning programs as educational applications with diversity and health of the flats, targeting Shin-an area. Through the programs, this study suggests environmental recognition and educational application friendly to nature for tidal flats.

II. AREAL OUTLINE

Important wet areas nominated by World Wide Fund for nature (WWF) and Asian Wetlands Bureau (AWB), famous worldwide organizations are 21 sites in Korea. Among them, tidal flats, coastal wetlands are 13 sites. Those flats are interesting ones, internationally, over 11 sites of them have possibility which could be nomi-

nated as protected wetlands by Ramsar Convention (Ministry of Oceans and Fisheries, 2015). In past, while the wetlands were negligible, government, scientists and several organizations exert in their efforts to nominate the flats to national parks or preservation areas recently. In particular, tidal flats have been located to the center of important environment education by private organizations, then, those concerns rapidly have increased from 'International Year of the Ocean (1998)' (UNESCO, 1998).

In Jeonnam Province, Suncheon Bay and Boseong-Beolgyo tidal flat in year of 2006, Muan tidal flat in year of 2008 and Jeungdo tidal flat in year of 2011 were nominated, respectively, as Ramsar protected areas (Table 1).

III. METHOD

1. Survey of tidal flats

This study aims to natural environments of geomorphology, geology and landscape in tidal flats, Shin-an gun. The study carried out through literature researches, surveys to study area and experimental analyses in laboratory. Preliminary investigations for the study was composed of basic understandings to study tidal flats, outlines of geomorphology and regional geology, referring to topographical map of 1:25,000 in scale. In the study, field works include surveys of the tidal flats, geomorphology and surrounding geology in tidal flat area and on ship

2. Assessment of naturality

Assessment of naturality on tidal flats used assessment indicators in PSR (Pressure-State-Response). PSR assessment model uses in the analysis of data transformed as pressure, state and response indicators from socio-economical data (Organization for Economic Co-operation and Development, 1993). OECD postulated constant data and chosen 'PSR assessment model'. The PSR assessment model indicates loaded influence to environments as the waste of contaminated ma-

Table 1. Representatives of Ramsar wetland areas in Jeonnam Province

Designation	Area(km ²)	Characteristics	Ramsar registration
Muan tidal flats	42.0	rich in biodiversity rich in geologically preservable value	2008
Suncheon tidal flats	28.0	rich in geologically preservable value hooded crane habitat	2006
Boseong-Beolgyo tidal flats	10.3	spontaneously superior variety of marine resources	2006
Jeungdo tidal flats	31.3	excellent landscapes and ecosystems UNESCO biosphere reserve designation	2011

terials and the exhaust of resources. Assessment frames comprise pressure-indicators influenced by interrelation between nature and humans, state-natural state based in local characteristics, representing environmental state and their changes, response- indicating restoration and preservation in accordance with problems as plans to state.

In this study, state assessment, natural state based in local characteristics is applied to the naturalness assessment of tidal flats only. The 'state assessment' was adopted quantitative method of Likert scale.

3. Development of experience program in tidal flat

Preparation of experience program in tidal flat comprises two kinds of meanings in education and service aspects. In the program, it is very important that a systematic plan for the program can lead to attract newly recognized concept and changes of attitude on tidal flat. The program must to do roles of service to visitors, together with above conceptual and attitudinal changes. In addition, all visitors must be joyful through the program, based on healthy. Therefore, the experience program friendly to nature was developed, with the least negative influences to natural environment and local cultures. This experience program on tidal flat considered following aspects; First, contribution to the preservation of ecological resources and their sustainable uses, Second, socio-economical benefits for local dwellers, Third, enhancement of environmental con-

cepts on natural and cultural resources.

IV. RESULTS

1. Natural Environments

1) Bigeum tidal flat

Geology around Bigeumdo is mainly composed of rhyolites and rhyolitic tuffs. And, southwestern and central parts of Dochoemyeon are narrowly occupied by sedimentary rocks. Tidal flats develop average 1.5km width along coastal lines in the southwestern part of Bigeumdo. In Docho, the flats develop 2.3km width along northeastern coast and 1.2km width along southwestern coast. In particular, tidal flat between Suchido and Hasuchido connect these two islands in low tide. Wholly, tidal flats of this area are preserved well except the cases of farming, exhausted fishing tools, life wastes etc.

