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# The Republic of Korea's experience with an ocean dumping management system to enhance compliance with the London Protocol: highlights of major institutional history over 40 years

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Since the late 1980s, in efforts to reduce the burden of waste treatment on land and to protect the nation's rivers, the Korean government has licensed dumping at sea only for waste difficult to treat on land. However, owing to the "not in my backyard" (NIMBY) phenomenon and the higher cost of land-based treatment, the amount of ocean-dumped waste has increased rapidly. The categories of waste dumped have also expanded to include sewage sludge containing highly concentrated hazardous substances, raising concerns about damage to the marine environment. The Korean Ministry of Oceans and Fisheries has noted that compliance with the London Protocol could be essential for limiting ocean dumping activities. The Republic of Korea enacted comprehensive measures to ensure compliance and formally acceded to the London Protocol in 2009. This paper presents Korea's implementation of the criteria that led to the cessation of ocean dumping of sewage sludge in 2016.

## KEYWORDS

ocean dumping, London Convention, London Protocol, precautionary principle, marine environment

## 1 Introduction

The treatment and disposal of waste generated by the approximately 51.8 million people living in the narrow area of 100,378 km<sup>2</sup> that constitutes the Republic of Korea is a sensitive socioeconomic issue for Koreans (Statistics Korea, 2022). This has made it difficult to reduce the treatment burden on land while protecting rivers and coasts. As a result, since

1987, Korea has been dumping organic waste, such as high-salt molasses, into the surrounding ocean, where it can decompose through the ocean's self-purification ability. Securing space for waste disposal facilities (i.e., landfills, incinerators) presents a particular challenge due to Korea's rapid rate of urban expansion, the presence of NIMBY syndrome, and the fact that dumping at sea costs less than landfill use or incineration. A greater variety of waste, such as sewage sludge, is dumped at sea than on land, with more than 20 times as much waste dumped at sea in 2005 than in 1987 (Chung and Hong, 2014; Chung and Hong, 2016).

Compared to the other forms of organic waste dumped at sea, sewage sludge has a significantly higher content of hazardous substances, such as heavy metals from households and factories. Consequently, public concern has deepened over both the quantity and variety of waste dumped at sea (Song et al., 2015; Chung et al., 2017; Jung et al., 2019; Babar et al., 2022). In addition, as waste dumping at sea is internationally recognized as a global rather than domestic problem, the "London Protocol," which strengthened the effectiveness of the existing "London Convention: Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972" came into effect in 2006 (Figure 1). The London Protocol, which ultimately replaced the London Convention (LC), specifies a step-by-step application system for ocean dumping of waste. This dictates that the permission and monitoring of dumping sites should follow assessment guidelines of waste dumping at sea, based on the precautionary principle, the "polluter pays" principle, and reporting of dumping (IMO, 2014; Hong and Lee, 2015; Chung et al., 2020).

In the Republic of Korea, international law takes precedence over municipal laws. In this context, the Korean Ministry of Oceans and Fisheries (MOF) issued the "Comprehensive Measures for Management of Waste Ocean Dumping" in 2006 to regulate the handling of various organic wastes, such as sewage sludge, to ensure that procedures were in line with the London Protocol, and to phase out ocean dumping. The MOF also amended the Marine Environment Management Act (which was replaced by the Marine Waste and Marine Contaminated Sediment Management Act in 2021) (Figure 1).

Chung et al. (2020) summarized the outcomes of these measures in a report submitted to the Office of the London Protocol in 2016 (Hong and Chung, 2016). This paper highlights the progress of the policies created to phase out the ocean dumping of sewage sludge, and shares considerations gained through the improvement of Korean regulations and policies to accommodate

the London Protocol. To this end, the paper explicitly discusses the identification of problems in the ocean dumping of waste, improvement of the legal system, conflict management, and application of the London Protocol.

## 2 Materials and methods

### 2.1 Identification of problems with the surge in the ocean dumping of waste

Table 1 lists the types of organic wastes included in the "Comprehensive Measures for Management of Waste Ocean Dumping" in 2006 (Chung et al., 2020), according to how they are managed as sewage sludge in line with the London Protocol. There are four types of sewage sludge: 1) Sewage treatment sludge, the residues of which result from sewage treatment processes in treatment facilities; 2) Livestock manure, which consists of livestock excretions and other liquid mixtures generated by livestock farms or related facilities; 3) Food waste leachate generated from food waste treatment plants; and 4) Wastewater treatment sludge generated from wastewater treatment facilities.

Ocean dumping of organic wastes, such as the four types of sewage sludge listed above (Table 1), is preferred to landfill use because the cost of ocean dumping is half that of incineration (Hong and Chung, 2016). Additionally, although waste must be managed in the order of reduction, recycling, incineration, landfilling, and dumping at sea, ocean dumping was the best-preferred option due to 1) the prohibition of direct landfilling of organic sludge; 2) exemption from the installation of treatment facilities in the case of dumping of livestock manure at sea; and 3) the prevalence of NIMBY syndrome regarding the installation of waste treatment facilities.

