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A study on Revision of Water Environment Conservation Act. for Freshwater Sediment Management

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Abstract

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With the beginning of the Four Major Rivers Project, interest in the contamination status of freshwater sediments in Korea has increased. In Korea, because there is no system such as laws and regulations related to the management of freshwater sediments, the periodic and stable management of sediments is insufficient. Moreover, the lack of institutional basis is a major factor that cannot support the input of the national budget in the domestic

administrative circumstances. Due to this limitation, there are cases in which freshwater contaminated sediment remains not properly treated despite the severe level of contamination. So, it can be said that the preparation of institutional basis for the treatment and stable management of contaminated sediment is a prerequisite. Therefore, this study intends to propose a new provision for sediment pollution through the revision of the “Water Environment Conservation Act.” which is most relevant to the management of freshwater sediment among domestic related laws. In order to derive improvements, the “Soil Environment Conservation Act.” and “Marine Waste and Marine Contaminant Sediment Management Act.”, which are the most relevant among domestic legal systems, were mainly analyzed. The American institutions “Clean Water Act.” and “Comprehensive Environmental Response, Compensation and Liability Act.”(as known as Superfund) were also analyzed because they are most advanced system in the field of freshwater sediment management policy. Based on those, factors that need to be enacted and amended in the “Water Environment Conservation Act.” were reviewed. Since the purification of contaminated sediment takes a lot of time and cost, this study proposed the necessary institutional devices in relation to the elements that require prior regulation of sediment contamination and the institutional elements for the post-polluted sediment treatment process. In addition, it was proposed to form a decision-making system that can provide a basis for judgment in determining whether to proceed the treatment of contaminated sediment, to determine the treatment method, and to support by national budget. Also, for preventing long-term neglect of contaminated sediment, measures were reviewed to prepare a separate budget so that the government could preemptively promote

sediment purification.

keywords : Sediment Management, Freshwater Sediment, Contaminated Sediment, Revision of the Water Environment Conservation Act., Institutional Improvement

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Chapter 1. Introduction

1.1 Background of Research

The bottom sediments of rivers and lakes are rock-derived substances separated by weathering and erosion of rocks, substances derived from biological activities, or chemically formed solid substances, or it refers to insoluble substances that have been formed or accumulated in the basin area through various routes such as erosion and sedimentation of the waterside soil and sedimentation of substances in the atmosphere.

The detailed investigation of sediments present in rivers and lakes in Korea has been expanded starting with the riverbed dredging for the 4 major rivers project, and it was confirmed that some of the sediments at the bottom of the river are presumed to be contaminated by heavy metals and organic substances due to the influence of the upstream section or the waterside area.

However, the "Soil Environment Conservation Act" and "Water Environment Conservation Act", which are judged to be similar to the area of sediment, do not have any provisions related to sediment and even the currently operating sediment monitoring network system is only being operated as a rule of the National Institute of Environmental Research under the Ministry of Environment.

Although there is a risk that sediment contamination may be leached into the water body and may harm local residents and related ecosystems, there is no system or regulation within the Ministry of Environment that can be managed.

Due to these limitations, the current situation of sediment policy is

that there is no national master plan that judges the contamination and risk of river sediments from a macroscopic point of view, determines the need for purification of contaminated sediments based on this, and establishes a plan thereafter.

In the past, the management subject of the river area was divided into the Ministry of Environment and the Ministry of Land, Infrastructure and Transport, so it was unclear who managed the polluted sediment. But nowaday situation where the unification of water management started in 2018 is completed, the management entity of polluted sediments generated in rivers can be clearly called the Ministry of Environment, and for this, it is essential to install related policy.

In the “Environmental Policy Framework Act”, which is the basis of the Environmental Law, “environmental contamination” is defined as air contamination, water contamination, soil contamination, marine contamination, radioactive contamination, noise/vibration, odor, sunlight caused by business activities and other human activities. It is defined as a condition that damages human health or the environment, such as interference or light contamination caused by artificial lighting (Article 3, Item 4), and the duty to prevent such environmental contamination in advance is given to the state and local governments (Article 8 (1)), to promote the saving and cyclical use of resources (Article 10 (1)), and to set environmental standards to protect the ecosystem or human health and to create a pleasant environment (Article 12) Detailed environmental standards for the water environment are established. But, environmental standards for sediments are excluded from the “Water Environment Conservation Act” and “Soil Environment Conservation Act”. The absence of such a system inevitably leads to obstacles in budget

input in the domestic administrative environment.
To overcome this limits, the purpose of this study was to create a sediment management system suitable for the domestic environment. In addition, when a new system is newly established, conflicts between the systems may occur, and the enactment of new laws and regulations is difficult to implement due to the complexity of the process. Also, rather than enacting a new law, it is assumed that the basic direction of the study is to amend the provisions of the existing related laws, the Water Environment Conservation Act, and to introduce some new provisions in the law.

1.2 Method of Research

This paper describes in the direction of proposing the revision of the Water Environment Conservation Act, which is related to the life cycle of sediments, in order to improve the currently operated domestic contaminated sediment management system. To this end, first, the current status of the sediment management system of domestic rivers and lakes and the sediment contamination status will be reviewed and the limitations of the current system will be analyzed. In order to overcome the limits, we refer to the relevant domestic laws and the advanced system of the United States to compose the provisions to be newly established in the “Water Environment Conservation Act.”

First of all, this study examines the “Soil Environment Conservation Act.”, a law that manages soil with properties close to sediment among domestic laws. Based on the implications, to establish the major direction of the sediment management system, the regulation of contamination, identification of the cause, and the flow of

purification treatment proposed by the Soil Environment Conservation Act are identified. In addition, the “Marine Waste and Marine Contaminated Sediment Management Act” and “Regulations on the Scope of Investigation and Remediation and Restoration of Marine Contaminated Sediments”, which are operated by the Ministry of Oceans and Fisheries to manage polluted sediments in the ocean, were mainly analyzed, and implications are drawn from the limitations existing in the applicable laws and regulations. To find the limitations, this study also looked at the limitations of the marine polluting sediment treatment regulations from a legal point of view. In order to present a more effective policy, it was reviewed to establish a legal basis that would allow the government to decide whether to participate in purification on its own in order to minimize environmental contamination based on the time it takes to identify polluters and to deal with contamination. Based on this amended clause, it is expected that the government will be able to charge the cleaning fee for the person responsible for cleaning up, after operating the budget with a dual strategy to minimize the spread of contamination at the same time as identifying the person responsible for cleaning up.

Among the overseas cases, the Superfund system, which will be described later, was judged to be the most advanced and focused on it. The reason that the Superfund system was judged as the most advanced and referenced was because the core goal of the Superfund system was most consistent with the policy direction presented in this paper. (The four core goals of Superfund are : First, Protect human health and the environment by cleaning up contaminated sites. Second, Make responsible parties pay for cleanup work. Thirdly, Involve communities in the Superfund process. And

the last one is Return Superfund sites to productive use.)

The focus of the study was to revise the provisions of the contamination regulation and treatment section in the “Water Environment Conservation Act.” by referring to the above domestic and foreign related systems and deriving implications, and related legislative proposals were presented by classifying them according to their characteristics.

1.3 Scope of Research

In this paper, the scope of the study was set to constitute the overall frame deemed necessary to manage the sediments that are not in the domestic environmental laws and regulations.

To this end, we established general rules that correspond to the outline of the sediment-related system, and based on this, we reviewed institutional measures for the regulation and treatment of sediment contamination. In addition, it aimed to establish auxiliary matters necessary to operate the system and to organize related matters.

In the general rules, it was explained that it was necessary to define sediments and to arrange contamination of sediments and their standards.

Regarding the regulation and treatment of sediment contamination, it is suggested to report contamination, inspect the contamination level, prioritize the person in charge of purification, standards and methods for contamination purification, risk assessment, plan to secure a budget, and establish a structure for decision-making did.

In the supplementary rules, it was decided which provisions were basically necessary to manage the sediments by explaining that

matters related to the registration of the sediment purification business and the matters related to the penalties were necessary.
This study was conducted based on the existing legal structure to reflect the above matters in the Water Environment Conservation Act.

Chapter 2. Literature Review

In Korea, research has been conducted on status of contaminated sediment in river and lake and contaminated sediment management index design, but river and lake sediments have never been dealt with from a systematic point of view. Accordingly implications could be obtained from the articles reviewing the institutionalization process of marine polluting sediments that follow a similar treatment method to that of rivers and lakes and improvement points after legislation.

