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Environmental Specimen Bank and Ecosystem Assessment

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Abstract

Environmental specimen bank (ESB) is a new tool to assess ecosystem in environmental impact assessment (EIA). ESB looks at changes in the concentration of pollutants in human and environmental specimens over long periods of time through retrospective analysis of archived samples. Korea started to design its National Environmental Specimen Bank (NESB) in 2007 and planned to launch an operational pilot project by 2010. NESB prepares five Standard Operating Procedures (SOPs) of shoots of Red and Korean pine, leaves of Mongolian oak, Pigeon's egg, and Common carp's muscle out of 14 planned specimens in 2009.

ESB contributes to monitoring the effectiveness of EIA projects and policies by providing a time capsule through ecosystem assessment of representative species. This study reviews ecosystem assessment in EIA and the ESB establishment in Korea and probes NESB applications in ecosystem assessment.

Keywords : Environmental Impact Assessment, Environmental Specimen Bank, Ecosystem Assessment

I. Introduction

Environmental specimen bank (ESB) is a new tool to monitor ecosystem retrospectively through a long-term storage of environmental specimens. It is defined as a repository of representative environmental specimens, an institution with supporting facilities through retrospective study of banked samples, and an environmental specimen time capsule to preserve the evidence of changes in specimens (Schwuger, 1992 and Kim, 2007). Also, ESB can contribute to checking the environmental status and monitoring the effectiveness of environmental impact assessment (EIA) projects and plans through assessment of exposed ecosystem. Assessment methods using ESB need to develop in EIA. National Environmental Specimen Bank (NESB) at National Institue of Environmental Research will become an important institution on Korean ecosystem assessment.

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II. Research Framework

This paper analyzes the studies related to ESB and existing research results. Some suggestions were obtained from US, Japanese, and German ESB visits from 2006 to 2009. Experince in international ESB design and construction reflected on NESB plan and management. Korean EIA system and methods were analyzed to show current ecosystem assessment. Research framework is as follows (Figure 1).

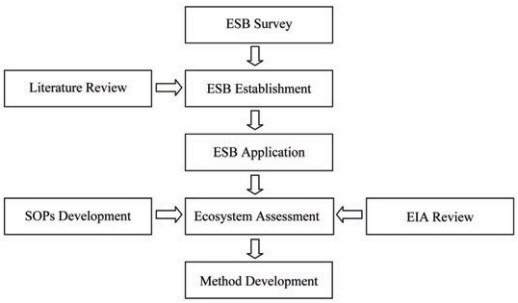

Figure 1. Research Framework

III. Ecosystem Assessment in Environmental Impact Assessment

EIA is a continuously evolving system. EIA in Korea improved markedly over the past three decades by enlarging EIA projects, instituting public participation and environmental monitoring, developing methodologies, and introducing strategic environmental assessment (SEA) (Kim and Yoo, 2007). The Prime Minister Decree on environmental review of administrative plan and project like SEA enacted in 1993. It covered environmentally sensitive projects which were not included in EIA project and administrative plans. This Decree covered only governmental projects; hence, the Prior Environmental Review System based on Environmental Policy Act replaced the Decree in 2000. This system covers governmental and private project (Han and Kim, 2001).

The Korea EIA system has two pillars: the prior environmental review system (PERS) in plan and program and the environmental impact assessment in project (See Figure 2) (Kim, 2002). These two systems will be integrated into EIA Act by the end of 2009. Environmental impact statement (EIS) from 1981 to 2007 has been prepared for about 3,500 cases (Ministry of Environment, 2008b).

Most EIA projects assess impacts on environmental criteria for predicted pollutant concentrations of air and water. EIA focuses on environmental pollutants prediction, constructing mitigation measures, and monitoring processes. Ecosystem assessment helps identify and avoid biodiversity 'show stopper' (Athanas, 2005). It is important to recognize the biological-ecological environment as a dynamic system (Canter, 1996).