2) Haeui tidal flat

Geology around Haeuido is mainly composed of rhyolites and rhyolitic tuffs, together with sedimentary rocks exposed narrowly in some regions. Tidal flat around the island includes Okdo located in central part of the flat. Okdo is radiately connected to Haeui, Jansan, Anzwa, Docho and Bigeum myeons by broad tidal flat. Between Okdo and Gido, tidal flat with 4km width in north-south direction and 2.5km east-west direction is well developed. In the area, Jangbyeongdo,

northeastern part of Sineuido, western part of Jansando, southern part of Anzwado, southwestern part of Dochodo and Suchido tidal flats are distributed. Accordingly, this area can be called as the central part of Shin-an tidal flats. Surrounding area of the flat has many laver farms along low tide lines, and is occupied a number of migratory birds. The flats represent healthy state in environmental aspect.

3) Aphae tidal flat

In area around Aphaedo, Jurassic granites are widely exposed, and rhyolites and rhyolitic tuffs are observed in Maehwado and Goido areas. Sedimentary rocks are narrowly encountered in the area. Tidal flats in the area are distributed in northern Aphae of 1km width, 1km width between Maehwado and Masando, about 900m width in northern part of Masando and 1.3 km width of Masando and Maehwado line etc. In the areas, many laver farms are located, and marine ecosystems are disconnected by link road among Masando-Hwangmado- Maehwado. The areas are highly injured in tidal flat naturalness because of burial and land reclamation. As a whole, tidal flats in the areas are highly injured. Accordingly, it is necessary to restore ecological disconnection.

4) Jeungdo tidal flat

Jeungdo area is mainly composed of Cretaceous sedimentary rocks and has fossil localities and diverse sedimentary structures. Tidal flats in the area develop 2km width in north-south direction along lines of Byeongpungdo, Daegijeomdo, Sogijeomdo and Soakdo islands. In the area, many laver farms are located, and tide embankments and roads cut off tidal flats in east-west direction. The tidal flats are considerably injured. So, restoration plan on the flats is urgently requested.

2. Assessment to healthy

Tidal flat is an exceedingly gentle coastal area with periodical repetitions of submergence and expose. The flats well develop in high tide interval area with ac-

tivated sediment supplies and show diverse forms in accordance with tide interval, wave, quantity and type of sediment supply. To assess and to choose excellent tidal flats with preservation value among exceedingly diverse types of tidal flats, objective and valid standards are acutely needed. In addition, it is necessary that can easily quantify the standards.

In foreign countries, Rattcliff(1977) model is frequently used as an assessment model on environmental preservation. He suggested several assessment items as scale, diversity, naturalness, scarcity, uniqueness, scientific value, cultural and historical value. After him, many researchers added his items to some ones which can show characteristics of proposed area (Eagles, 1984; English Nature, 1997; Kelleher, 1999; Klijin, 1994; London Ecology Unit, 1994; Millard, 1993; Sutherland & Hill, 1995; Usher, 1980)

Naturalness assessment on Shin-an tidal flats used 'state' assessment of PSR indicators on the basis of preservation value assessments in our and foreign countries. In the study, items of ecosystem state, function and environment of tidal flat and life qualities of local dwellers were picked up. The results are <Table 2>. Tidal flat around Bigeumdo sustains highly preservable ecosystems as biological preservation area in spite of its small scale. In addition, the flat possesses preservable items of landscape, sediments, seawater quality, geomorphology and geology. Tidal flat around Haeuido widely develops along lines connected Okdo to Gido, and Okdo is located at point usable as sea transportation center of Palgupo area. Together with this benefit, the island has highly preservable ecosystems and represents highly preferable landscapes, seawater quality, sediments, geomorphology and geology. Then, the island shows considerable fishery products and incomes of dwellers. Contrary to above states, Aphae tidal flat is considerably injured by burial and land reclamation in spite of larger scale distribution. Its naturalness is lower in level because of suspensions, exhausted fishery tools and life wastes. In Jeungdo, tidal flat is also lower in naturalness assessment because of ecosystem disconnection relating with land reclamation and burial.

Table 2. PSR indicators of tidal flats 'state' assessment

Category		Evaluation items	Bigeum	Haeui	Aphae	Jeungdo
State	Ecosystems and tidal flats	- size of the tidal flats	2.7	3.3	3.7	3.0
		- rare plants and animals, valuable ecosystems	4.3	5.0	3.3	3.0
		- marine biota (species, populations, etc.)	3.0	4.0	3.0	3.0
		- existence of coastal vegetation	3.0	3.7	3.0	3.0
		- natural landscape	3.7	4.3	2.7	2.7
		- comprehensive assessment of the tidal flats	3.0	4.7	3.7	3.0
	Tidal flat environment	- sediment and water environment status	3.7	4.0	3.0	3.0
		- states of the natural environment of the coast near the mainland	3.3	4.7	2.7	2.3
		- conservation of geomorphological and geological value	3.7	4.3	3.0	3.7
	Local residential quality of life	- fishery product - local fishery income	3.3	4.0	3.3	3.0
Sum			30.4	38.0	28.1	26.7

Table 3. Tidal flats experiential learning program example

Class	Contents	Facilities
direct experience	tidal flat experience, watching high and low tides, bird watching including migratory birds and formatting, observation of ecosystem	observatory
indirect experience	role of tidal flat, importance, geomorphological characteristics of the local history	visitor center
learning communities	back view village, talk to the villagers, listening to local legends, local food experience, tour around the historic sites and museums	exhibition hall, museum

3. Development of program

Development of experience learning program of tidal flat is largely divided into three parts of direct experience, indirect experience and local societal works.