Lee (1998) analyzed the current status of domestic contaminated sediment management in "Measures for Management of Contaminated Sediments in Lakes and Rivers". He pointed out that there is no procedure to check the quality control of the results when collecting, processing, transporting, analyzing, and interpreting the overall sediment samples, and it is difficult to secure the reliability of the obtained contamination data.

Park (2004) pointed out that the actual conditions of soil contamination in each country are different their share in social problems is different and the goals and approaches of soil environment conservation policies pursued between countries are different. Based on these, the scope of soil contamination suitable for the domestic soil environment was presented, and he argued that the concept of risk assessment and the limit of recognition of soil contamination should be designed for the definition of soil contamination.

In a study on the development of a dredging index for the improvement of contaminated sediments in coastal waters, Lee (2004) argued for the establishment of a reasonable Dredging Index

(DI) for judging whether dredging performed to improve the contamination level of rivers and coastal sediments. Since the evaluation indicators used in other countries differ from each other in economic power, environmental characteristics, and purpose of sea area use, he argued that it is unreasonable to directly use these indicators in Korea, and a Korean-style dredging evaluation index using domestic data is presented. In addition, a model for determining the scope and depth of dredging in the sea area was presented by applying an index reflecting the social and economic conditions to be considered during dredging.

Kim (2009) analyzed the current status of contamination of domestic river sediments, reviewed the related literature, and suggested management directions. He explained that a management plan for contaminated sediments should be established that reflects the characteristics of the contaminated site and the human and environmental impacts caused by the contaminated sediments.

Upal Ghosh (2011) analyzed cases in the US and Europe where in-situ sorbent amendment was applied instead of conventional dredging or conventional capping for the treatment of contaminated sediments. He pointed out that dredging has limitations in that contamination can recur due to the loss of contaminated sediments and re-suspending of pollutants during the dredging process. In addition, it was pointed out that conventional capping can cause changes in water depth and change the aquatic ecosystem, and the existence of topsoil makes it difficult to predict the recycling of pollutants. Although the in-situ sorbent amendment has the disadvantage that it is difficult to control the total amount of pollutants and lowers the possibility that the pollutants can be treated by natural circulation in the ecosystem, it can be used in

combination with dredging or conventional capping. Moreover it has advantage to apply for the condition that is hard to dredge geologically or sensitive aquatic ecosystems.

Ata Akcil (2014) reviewed various methods for the treatment of heavy metal-contaminated freshwater sediments. He analyzed cases such as conventional dredging and traditional capping that physically treat contaminated sediments, suggested limitations, and analyzed cases using chemical-biological methods including in-situ sorbent amendment. He also emphasized the need for research on resource recovery for sustainable use of dredged sediments and the derivation of more economically reasonable chemical and biological purification methods.

In the revision of laws and regulations related to marine contaminated sediments, Kim (2013) explained the limitations of the current legal system for the management of marine contaminated sediments. It was pointed out that the establishment of the term marine contaminated sediments is incomplete, and that there is no detailed definition of collection, treatment, purification, and recycling of contaminated sediments in the law. In addition, the problem was that there were no basic principles and basic plans that could be the standard while managing marine contaminated sediments. He argued that without these terminological standards, there could be a lack of unity and efficiency in marine contaminated sediments management, problems in disciplining all processes of collecting and disposing of contaminated sediments, and conflicts between laws. In response, he argued that the Marine Contaminated Sediments Management Act should be independently enacted and operated.

Jang (2014) tried to suggest a legislative improvement plan based on the results of reviewing the current status and problems of the

marine contaminated sediment purification and restoration project. He pointed out the current system that treats marine contaminated sediments as waste due to the lack of legal basis, impeding the efficient use of resources and increasing the possibility of secondary contamination caused by ocean dumping. To improve the problem, he insisted on the establishment of a law to establish purification standards and methods. In addition, he emphasized the need for step-by-step classification, such as recycling, landfill, isolated disposal, and marine discharge, for the recycling of contaminated sediments, rather than a general waste treatment method. He argued that it would be appropriate to establish and operate a new 'marine contaminated sediment treatment business' in addition to the existing 'sediment pollutant collection business' for vitalization of the industry and stable business management.

Choi (2016) argued for the promotion of a life cycle plan that could establish a nationwide marine contaminated sediment management system and systematically carry out purification and restoration projects of polluted sediments. To this end, the study pointed out that the problems of the existing system include the uniform cleanup project of dredging, lack of governance that can collect opinions from various stakeholders such as local residents, local governments, experts, and related ministries, and a policy environment that cannot induce the revitalization of cleanup and restoration projects and research.

Chapter 3. Analysis of Domestic Freshwater Sediment Status and Management System

3.1 Status of contaminated freshwater sediment

Through the status of sediment contamination, it can be understood that sediments have different contamination characteristics depending on the surrounding watershed environment. While it was found that organic contamination such as BOD, TP, and TN was found in samples around agricultural areas, livestock areas, and downtown areas (Jeong et al, 2020), samples which are contaminated by heavy metals were prominent around industrial areas. (Lee et al, 2000)

Table 3.1 Severly Contaminated Sediment Points

	T-P, T-N, Loss on ignition	Metalic	
	very high	high	Sum (point)
River	**Sooyeong RV5**, Anseong Str3, Gwangsan, **Donghong Str,** Namhaebong Str, **Jeonju Str6,** Oedoe Str	-	10
	Dosan, Bonghwa, Shin Str3	Anyang Str5, Hwangji2, Geumho RV6, Miho Str6-1, Hyeongsan RV4, **Sooyoeng RV5**, Gap Str5-1, Gwangju2-1 Cheongwon1, **Donghong Str**, **Jeonju Str6**, Gokgyo Str2,	12
Lake	Daecheong D1, **Daecheong D2**, Gyeongcheonji1	-	4
	Andong D2	Goesan D3, Hwacheon D1, Hwacheon D2, Andong D3, Hwacheon D3, Andong D1, **Daecheong D2**	7
sum (point)	10	23	33

Looking at the results of the operation of the measurement network, it was found that the main points where the health of the aquatic ecosystem was judged to be very poor include Andong Lake in Andong-si, Gyeongsangbuk-do, Hyeongsan River in Pohang-si, and Paro Lake in Yanggu-gun, Gangwon-do, which are the uppermost parts of the Nakdong River.

In the case of Lake Andong, the results of operation by point of the measurement network were judged to be 'very bad' (Andong Dam 2) and 'bad' (Andong Dam 1, 3). As a result of the investigation, cadmium, mercury, and arsenic were detected in the sediment. Not only cadmium was confirmed as grade IV, but cadmium grade of Lake Andong was judged to be 'bad to very bad'.

In the case of Lake Paro, copper, nickel, arsenic, and mercury were detected in the sediment. Most of them are identified as grades I to II, and the operation results for each point of the measurement network are judged to be 'bad' (Hwacheon Dam 1, 2, 3), because of the variety of heavy metals that cause contaminaton.

As a result of the investigation of 6 points in Hyeongsan River, mercury was confirmed as grade IV at 5 points. In particular, it was detected the highest at confluence of the Hyeongsan River and Gumu stream, which is presumed to be due to a large amount of heavy metal leakage due to the collapse of the embankment of the waste landfill upstream of Gumucheon in 1994.

By contamination sources, classifying other rivers and lakes where have contaminated sediment is as follows. First of all, with the exception of Donghong stream and Oedo stream, which have exceptively geological characteristics, among the rivers which have contaminated sediment by the T-P, T-N, and Loss on ignition, it is assumed that the location of these rivers have caused the

accumulation of those contamination elements for a long time, because most of them are located in the downstream areas of the city. Secondly, metals of copper, lead, nickel, arsenic, mercury, zinc, cadmium, and chromium exist in many places judged to be very bad or bad. As the case of very bad, Shin Stream 3 (estimated dyeing factory) and Bonghwa, Dosan, Andong Dam 2 (estimated Seokpo smelter and abandoned mine) were selected. The points judged as bad include Miho Stream 6-1 (estimated industrial complex), Gap Stream 5-1 (estimated industrial complex and metropolis discharge water), Hwangji 2 (estimated abandoned mine), Hyeongsangang 4 (Gumucheon and industrial complex estimated), and Donghongcheon (geological characteristics), Anyang Stream 5, Geumho River 6, Suyeong River 5, Cheongwon-1, Gokgyo Stream 2, Jeonju Stream 6, Gwangju 2-1 (estimated metropolis discharge water and urban rain water).