Korean ecosystem has about 100,000 species and 29,916 of them have been identified through surveys including 18,117 species of fauna, 8,721 species of flora, and 3,528 species of fungus and protista. Korea has 76 natural parks of 7,809 km^2, covering 7.8% of the total territory and these parks comprise of 20 national parks, 23 provincial parks, and 33 county parks (Ministry of Environment, 2008a). In addition, the government has designated 221 endangered animal and plant species for protection in 2005.

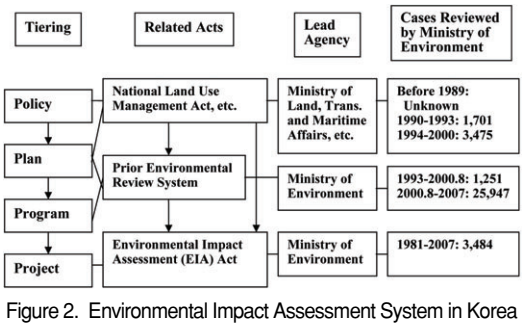

Figure 2. Environmental Impact Assessment System in Korea

The development pressure may have negative influnces on Korean ecosystems; thus, EIA discusses mitigation measure and replacement habitat to minimize such impacts.

Ministry of Environment conducted the first 'National Ecosystem Survey' from 1986 to 1990. Based on the survey, the Degree of Green Naturality Map was produced to evaluate plant species and vegetation. The second survey from 1997 to 2005 produced the Ecosystem and Nature Map including flora, fauna, and natural features (Kim *et al*., 2009). These two maps are used for ecosystem impact assessment of development projects and for planning in the screening and scoping stage of PERS and EIA. Most of impact assessment on ecosystem does not assess the pollutants of exposed species of the ecosystem.

IV. Environmental Specimen Bank Establishment

Rachel Carson's widely read book, *Silent Spring*, refers to a hypothetical future springtime in which birds and other animals are silenced by exposure to synthetic chemicals such as dichlorodiphenyltrichloroethane (DDT). *Silent Spring* is one of many books written after World War II to alert public to seriousness of ecosystem disruption (Ortolano, 1997). If we can preserve environmental specimens intactly, we have a better possibility of identifying pollutants in the future. Thus, ESB will become a safe long-term repository for representative environmental specimens collected over decades to preserve constituent properties. It provides a capability of hindcasting; future investigators will be able to extend their research through retrospective study of banked samples with quality assurance of analytical results (Kim, 2007).

Environmental specimens in ESB contain a scientific history of environmental pollution impacts which can be reinterpreted for pollutants in the future (Kim, 2007). ESB shows an important role in preserving the historical record of flora and fauna impacted by environmental pollutants.

NESB 2007-2010 budget is approximately 8 billion won (6 US million) with ESB building construction, storage facilities including cryogenic freezers and electric freezers, vibrating cryomill, vertical liquid nitrogen storage tank, experimental equipment, and standard operating procedures (SOPs) preparation. Korea started to design NESB in 2007 and NESB is envisioned as a two-story building with the basement occupying 2,340 m^2 in 2009 (Kim and Yoo, 2007).

V. Ecosystem Assessment Through Environmental Specimen Bank

The NESB acts as a 'time capsule' to create a long-term basis of EIA projects and policies on ecosystem. The types of banked specimens should detect the input of substances to the ecosphere or the human organism. The priority of environmental specimens is to select typical representatives from every food chain level of ecosystem. For instance, primary producers such as pine trees, consumers such as birds, and decomposers such as earthworms will be chosen.

The specimens for the National Environmental Specimen Bank will be taken from specific geographic areas representing the main types of ecosystems found in Korea: rivers, agricultural land, managed forests, urban areas, natural woodland and marine habitats. The specimen collection locations demonstrate varying degrees

of influences caused by human activities to give an accurate overall picture of the state of the environment (Kim and Yoo, 2007).

Sampling is necessary to integrate into quality assurance systems for environmental analysis and make sure of getting the information and accuracy required with appropriate effort (Wagner, 1995). The selection of the sampling procedure has a decisive effect on the quality and quantity of the sample material (Ruedel, et.al, 2009).