<Table 3> is the suggestion in accordance with each experience type considering environmental and eco-

nomical aspects of tidal flats.

1) Direct experience program

Direct experience program is to undergo directly the natural state of the tidal flats. The program is unambiguously distinguished in experience on surround-

ing environments including the flats. However, minor mistakes in the program can bring about negative effects in ecologically sensitive area. Therefore, carefulness and preliminary education in the program are needed. Programs related to it are as follows; field survey of tidal flat, observation of high and low tide times, bird watching (including migratory birds), survey of bottom ecosystems in tidal flats.

The experience program must be planned that participants feel tidal flats themselves. Together with the experience, the participants would recognize economical benefits including fishery resources from tidal flats. They will observe marvelous natural phenomena and wonders of periodical tides, phase changes of moon etc, then, they would have mystical feelings on the nature. In addition, the participants would experience the importance of tidal flats enough through migratory birds, tidal ecosystems and fishery resources.

2) Indirect experience program

Indirect experience program, a kind of lecture type learning, would make the participants to deepen knowledge on role, environment and ecology of tidal flats. Lecture typed program can display stronger effects for environmental sensitivity and knowledge on the flats. Then, the program enhances participants' understandings on tidal flat areas involving local historical and topographical characteristics. The lecture program can be processed through lecture of the expert, guidance of local dweller, installation of explanation plate and preparation of guidebook. Direct and indirect experience programs are mutually dependant. For example, preliminary indirect experience can lead better results for direct one on tidal flats.

3) Local societal works

Local societal works is to understand and to experience historical and social characteristics of regional community. It is important that, related with tidal flat area, the program must be directed toward the understandings on regional community with aspects of social development and regional circumstance. Through local societal works, visitors in the tidal flats would natu-

rally harmonize the area. Those examples might be our country with three faced marines, thanks for fishery men etc. In addition, the works could include programs as fishery village tour, myths and folk songs related with seas, foods of fishery village and tour of historical sites or museums.

V. DISCUSSION

Whole activities by humans are important factors that injured tidal flats and their ecosystems. Controversies to value and role of tidal flats have given rise up interests on them, then, visitors on the flats are increasing annually. In spite of positive effects on the flats, excessive interests on tidal flats glorified as tidal flat inquiry, natural survey and experience program bring to that the flats are injured, and, next, all of the flats' functions and roles are exhausted.

Similar to above results, Shin-an tidal flats in southwestern coasts of Korea are environmentally injured by thoughtless human activities, yet the flats sustain healthy state. These results are due the lack of education and consideration on tidal flats. Recently, touring development in large scale to the flats accelerates contamination and damage leading the decreases of self-refining and acceptance for the flats. Damages by visitors in tidal flats are serious because of lack of education on the flats. From above situations, experience programs friendly to the nature are urgently necessary on purposes of the better preservation of coastal ecosystem and desirable ecology education. Then, to accomplish above purposes can request following suggestions.

Firstly, integrated system to publicize and to educate the importance of marine ecosystem must be constructed. For the construction of the integrated system and periodical education, linkages among organizations, schools and civil environment groups are necessary. Secondly, basic facilities for landscape, ecosystem and eco-tourist are needed. Those facilities must be receptive in ecologically acceptable limits and chosen in the consideration of using ages and seasonal

conditions. And the facility construction must be decided on bases of data as civil-social resources of surrounding area, relation to tourist attraction, local economic benefits etc. Thirdly, administrative and monitoring plans considering regional characteristics are necessary. To preserve coastal wetlands and to induce experience program to the wetlands, concrete administration, in the beginning, plans must be existed with obvious roles to an administrative player. In addition, constant assessment and monitoring to the results of established administration on the flats can lead to change and to supplement administration model as a whole. Through above procedures, effective eco-tourism can take root.

To attract experience program itself in tidal flats would be to destroy marine ecosystems. Meanwhile, suitable experience program that carry out environment education and establish valid facility on tidal flats can be better effective plan for leading constant development of coastal ecosystems.

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