3.2 Operation Status of Monitoring Network

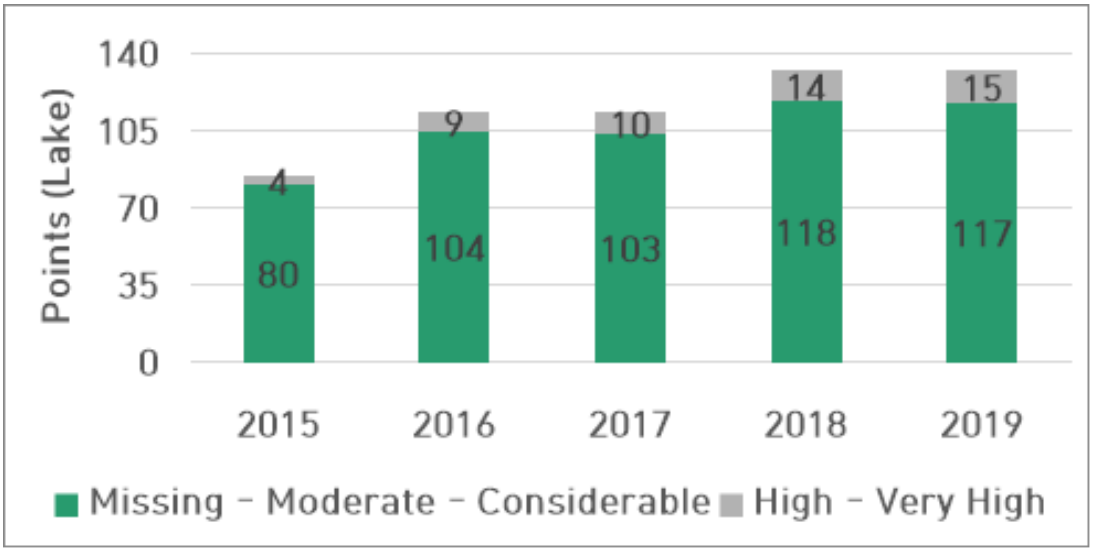
Sediments in rivers and lakes are composed of insoluble substances in water space, including various substances transferred from upstream streams, including erosion of the riparian soil, transport of runoff, and sedimentation of atmospheric substances. In order to check the health of the aquatic ecosystem of freshwater sediments, a monitoring network has been installed for major rivers and lakes in Korea since 2012, and has been operating with the trend of increasing the number of points every year. As of 2020, 308 locations (176 rivers, 132 lakes) are in operation.

Table 3.2 Operation Status of Sediment Monitoring Network (2015-2019)

		2012	2013	2014	2015	2016	2017	2018	2019
points	River check per 6 month	144	177	177	174	174	173	176	176
	Lake check per 1 year	-	-	50	84	113	113	132	132
sum		144	177	227	258	287	286	308	308

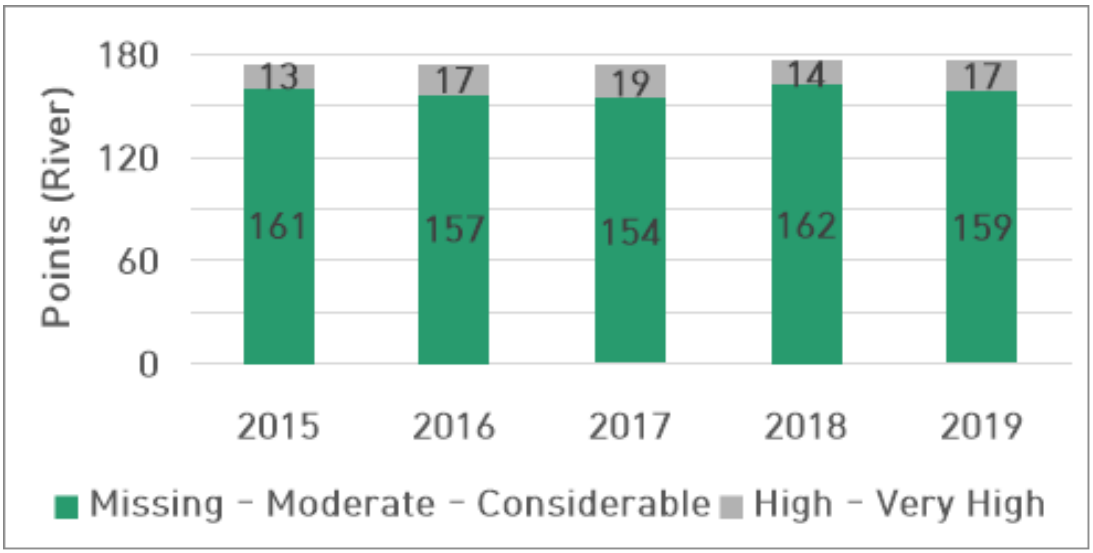
As a result of examining the results of the operation of the sediment monitoring network, it can be seen that in the case of the lake, the number of points graded very high and high is increasing due to the expansion of the number of points in the lake monitoring network over the past 5 years, but the ratio to the total number of survey points is a similar trend. (7.47%, 9.77%, 10.98%, 7.95%, 9.66%)

Figure 3.1 Data Trend for number of Contaminated Sediment points (Lake)



The results of the river has similar trend, and it can be seen that the number of points graded very high and high has a similar trend over the past five years, but the ratio to the total number of survey points is increasing. (4.76%, 7.96%, 8.85%, 10.61%, 11.36%)

Figure 3.2 Data Trend for number of Contaminated Sediment points (River)



Analyzing the main causes of lakes and rivers being judged to be very high and high, heavy metal contamination was the main factor, and this is estimated to be the effect of discharge water from industrial complexes.

3.3 Contamination Assessment System

For contamination assessment, contamination factors are classified into general factors[1] (organic substances and nutrients) and metal factors[2]. In the case of metals (8 types), contamination evaluation

1) organic substances and nutrients (3 types) : IL, T-N, T-P
2) metal (8 types) : Cu, Pb, Ni, As, Hg, Zn, Cd, Cr

standards for each grade (I-IV) were prepared (enforced in November 2015), but general factors' standards (Ⅰ~Ⅲ) are incomplete.

Table 3.3 Contamination Evaluation Criteria for River Sediment

factors \ grade		I	II	III	IV
organic substances and nutrients	Ignition Loss (%)				13 ↑
	T-N (mg/kg)				5,600 ↑
	T-P (mg/kg)				1,600 ↑
metal	Cu (mg/kg)	48 ↓	228 ↓	1,890 ↓	1,890 ↑
	Pb (mg/kg)	59 ↓	154 ↓	459 ↓	459 ↑
	Ni (mg/kg)	40 ↓	87.5 ↓	330 ↓	330 ↑
	As (mg/kg)	15 ↓	44.7 ↓	92.1 ↓	92.1 ↑
	Hg (mg/kg)	0.07 ↓	0.67 ↓	2.14 ↓	2.14 ↑
	Zn (mg/kg)	363 ↓	1,170 ↓	13,000 ↓	13,000 ↑
	Cd (mg/kg)	0.4 ↓	1.87 ↓	6.09 ↓	6.09 ↑
	Cr (mg/kg)	112 ↓	224 ↓	991 ↓	991 ↑

Table 3.4 Contamination Evaluation Criteria for Lake Sediment

factors \ grade		I	II	III	IV
organic substances and nutrients	Ignition Loss (%)				13 ↑
	T-N (mg/kg)				5,600 ↑
	T-P (mg/kg)				1,600 ↑
metal	Cu (mg/kg)	60 ↓	228 ↓	1,890 ↓	1,890 ↑
	Pb (mg/kg)	65 ↓	154 ↓	459 ↓	459 ↑
	Ni (mg/kg)	53 ↓	87.5 ↓	330 ↓	330 ↑
	As (mg/kg)	29 ↓	44.7 ↓	92.1 ↓	92.1 ↑
	Hg (mg/kg)	0.1 ↓	0.67 ↓	2.14 ↓	2.14 ↑
	Zn (mg/kg)	363 ↓	1,170 ↓	13,000 ↓	13,000 ↑
	Cd (mg/kg)	0.6 ↓	1.87 ↓	6.09 ↓	6.09 ↑
	Cr (mg/kg)	112 ↓	224 ↓	991 ↓	991 ↑

Table 3.5 The Possibility of Toxic by Contamination Source and grade

organic substances and nutrients	IV : serious and obvious contamination
metal	I : Less likely to be toxic to benthic organisms II : Potential to be toxic to benthic organisms III : Relatively high possibe to be toxic to benthic organisms IV : Very likely to be toxic to benthic organisms

Table 3.6 Contamination Evaluating by grade

Evaluation[3]	grade
Moderate	All 'I' grade for metal factors
Considerable	1 or more of grade 'II' or 'III' among metal factors
High	Metals 'II' grade standard index[4] of 0.34 or higher
Very High	1 or more of grade 'IV'

1. Moderate : Normally affected by surrounded circumstances
2. Considerable : Toxicity to benthic organisms is possible, and adverse effects need to be confirmed through toxicity tests.
3. High : High possibility of toxicity to benthic organisms, needing to confirm the scale of contamination by expanding the scope of investigation to upstream and downstream.
4. Very High : Severely and clearly contaminated, needing to manage discharge facilities and public waters on mid to long term

3.4 Legal Basis for Sediment Managament

Currently, there is no legal basis for the overall management of polluted sediments, including the definition of sediments, under the domestic environmental law. For this reason, the sediment measurement network, unlike other environmental monitoring networks, can not be prescribed by the law that are the basis for its operation. Currently, there are only two regulations related to

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3) It would be judged as the level with the highest level of contamination, if a point is contaminated by multiple factors.