The SOPs ensure continuity in the identity of materials and origin of the specimen (Rossbach and Jayasekera, 1996). NESB prepares the SOPs of shoots of Red and Korean pine, leaves of Mongolian oak, Pigeon's egg, and Common carp's muscle in terrestrial, riverine and marine environment in 2009. For example, pine has been used as a sensitive effect indicator and an accumulation indicator. Earthworm establishes a close relationship between the mostly organic soil cover and the soil horizons below. Consequently, it exhibits the pollution state and status of the medium soil as a whole. Freshwater mussel is used as an organism for environmental monitoring (UBA, 2003). Proposed NESB Specimen List by Ecosystem is shown in Table 1.

Ecological and human exposure assessment in EIA project areas enables researchers or decision-makers to check impacts of all activities over a

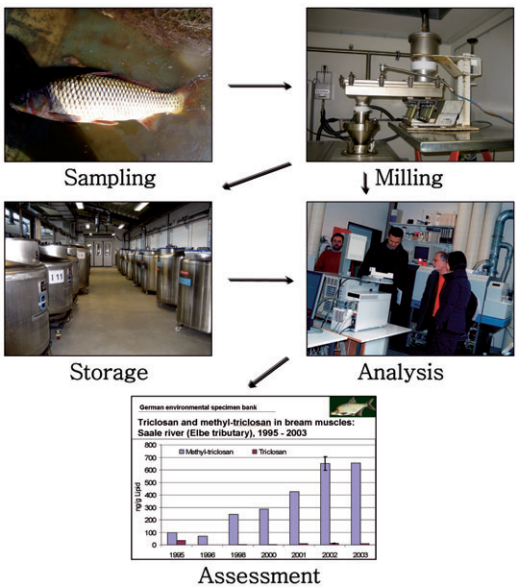

Figure 3. General Process of Environmental Specimen Bank

Source: Kim, 2007

Table 1. Proposed NESB Specimen List by Ecosystem

Ecosystems	Type of Specimen	Scientific Name	Common Name	Food Chain	Target Organ
Terrestrial	Pine	*Pinus densiflora*	Red pine	Producer	First-year shoots
	Pine	*Pinus koraiensis*	Korean pine	Producer	First-year shoots
	Oak	*Quercus Mongolia*	Mongolian oak	Producer	Leaves
	Zelkova	*Zelkova serrata*	Zelkova	Producer	Leaves
	Soil			Medium	
	Earthworm	*Lumbricus terrestris*	Night crawler	Decomposer	Body
	Bird	*Columba livia*	Domestic pigeon	Consumer	Content of egg
Riverine	Sediment			Medium	
	Freshwater fish	*Cyprinus carpio*	Common carp	Consumer	Musculature, Liver
	Mussel	*Unio (Nodularia) douglasiae*	Freshwater mussel	Consumer	Soft tissue
Marine	Mussel	*Mytilus edulis or (M. galloprovincialis)*	Blue or Mediterranean mussel	Consumer	Soft tissue
	Fish	*Mugil cephalus*	Mullet	Consumer	Musculature, Liver
	Bird	*Larus crassirostris*	Black-tailed gull	Consumer	Content of egg
	Algae	*Ulva pertusa*	Sea lattuce	Producer	Plant boday

Source: Kim, M. *et al.*, 2008

long time. Figure 3 shows the five typical stages of ESB operations.

VI. Conclusions

NESB will lead to a better understanding of the effectiveness of EIA projects and policies on ecosystem. It preserves a variety of environmental specimens from ecosystem to observe and analyze changes of pollutants. Also, the development of NESB will improve the reliability of environmental monitoring and ecological risk assessment on ecosystem of the EIA process. NESB application methodologies continue to develop in order to implement retrospective analysis and environmental assessment.

* This is the revision of the paper from Vietnamese and Korean Experiences in Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) which was published in the Vietnam-Korea Workshop on August 21, 2009.

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