4) Metals 'II' grade standard index $= \sum_{i=1}^{8}(\frac{EC_i}{PEL_{K_i}})/8$

(EC_i : concentration by metal factors, PEL_{Ki} : 'II' grade standard for each metal factors)

the operation of sediment measurement networks. The first is about the types of measurement networks that can be installed and operated by the head of the National Institute of Environmental Research, the head of the watershed environment office, and the local environment office that exist in the enforcement regulations of the Water Environment Conservation Act, and the second is only the quality control guidelines and contamination assessment standards in the regulations of the National Institute of Environmental Research. The limitation of the lack of regulations inevitably leads to the problem of being organized as a sub-priority in securing the budget (Choi, 2011). For this reason, not only the operation plan of the measurement network and the institutional basis for the purification of contaminated sediments, which were necessary to manage the sediment contamination and current status across the country so far, but also the completion of the basic index of sediment contamination evaluation standards was being delayed.

Chapter 4. Comparison of Contaminated Sediments Policies: Korea and U.S

4.1 Analysis of domestic laws

The current status of domestic contaminated sediment management related laws and regulations are as follows. Most of all, the 「Water Environment Conservation Act」 aims to properly manage and preserve the water environment, but there is no legal basis for the management of sediments in rivers and lakes. Under the current laws and regulations, there are no sediment-related regulations in the Act, Enforcement Decree, and Enforcement Regulations other than the installation of a sediment measurement network for water environment conservation in public waters (related to Article 9 (1)), so there is limit to judge and treat sediment contamination. The classification of dredged contaminated sediments can also be found in the Enforcement Rules of the Waste Management Act. However, the law also does not contain any provisions regarding the return of contaminated sediments to resources, and only classifies them as general industrial waste for landfilling. Since the "Soil Environment Conservation Act" aims to purify, properly manage and preserve soil, it is not easy to directly apply regulations to manage sediments. However, since it is a law that can share a conceptual framework for the purification of polluted resources (soil), a comparison with the sediment system was performed. Moreover the "Marine Waste and Marine Polluted Sediment Control Act" also shares the same policy direction as the "Soil Environment Conservation Act", a comparison was performed

to refer to the parts applicable to the river sediment management regulations.

4.1.1 Review of Soil Environment Conservation Act.

The “Soil Environment Conservation Act.” aims to purify soil and to manage and preserve it properly, but unlike general soil, there are limitations in applying the soil remediation treatment procedure to sediments which have differences in particle size, moisture content, and combination of organic and reducing substances. However, under the basic premise of recognizing soil as a resource, ‘Soil Environment Conservation Act.’ stipulates not only the duty of purifying contaminated soil, but also provides a legal mechanism to closely review the direction of soil remediation based on risk assessment, and it works as reference for establishing the institutional direction of sediment remediation.

First of all, Article 4 specifies the establishment and implementation of a master plan for soil conservation for soil conservation. The master plan covers the current status of soil contamination, future prediction and prevention, as well as technology development and education for soil remediation. Based on those factors, the freshwater sediment system should build on understanding the current status and progress of contamination information which is obtained from the sediment measurement network, and also include major principles for contamination prevention. However, compared to the management of soil contamination, freshwater sediment contamination is not easy to recovery and recycle, so development of related technology and

industry should be considered as secondary.

Article 5 defines the measurement of pollution degree. In this provision, the head of a local government is appointed as the authority to investigate the soil contamination condition, and it stipulates the actual condition investigation on the area of concern.

Articles 8 and 10-4 contain the authority to investigate contaminated soil and the responsibility of the person in charge of purification. To do regular measurement of soil contamination level, soil contamination survey, and detailed soil survey, in article 8 it is allowed to access the land and the authority to change and remove occupied facilities. Article 10-4 explains the criteria for stipulating the person responsible for cleaning up for each situation. Contamination of freshwater sediments is more often caused by industrial activities or environmental pollution accidents than by nature, so it is essential to clarify the responsibility for contamination and assigning the duty to clean up. The priority of the person in charge of purification is as follows: 1) A person who causes soil contamination by leakage, spillage, dumping, neglect, or other acts of soil pollutants, 2) The owner, occupant, or operator of a facility subject to soil pollution control that was the cause of soil contamination at the time of the contamination occurrence, 3) A person who has comprehensively succeeded in the above-mentioned 1st and 2nd priority purification responsibilities due to merger, inheritance or other reasons, 4) A person who owned, currently owns or is in possession of contaminated land. Like these, it is essential to legally present the priority of purification because large cost would be involved in the purification process of sediments. However, since the law was promulgated on January 5, 1995, the responsibility of the person in charge of purification has been

subdivided as of January 6, 1996, and January 1, 2002 for cases where the national budget is available judging from the starting point. Therefore, matters related to responsibility and support for sediment purification should also be additionally reviewed on the effective date in relation to the enforcement of the law. Articles 11 to 15-8 of the Act deal with the regulation of soil pollution, and among these, the risk assessment clause corresponding to Article 15-5, is need to be carefully reviewed. Unlike this Act, which aims to completely purify contaminated soil, because freshwater sediments are closely related to the movement of water compared to soil, in the risk assessment for contaminated sediments, the effects on the surrounding environment and the human body should be clearly evaluated, and a legal basis should be prepared which reflects the moving characteristics of contaminants.

Chapter 3-2 of the Act includes the qualifications, conditions and obligations of specialized soil-related organizations and soil remediation businesses. In consideration of the large difference in the properties of the sediment from the general soil, and the need to deviate from the current dredging unilateral treatment method that tends to result in landfilling, the licenses of related organizations and purification businesses should be granted. For this purpose, it is required to have a separate capability (methods such as capping, MNA, in-situ, etc.) that is different from the existing soil remediation, and the qualifications and conditions should be set to choose the person who has been proven to be able to prepare measures other than dredging. Chapters 4 and 5 deal with matters related to the authority of administrative agencies to execute various matters presented in the law, penalties and sentencing regulations, the obligations of related agencies to cooperate, and

budget support.

4.1.2 Review of Marine Waste and Marine Contaminated Sediment Management Act.

The domestic sediment-related laws are divided according to the management entities of the water body. Since the Ministry of Environment has jurisdiction over freshwater and the Ministry of Oceans and Fisheries has jurisdiction over the oceans, the subject of managing freshwater contaminated sediments belongs to the Ministry of Environment, and the subject of managing marine contaminated sediments belongs to the Ministry of Oceans and Fisheries. However, in contrast to the lack of procedures for managing freshwater contaminated sediments, the Ministry of Oceans and Fisheries enacted the "Marine Waste and Marine Contaminated Sediments Management Act." in December 2019 to manage marine contaminations in sediments, and it came into effect in December 2020. This Act provides definitions and management laws for marine wastes and marine contaminated sediments.

Article 5 of this Act contains the content for establishing a 10-year master plan to properly manage marine waste and marine contaminated sediments. It includes the basic direction of the management policy, matters related to treatment such as collection and purification from contamination status investigation, prevention and reduction of occurrence, post-contamination management, and matters for securing management resources. In Article 16, the Act gives the authority about ordering the purification duty for the one who cause the marine contaminated sediment to the sea area management agency, which is the main body of sea area

management, and the details of the purification plan of the pollutant are dealt with in appendix of the Act.

Article 17 contains the details of follow-up management after the marine pollution sediment purification project has been carried out, and it specified not only the need to check whether the sediment was re-contaminated after a set period after the project, also the essential investigations and measures for this process. Article 18 regulates the use of dredged materials. As a detailed plan, it is suggested that the dredged material can be used as a material for the construction of a beach, the creation and restoration of wetlands, the creation of an artificial island, the maintenance of a fishing ground, and the construction of port facilities and fishing port facilities. It means that marine sediment management policy also recognizes sediment as a resource and seeks to reuse.

The regulations related to the treatment of marine contaminated sediments were revised in February 2018, and the regulations include sampling and analysis methods for contaminated sediments, classification of purification/restoration projects, survey on the distribution of contaminated sediments, setting and implementation of the scope of purification/restoration, the process of follow-up monitoring.

However, in the case of marine contaminated sediments, unlike land, they are deposited in the public area (open waters), and since the sedimentation occurs due to the circulation of seawater, it is difficult to identify the cause. Due to these limitations, in this Act., the enforcement ordinance and enforcement rules were carefully designed for the purification and treatment of the collected marine contaminated sediments rather than the regulations to investigate the polluters.

4.2 Analysis of U.S Contaminated Sediment Institutions

The main reference was made to the sediment treatment system of the United States. So far, Korea's sediment policy has referenced Japan's in a broad framework, but Japan has the basic policy of judging polluted sediments as wastes (Choi et al, 2016). On the other hand, in the case of the United States, the system for sediment management was established based on the health of aquatic ecosystems and risks to humans. In the case of the U.S, separate regulations are in operation for each state, and different standards are operated depending on the authority in charge of sediment management. Among these regulations, it was the Clean Water Act (CWA) and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) operated by the US Environmental Protection Agency (EPA) that presented the criteria for judging sediment contamination, so two regulations were focused on.

4.2.1 Clean Water Act

Article 115 of the CWA specifies the EPA's legal authority to conduct on-site inspections of toxic contaminants in ports and navigational areas to determine contamination status. In addition, for acts exceeding the emission allowance, the government is granted the right to be a party to the lawsuit and the authority to regulate illegal activities of the emitter through litigation. Article 504 stipulates that if it is proven that the contaminated sediment has

affected the health or economic activities of residents, the person responsible or responsible for the contamination must purify the contaminated sediment. In particular, it was established that the person responsible for discharging contaminants is responsible for the disposal of contaminants in the event of contamination, even if the pre-determined allowable amount is observed. Article 118 stipulates that representative agencies or managers who have received public opinion should disclose to the public information on the effects of pollutants in Great Lakes sediments on public health and the environment. Also, it is stipulated that the disclosed content should include a standard value that can protect the health of ecosystem components including humans from bioaccumulation of toxic substances. In addition, in order to update the standards for contamination determination, a device for annual review of standards is provided in Article 304 (a)(1).

4.2.2 Comprehensive Environmental Response, Compensation and Liability Act

CERCLA is a so-called 'Superfund', which is a system for cleaning up contaminated sediments. Superfund is a trust fund formed based on taxes levied on substances that can cause contamination. EPA has established and is operating a superfund system with an amount of about $5.7 million (as of 2019). About $2.8 million was recovered from the polluters that caused contamination and were identified by government by after the cleanup operation based on Superfund. It has been announced that the fund is currently operating by charging approximately $1.8 million to those who handle potentially polluting substances.

Of course, Superfund is a system to solve all kinds of contamintaion, not just sediment case, so this study focus on the entire process such as, site assessment, site characterization, and remedy decisions to analysis how to approach and solve the environmental problems.

The contamination status evaluation process is performed based on HRS(Hazard Ranking System). HRS is a numerical-based pre-assessment system used to assess the potential for harm to the environment. HRS identifies and evaluates contaminated areas according to standards and ranks them to confirm cleanup priorities. Also, the contaminated site where has the score of HRS less than 28.5 points, can not be applied by Superfund, and have to review the environmental problem within local government scope. Within the Soil Environment Conservation Act, which is most closely related to sediment contamination remediation among domestic laws, there is no system for judging remediation by judging the risk numerically as above. Therefore, there is a limit that the priority of purification is determined according to public opinion rather than the national budget allocated for purification according to the objective degree of the risk. Therefore, in order to solve this limitation, the introduction of an evaluation system like HRS which has the advantages of being able to selectively pay a budget according to the degree of risk and entrusting the local government to carry out the purification according to the degree of risk is a worthy of consideration.

Afterwards, according to Article 121 of CERCLA, the pollution remediation site that has been subject to remediation should identify its characteristics, determine a restoration method, and then conduct a Remedial Investigation and Feasibility Study (RIFS) to review whether the project is feasible. In the remediation investigation

stage (RI), the condition of the site, the characteristics of the polluting factors, the risk estimation, and the efficacy and cost of remediation are reviewed. Then, in the feasibility study (FS), various remediation alternatives are placed and the economic feasibility of each method is reviewed. In the process of reviewing the economic feasibility, these are reviewed; whether the risk to humans is large depending on the length and length of the project period, the impact of the purification method on the environment, and the cost required to rectify the site in case of purification failure. According to those consideration, the purification period, method, and the size of investment budget are determined. (Kim et al, 2009)

The decision-making stage to determine the purification method is carried out based on the consensus and opinion gathering of experts and local residents. Based on the opinions gathered, a method with excellent cost-effective purification and restoration project is determined to select a method for purification and restoration of polluted sediment suitable for the environmental characteristics of the target area. To proceed with this process, a Multi-Criteria Decision is performed. Within this technique, the relative importance of analysis elements is quantified and a conclusion is drawn in a quantitative form. In addition, it includes establishing a business plan with less trial and error through analysis of past cases of purification and restoration projects.

4.3 Comparative implications of the U.S. institutions

It can be seen that the characteristic of the US system is that it

concentrates on cleanup and follow-up management of the area after contamination occurs. However, as Korea's environmental law is based on the "Framework Act. on Environmental Policy", in accordance with the principle of responsibility for the cause of contamination in Article 7 of the law, Korea's sediment management policy not only provides follow-up management, but also prevention of contamination, identification of the cause of contamination, compensation for damages and purification responsibility of contamination. In addition, it is necessary to design an indicator that can judge the risk beyond the level of judging contamination. The most necessary thing in the design of the index is to develop Korean-style evaluation standard based on various indices of the river aquatic ecosystem obtained using the measurement network. It can be seen from the previous paragraph that the United States' standards for managing contaminated sediments are established in consideration of how much contaminated sediments in the ecosystem affect organisms. In the case of Korea, the operation of measuring networks started in earnest from the time of the Four Major Rivers Project. For this reason, there was a lack of effort to establish data on the background concentration or biological effects of river sediments accumulated before, which led to limitations in setting purification and restoration standards for major rivers during sediment treatment such as dredging. (Kim et al, 2010) Compared to the past, it is true that the measurement network data for about 10 years since 2012 has been accumulated, and there are more data that can be used to determine pollution compared to the past, but it is still limited to directly calculate the priority of the purification project for major polluted sites in Korea based on the data. Therefore, it is necessary to establish a system to examine the

trend of contamination change by expanding the regional measurement network along the water system and routinely evaluating pollution based on the information obtained from the measurement network and judging the actual risk. In addition, with reference to the standards for sediment management in the United States that is based on the overall ecosystem such as natural abundance and biological impact data, Korea's standards should also include not only water systems but also the surrounding ecological environment. Only when the relevant standards are prepared will it be possible to objectively judge how much damage to humans or ecosystems can actually be caused by substances such as heavy metals accumulated in sediments.

Next, based on the above-mentioned indicators, a system for comprehensively managing contaminated sites that the state should manage should be prepared. Through this, when a list of purification rankings can be established, it will be possible to review which contaminated sediments can be cleaned with the limited budget.

Finally, a joint public-private-academic governance operation is required. (Ahn, 2015) There is a limitation that the participation of local residents in taking cleanup measures is not systematically guaranteed at present, and there is no concrete basis for assigning responsibilities or roles to dialogue channels with polluters and follow-up management after cleanup measures. The operation of governance can also affect follow-up management. In the situation of purification and restoration of contaminated sediments it is essential to consider (if dredge is performed) side effects such as the occurrence of suspended soil due to dredging, diffusion due to re-suspending of pollutants in the sediment, and post-treatment of dredged contaminated sediments which can cause secondary

environmental problem. In some cases, if the adverse effects from secondary environmental contamination are large, it may be necessary to re-examine the origin of purification and restoration. For this selection, cost factors and environmental feasibility factors should be reflected. In addition, open management of governance is essential for all discussions, and it is expected that only when such institutional devices are in place, the effectiveness of domestic purification and restoration projects can be increased and the validity of project execution can be secured.

Chapter 5. Proposal of Legislation for Contaminated Sediment Management System

5.1 Legal Directionality for Contaminated Sediment Management System

In the preceding paragraphs, this paper examines the sediment measurement network systems currently in operation in Korea and institutional cases of sediment management at home and abroad. Due to the nature of the domestic administrative environment, the completion of the legal basis is a necessary condition for national budget input. Accordingly, in order to stably manage the sediment environment of domestic rivers and lakes, it is necessary to establish a stable monitoring system, limit contaminants, and in some cases enact and amend relevant provisions to implement state-led sediment treatment. To this end, in order to review the provisions that need to be enacted and amended among the current laws and regulations, the implications were derived by referring to overseas cases.

In order to establish a direction in the legislative process of the sediment system, various cases of foreign sediment management related laws were examined. First of all, it was found that sediments were managed within the law for managing the water environment rather than the law for managing the soil environment. This can be divided into the following two reasons.

First, although the physico-chemical properties of the sediments are similar to those of the soil, the location of the sediments, the ecosystem containing the sediments, and the process of creating the

sediments are dependent on the water system. The process by which polluting sediments are formed is also dependent on the water system. As can be seen from the measurement network operation results investigated previously, the major cause of artificially generated contaminanted sediments is contaminants in sewage and wastewater that are not properly treated. Therefore, for the management of polluted sediments, it is a prerequisite to block the inflow of pollutants into the water system, which is the starting point of pollution.

Secondly, it is necessary to construct a river bed to treat the contaminated sediments present in the freshwater. Accordingly, it can be said that it has a large correlation with the related laws, “Water Environment Conservation Act” and “River Act”. Among them, the “River Act” has limitations in terms of managing the water system as it is limited to the structural work of the river bed. Therefore, it could be judged that the “Water Environment Conservation Act”, a corporation that manages the overall behavior and quality of water bodies, has a greater correlation with the quality control of river sediments.

Therefore, in order to introduce a system related to sediment in Korea, it is necessary to review it in the direction of establishing new regulations or a new provision in the “Water Environment Conservation Act”. However, in the case of new regulations, it is logical to enact and amend related regulations within the framework of the “Water Environment Conservation Act” because it may overlap with the existing “Water Environment Conservation Act” in the field of regulating contaminants. Based on prior logics, the enactment and amendments factors about management of contaminated sediments in “Water Environment Conservation Act“. are reviewed as follows,

and they reflects domestic and foreign research cases, the current status of overseas systems, and the current contaminated sediment measurement system.

5.2 General Rules for Contaminated Sediment Management

The basis for the improvement of the legal system for the management of freshwater sediments is the establishment of the concept of "Sediment" and "Contaminated Sediment", which are not currently stipulated in any law. First of all, “Sediment” can be defined as follows: “A collective term for gravel, sand, clay, organic matter, and mineral matter which are accumulated on the bottom of lakes, rivers, estuaries, and seas through internal bio-chemical actions or flowing grom the lands.” (Lee et al. 1998) Based on the life cycle of sediments, the direction of whether contaminated sediments will be treated in the water environment field or the soil environment field should be determined. As mentioned above, since the life cycle of sediments is dependent on the water system, the management of sediments should be dealt with in the field of water environment, and the proposed concept of sediments can be judged to be appropriate.

The definition of ‘Contaminated Sediment' should be presented separately. This separate establishment of the concept of 'contamination' can also be seen in the definition of Article 2 in the "Soil Environment Conservation Act", a related law. The definition of ‘Contaminated Sediments’ can be defined to “Including contaminants that exceed the standards prescribed by Ordinance of the Ministry of Environment, or substances that have a detrimental effect on

human health, property, living environment, or natural environment by referring to the contents of the Sediment Measurement Network Operation Standards in the National Institute of Environmental Research. However, for this, the detailed standards for contamination included in the ordinance of the Ministry of Environment ("Water Environment Conservation Act." Enforcement Rules) should also be reestablished as the enforcement rules of the same law, not the regular rules of the National Institute of Environmental Research. In addition, in defining 'contamination', though the concentration of a contaminant is higher than standard, if the cause is natural, not human action, it should be considered whether we can call it 'contamination'. For example, in the case of soil containing more than the standard of fluoride due to natural causes, there is a debate as to whether or not it should be judged as contamination on the "Soil Environment Conservation Act.", and these problems cause the delay of decision whether to purify. Therefore, in order to prevent similar problem from the sediment policy, it is necessary to clearly classify the case where the concentration is naturally exceeded.

After the concept of 'Contamination' is established, standards for the level of concern that contamination can cause should be prepared within the legislation. Currently, the standards for sediment contamination remain at the level of the administrative regulations of the National Institute of Environmental Research, so they do not have institutional enforcement power. Therefore, the level of concern for contamination must also be designated as one of the enforcement rules that stipulates the matters entrusted to the "Water Environment Conservation Act." and the contamination standards for rivers and lakes of organic matter and nutrients that

have not yet been established should be completed.

When the standard of concern is prepared, provisions on the measurement of sediment contamination level that can confirm the status of sediment should be established accordingly. Even within the regulations of the National Academy of Environmental Research, which is currently operating the sediment measurement network, there is no content on the installation standards of the measurement network or the method of selecting the area to be investigated. Therefore, in order to manage sediment contamination in the mid- to long-term, information on the operation of the measurement network should be prepared and organized in the Master Plan for Water Environment Conservation, which will be described later.

A legal distinction between 'treatment' and 'purification' is also necessary. Because 'purification' usually means removing all contaminants, it may not be able to cover methods such as in-situ capping, which is one of the various 'treatment' methods currently managing contaminated sediments. If these expressions are not legally separated, legal disputes could be occured in the future. Therefore, it is necessary to discuss whether to include the level of removing all contaminants from the sediment and returning it to the state before contamination in the meaning of 'purification'.

The master plan for sediment management should be included in the establishment of the Master Plan for Water Environment Conservation to be established for mid- to long-term management. Current Master Plan for Water Environment Conservation includes changes in the water environment, target standards for water environment, changes of nationwide water environment pollutants and long-term prospects, policy directions for water environment management and conservation, and the contents of the water

environment management policy for preparing climate change which is dealt on the “Low-Carbon Green Growth Basic Act.”. However, because of the absence of any contents for managing sediments and related technologies and industries in master plan, it is necessary to establish delegation rule for supporting sediment management on the Enforcement Decree of the Act and the Enforcement Regulations to systematically involve the above matters.

Contents for the method, object, procedure of contamination level measurement and investigation for sediment contamination status survey should also be prepared in the master plan. Detailed procedures for those should be established within the “Water Environment Conservation Act.”, such as periodically performing management of rivers and lakes based on the measurement network for the conservation of the water environment in public waters. The detailed procedures for this should be established in the same way that the management of rivers and lakes is periodically performed based on the measurement network for the conservation of the water environment of public waters within the “Water Environment Conservation Act.”. Accordingly, for the management of sediments, it should be established based on the content that the Minister of Environment should periodically investigate, measure, and analyze the current status of sediment contamination on rivers and lakes, as prescribed by Ordinance of the Ministry of Environment. In addition, the Mayor/Do Governor, the head of a large city, or the water surface manager shall grant the authority to investigate the current status of sediment contamination in the jurisdictional area, if it is needed to understand the current status of sediment contamination, and the obligatory proviso for reporting the results of the investigation to the Minister of Environment should be ipmopsed to

them to enable overall management of contaminated sediments. When such a periodic and continuous master plan is established, it is possible to grasp the current status of contaminated sediments in the whole country, and based on this, it will be possible to organize and execute the purification budget.

5.3 Regulation for Contaminated Sediment

Provisions on the regulation of sediment contamination should be formulated. Regulation-related provisions should basically contain contamination report, contamination level inspection, priorities of the person in charge of purification, standards and methods of purification, and risk assessment. In Korea, it is a essential to report status of contamination to the head of the competent local government when environmental contaminaion is confirmed such as soil, water, and air. Accordingly, if the contamination of sediment is also confirmed, the person who caused the sediment contamination, the person who owns and operates the facility that causes the sediment contamination, and the person who confirms the sediment contamination must report it. After that, it should be done to confirm the cause and degree of contamination through the stage of a fact-finding investigation. Setting the priorities of the person responsible for cleaning up is the most important clause in the regulation of sediment contamination. The priority of the person in charge of purification in the "Soil Environment Conservation Act." is as follows: 1) A person who causes soil contamination by leakage, spillage, dumping, neglect, or other acts of soil pollutants, 2) The owner, occupant, or operator of a facility subject to soil pollution control that was the cause of soil contamination at the time of the

contamination occurrence, 3) A person who has comprehensively succeeded in the above-mentioned 1st and 2nd priority purification responsibilities due to merger, inheritance or other reasons, 4) A person who owned, currently owns or is in possession of contaminated land.

Because the purification of contaminated sediments involves a large cost, a legal basis must be prepared for how to assign the responsibility for purification in determining the priority of the responsibility for purification. However, in the case of sediments, unlike the soil, the area where the contaminated sediments are exist is located corresponds to the public area of the water system, so the contents related to the ownership of the area where the sediment exists should be excluded unlike the case of the soil. Since the ocean sediments also exist under the public domain, provisions on the responsibility for purification in the "Marine Waste and Marine Contaminant Sediment Management Act." and "Regulations on the Scope of Investigation and Remediation and Restoration of Marine Contaminated Sediments, etc.", define the duty of purification relatively simple; the person who caused the contamination. However, this vague definition of the person responsible for cleaning up may neglect the cleaning duty through administrative litigation or bankruptcy, becuase huge amount of cleaning costs would be needed, and it can lead to the long term negligence of contaminated sediments. In addition, neglect of the above contaminants implies the possibility that the person who caused the contamination will not be held responsible as it encourages purification through the input of the national budget. Sediment contamination does not occur in a short period of time, but has the property of accumulation, and has the characteristic that

contaminants can be transferred from various pollutant factors through the water system. Therefore, in setting the ranking of responsibility for pollution of rivers and lake sediments, it is necessary to develop a technique for ranking and to assign the order of cleaning responsibility in detail, such as a method that reflects the contribution of contamination or the method of assigning the same cleaning responsibility to a cavity who discharges contaminants to the water system.

Criteria for risk assessment should also be established. In Korea, the level of contamination is evaluated by drying and pulverizing samples taken from the point where the sediment measurement network exists. However, in the case of this method, there is a limitation in that it is not possible to distinguish between the case where there is no possibility of elution of the contaminant in the sediment or the case where the background concentration of heavy metal is high due to the geological characteristics. Therefore, through the risk assessment procedure, it should be possible to determine not only the level of the contaminant, also how much the contaminats actually affect the aquatic ecosystem, how likely it is to be leached, and whether it is likely to be delivered to humans.

5.4 Budget Establishment for Contaminated Sediment Treatment

Even if the control of contaminated sediments and a cleanup order are given, various problematic situations can arise in handling them, which can be confirmed even when compared to the situation of soil remediation. First of all, it is reasonable to realize the principle of cost burden for polluters (according to Article 7 of the “Framework

Act on Environmental Policy") in the cost burden of the large-scale execution of sediment purification, but purification of contaminated sediments entails a large cost. "Superfund" is also based on the principle of paying the polluter's cost, so the person, corporation, or organization that causes environmental contamination is basically responsible for cleaning up the contaminated environment. However, in cases where it is difficult to treat contaminated sediments, the US EPA, the competent authority, prioritizes cleaning and restoration work, and the polluter is required to bear the budget invested in the process. Superfund is also based on the principle of paying the polluter's cost, so the person, corporation, or organization that causes environmental contamination is basically responsible for cleaning up the polluted environment. However, in the case of an urgent need to deal with polluted sediments, the US EPA, the competent authority, preemptively performs purification and restoration work, prior to the polluter who pay the budget invested in the process later. To date, it has been reported that more than 70% of the cost of cleanup and restoration under the Superfund scheme is borne by the actual polluters (Wright et al, 2017). This means that in 30% of cases, there was a limit to the identification of the cause of contamination, and the cost of purification and restoration was covered by the fund. Looking at the case of soil remediation similar to sediment remediation, if the cost of remediing contaminated soil is greater than the value of the land, the person in charge of remediation often proceeds with a lawsuit to avoid paying the remediation cost rather than carrying out remediation. Moreover, the insurance company of the person in charge of purification often files lawsuits to avoid such payment situations. In this case, the implementation of the cleanup of the contamination is

at a stalemate, and the spread of the contamination often persists for a long time. (Kim, 2019) Moreover, the "Soil Environment Conservation Act." recognizes the supplementary responsibility for remediation by prioritizing remediation orders when there is more than one person in charge of remediation. This legal basis allows the person in charge of cleaning up to assert the existence of a higher level person in charge of cleaning up rather than denying one's responsibility for cleaning up, in turn, competent administrative agency which has responsibility for investigating the cause of contamination takes a lot of time and administrative effort to identify it. Therefore, the recognition of such supplementary responsibility is bound to become a factor that can give expedient methods to the normal implementation of soil remediation. (Kim, 2019) In conclusion, just as the delay in soil remediation due to conflict causes the expansion of soil contamination, which is harmful to the health and environment of local residents, it can be seen that the ripple effect of adverse effects on the ecosystem will be more serious when the purification of sediment contamination is delayed because sediment exists in the water system. Therefore, it is necessary to prepare a dual method of preemptively injecting the budget to prioritize purification and at the same time proceeding with investigations related to contamination and charging the cost related to the person responsible for contamination. What needs to be installed for this purpose can be seen as a provision that the government can preemptively carry out purification and the composition of a budget that can carry out this process.

First of all, it is necessary to provide a proviso clause for cases where it takes a long time to identify and purify the cause of contamination or when the person responsible for contamination does

not have the ability to purify contamination. According to Article 43 of the “Framework Act on Environmental Policy”, the state and local governments must prepare policies necessary to relieve damage caused by environmental contamination or environmental damage. Therefore, if it takes a lot of time to identify the cause of sediment contamination or it takes time to prepare the cost, a legal device should be prepared to prevent further contamination of the environment due to neglect of the contamination, and regulations should be enacted that allow the state or local government to implement a project first and have a cost claim for it, based on the basic principle that the state or local government is responsible for the management and supervision of the environment as well as being an agency that orders measures for waste treatment. (Park, 2020)

The following four methods were reviewed for the method of preparing the budget.

The first is the establishment of a new environmental improvement special account. For example, Korea is currently operating the "Special Account for Water Quality Improvement", which forms a budget to compensate for the limited business activities in the upstream area compared to the downstream area to prevent water pollution. By borrowing this point, it may be possible to review a plan to form a sediment pollution prevention fund by levying taxes according to the amount of pollutable substances from corporations or individuals operating business sites that may cause water system pollution. As such, special accounting has the advantage of being free from the principle of unification of the budget, which does not directly link specific revenues with specific expenditures, or the principle of unifying the budget without organizing the budget in various forms. In this aspect, the special accounting has the

advantage of being able to promote the project relatively stably, and being easy to execute in cases when the pollution purifying budget size is unclear. However, special accounting has a limitation in that it must create its own income, such as related charges or fees, and reflect it in revenue or operate it depending on the transfer money from the general accounting.

The second way is the operation of the cooperative. In Article 10-5 of the "Soil Environment Conservation Act", oil facilities or land dealing with toxic substances are designated as facilities subject to specific soil pollution control, and the article allows installer or operator of the facility to establish a mutual aid association for secure financial resources about soil remediation. In this way, the fact that a mutual-aid association is established to respond to pollution in the existing laws and regulations has the advantage that it is easier to enact new laws, because the principle of joint water system joint response can be similarly applied through the operation of the mutual aid association. in the sediment problem, However, the limitation is that a mutual-aid association can be formed after a consensus is formed that all members have possibility for causing contamination and responsibility for purifying contamination. It is a prerequisite to recognize that business sites connected to a common water system have responsibility for contamination prevention and treatment.

The third way is to purchase insurance. Sediment purification requires a huge cost, and the financial ability of the pollutant has a great influence on the spread of contamination due to the treatment period or neglect of the contamination. In preparation for such a case, the insurance system is used as part of a mechanism to guarantee the execution of the cleanup cost. However, this includes

the risk that policy continuity may be insufficient in a way that is dependent on the relevant insurance company, and has limitations in that related costs must be continuously paid.

The last option is to raise the fund. As seen in Article 5 (1) of the National Finance Act, a fund is established by law when the state needs to flexibly manage a specific fund for a specific purpose, and it means money that can be managed without relying on revenue and expenditure budgets. Although the fund has the advantage of higher budgetary autonomy compared to the general and special accounts, there is a need to form a consensus in advance in establishing a separate fund for sediment purification. In order to operate the fund, it is essential to review the administrative power that is actually required to operate the fund, as it is necessary to agree on the collection of taxes from the majority to deal with pollutants affecting specific areas and specific people.

5.5 Decision-making system for managing contaminated sediments

As described above, as seen in the case of Superfund in the United States, for discussing whether to invoke the proviso clause regarding the government intervention for the treatment of pollution prior to spread of sediment contamination, or for deciding whether to support the treatment method and support, A National Sediment Remediation Advisory Committee (tentative name) is required to carry out the decision-making process. Therefore, as mentioned above, in order to determine the priorities and methods of purification, it is essential to have an advisory committee that can support them. The Cleanup Advisory Committee can be established by referring to the

format of the ‘Soil Remediation Advisory Committee’ stipulated in the “Soil Environment Conservation Act.” or the “Marine Remediation Advisory Committee” suggested in the “Regulations on Investigation and Remediation of Marine Contaminated Sediments,” Referring to the above similar systems, the Sediment Remediation Advisory Committee can be organized with up to 9 members including the chairperson. In addition, the members of the committee should consist of those who have been engaged in sediment related work for a long time, those who have served as assistant professors or higher at schools pursuant to Article 2 of the “Higher Education Act.”, those with legal knowledge and qualifications, and public officials of related institutions. The committee will have to advise and review matters concerning the priority and burden of the cleanup order when there are multiple cleanup managers.

The role of the advisory committee should begin by identifying the characteristics of the target site for pollution remediation, determining the restoration method, and conducting an investigation to review whether the project is feasible. It is necessary to estimate the actual risk of the contamination, and review the efficacy and cost of the purification treatment, as identifying the condition of the contaminated site and the characteristics of the contaminating factors. After that, the feasibility study should be conducted to review the economic feasibility of each method for various treatment methods, and the environmental impact related to the project period, each purification method, and the retrieving cost in case of a purification failure should be reviewed.

5.6 Guidelines for Sediment Purification Business and Supplementary Rules

The “Marine Waste and Marine Contaminant Sediment Management Act” established a provision on the registration of marine waste management business in Article 19 to grant qualifications for managing marine waste. Under the category of marine waste management business, there are marine waste disposal business, marine waste collection business, and marine pollutant sediment purification business, but disposal and waste collection businesses are confined to the special business fields on the ocean. (Choi, 2018) Therefore, as a business that manages contaminated sediments in rivers and lakes, only contaminated sediment remediation, which collects, purifies, and transports contaminated sediments, is defined as a new business, and the provisions on related facilities and capabilities should be prepared by applying mutatis mutandis Article 25 (5) of the “Waste Management Act.”, which stipulates on business related to movement such as collection and transport of waste. Diversity of purification technology is also required to the business operator. As mentioned above, in order to establish most optimized sediment treatment method for the domestic environment, it is essential that business operator have the technical skills for operating various methods such as MNA (Monitored Natural Attenuation), in-situ capping, and sorbent amendment as well as dredging. If technological diversity is on the basis, countermeasures will be better prepared which reflect ecosystem, economic factors, and time factors of the target site.

Penal provisions should be added. Effectiveness of the penal provisions in the “Marine Waste and Marine Contaminant Sediment Control Act.” is insufficient to regulate the contamination of marine sediments, because these penal provisions are not designed with

detail. (Kim, 2013) Therefore, the penalty provisions in the “Water Environment Conservation Act.” should be stipulated considering detail cases: whether the polluters have intentionality for the contamination or not, those who falsely report purification facilities or capabilities, etc.

Chapter 6. Conclusions and recommendations for follow-up studies

In this study, the direction of institutionalizing river and lake sediment management was investigated. To this end, the points for improvement were pointed out through the domestic sediment management system and related regulations, and the main matters necessary for the regulations were presented based on the relevant laws and systems at home and abroad. This can be summarized as follows.

First, matters related to sediment investigation, pollution control, and establishment of a master plan should be newly established and regulated in the current “Water Environment Conservation Act.”. This was due to the fact that the formation process of sediment and the process of contamination depend on the water system,

In the case of overseas referenced, it was found that sediments were managed in the regulations related to water systems.

Second, in view of the “Soil Environment Conservation Act”, which manages the soil most similar to the properties of the sediment, the contents that should be mainly included in the new provisions related to the sediment can be classified into the contents corresponding to the general rules and the detailed regulations. .

First of all, the general rules should include the definition of 'sediment' and 'sediment contamination', which are basically absent in the current law. Methods of measurement and analysis and provisions on the operation of relevant advisory committees should be included.

After that, the detailed regulatory measures include raising the standards for judging and worrying contamination, which remain at

the level of the regulations of the affiliated institution, to the legal level. In the event of sediment contamination, the priority of selection of the person in charge of purification, standards and methods of contamination purification, and risk standards It should include procedures for deciding whether to implement the project or not, and provisions related to direct government cleanup.

The following three items are suggested for further discussion in the future.

Firstly, it is necessary to establish risk standards based on information on the domestic ecosystem. contamination standards set by the National Academy of Environmental Sciences are different from the risk standards, and there is a limit in linking and judging which elements will actually harm the human body and the ecosystem how much. For example, in the case of a high concentration of heavy metals due to geographical characteristics such as Jeju Island, it is difficult to determine that there is a risk even if the concentration of heavy metals is high because the existing environment has a high background concentration. Therefore, objective judgment will be possible in determining the method of purification and treatment of sediments only when regional risk assessment standards that reflect background information on the domestic environment are prepared.

Secondly, it is necessary to study what factors will be reflected in the decision of sediment purification and treatment. Basically, purification of sediments costs a lot of money, and it takes a lot of time to identify the responsible person, so a lot of review is needed to carry out purification and treatment of polluted sediments. Therefore, it is necessary to review what factors such as economic factors and utility factors will be reflected in selecting

whether and how to proceed with the purification and treatment.

Finally, there are studies on techniques that can reveal the cleaning responsibility. First of all, with respect to the budget for contamination remediation of sediments, in most cases, a huge budget is required for remediation, so it is essential to accurately analyze the contribution rate when calculating the cost. Since most of the current contamination tracking is isotope-based tracking, various techniques for tracking contamination should be developed in order to increase the accuracy. In addition, it is also necessary to develop an analysis technique to shorten the time required for contamination tracking to minimize the spread of contamination. Therefore, as with the problems in the previous two areas, additional research should be conducted on whether there is a problem in analyzing the accurate contribution rate in the current tracking method and whether it is possible to shorten the analysis time to minimize the spread of contamination.

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초 록

지난 4대강 사업의 시작을 기점으로 우리나라의 담수 퇴적물의 오염현황에 대한 관심도가 높아졌다. 국내에는 담수 퇴적물을 관리하는 것과 관계된 법령 및 규정 등의 제도가 전무한 상태로 퇴적물들의 주기적이고 안정적인 관리가 다소 미흡한 실정이다. 또한, 제도적 근거의 부재는 국내 행정환경 상 국가 예산의 투입을 뒷받침할 수 없는 주요 요인으로 작용한다. 이러한 한계로 현재 담수 오염퇴적물 중 오염의 정도가 심함에도 불구하고 적절하게 처리되지 못한 채 남아있는 사례들이 발생하고 있다. 따라서 오염퇴적물의 처리 및 안정적 관리를 위해서는 제도적 근거 마련이 선결과제라 할 수 있다. 이에 본 연구에서는 국내 관계 법령 중 수저 퇴적물의 관리와 가장 관련성이 높은 “물환경보전법”의 개정을 통한 퇴적물 오염 관련 조항의 신설을 제안하고자 한다. 이를 위해 국내 제도 중 가장 관계가 큰 “토양환경보전법”, “해양폐기물 및 해양오염퇴적물 관리법”을 분석하고 개선 사항들을 도출하였으며, 하천 및 호소 오염퇴적물 관리 부문의 선진 제도인 미국의 “Clean Water Act.”와 “Comprehensive Environmental Response, Compensation and Liability Act.”를 분석하였다. 이를 토대로 “물환경보전법” 내 제정 및 개정이 필요한 사항들에 대하여 검토하였다. 오염퇴적물의 정화에는 막대한 비용과 시간이 소요되는 만큼 퇴적물 오염의 사전적 규제가 필요한 요소, 사후 오염퇴적물의 처리 과정에 대한 제도적 요소들과 관련하여 필요한 제도적 장치들을 제안하였다. 또한, 본 제도의 집행에 있어 오염퇴적물의 정화처리 진행 여부, 처리 방식의 결정, 국가지원 여부 등을 결정하는데 판단 논거를 부여할 수 있는 협의체를 구성할 것을 제시하였으며, 퇴적물 오염의 장기적인 방치를 막기 위해 정부가 선제적으로 퇴적물 정화를 추진할 수 있도록 별도 예산을 마련할 수 있는 방안들에 대하여 검토하였다.

주요어 : 퇴적물 관리, 담수 퇴적물, 오염 퇴적물, 물환경보전법 개정, 제도개선
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