The factors that led to the preference for ocean disposal are listed in Table 2. For example, because of the destabilization of landfills by organic sludge and the generation of large amounts of unfavorable gas, direct landfilling of organic sludge has been prohibited since 2003. Moreover, the requirement to install livestock wastewater treatment facilities has been exempted since 2002, when all livestock wastewater generated from livestock wastewater discharge facilities was entrusted to a marine discharger.

In particular, although the amount of waste is increasing rapidly due to the improved quality of life, the lack of a recycling policy,

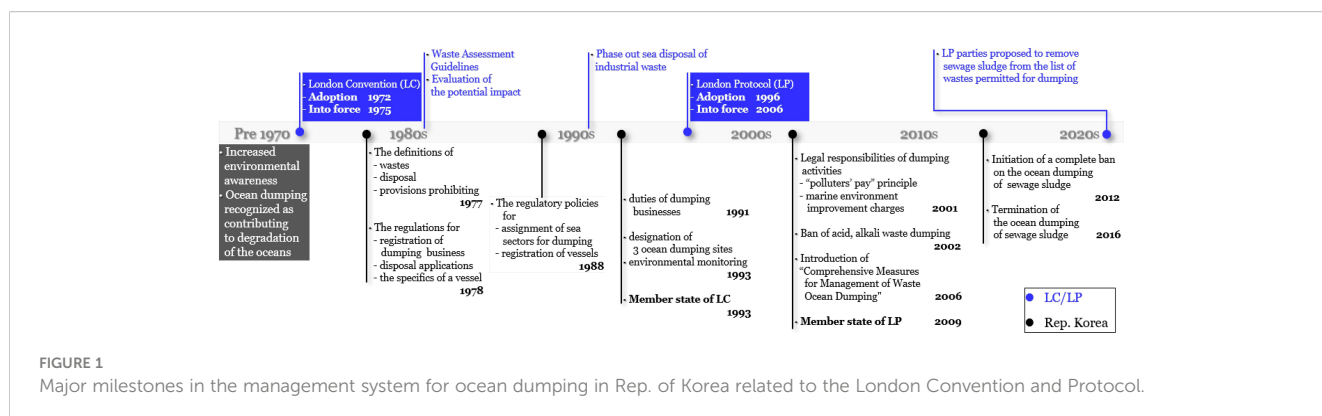


TABLE 1 The types of organic wastes managed as sewage sludge in Rep. of Korea.

Types	Definition	Sources	Remarks
Sewage treatment sludge	Residues resulting from sewage treatment processing	Sewage treatment facilities operated by government agencies	Ocean dumping was banned in Jan. 2012.
Livestock manure	Liquid mixtures consisting of livestock excretions and water used for raising livestock or sludge generated from treating such liquid mixtures	Pig farms or livestock excretion treatment facilities	Ocean dumping was banned in Jan. 2012.
Food waste leachate	Leachate generated from treating food waste	Food waste resource plants as compost and feed	Ocean dumping was banned in Jan. 2013.
Wastewater treatment sludge	Sludge resulting from wastewater treatment processing	Wastewater treatment facilities	Marine disposal was banned in principle in Jan. 2014 (but was permitted temporarily for two years, only for cases in which its inevitability was proven).

awareness of ocean waste dumping, and the absence of macroscopic marine environmental policies have made ocean dumping the preferred option for waste management, and one that Korea is highly dependent on (Chung and Kim, 2008; Chung et al., 2020).

### 3 Results

#### 3.1 Improving the legal system governing ocean dumping for accession to the London protocol

The Republic of Korea’s first law regarding ocean waste dumping was “the Marine Pollution Prevention Act” promulgated

TABLE 2 Preference factors for ocean waste dumping (Chung and Hong, 2016).

Preference factor	Contents	Remark
Prohibition of direct landfilling of organic sludge	The prohibition of direct landfilling due to the destabilization of organic sludge landfills and the generation of large amounts of unfavorable gas	Effective from July 2003
Exemption from the installation of livestock wastewater treatment facilities	Exemption from the requirement to install livestock wastewater treatment facilities if all livestock wastewater generated from livestock wastewater discharge facilities is entrusted to a marine discharger	Effective from November 2002

in 1977. This act defined ocean waste dumping for the first time, and had already been amended several times through the addition of new regulations to establish the management system of ocean dumping before ocean dumping commenced in 1987 (Table 3).

Waste dumping regulations were established in 1978 with the enactment of the Enforcement Decree of the Marine Pollution Prevention Act. The registration system was implemented on July 1, which required owners to register waste transport vessels with the Maritime and Port Administration Commissioner. The facilities, structures of the registered vessels, method of transporting waste, and other necessary matters were prescribed by the Ordinance of the Ministry of Transport with the local Maritime Affairs and Port Administration. In the 1980s, application requirements for ocean dumping were regulated more precisely to reflect the provisions of the London Convention.

In 1993, following revisions to the enforcement regulations of the Marine Pollution Prevention Act, three waste dumping sites (Yellow Sea-Byeong, East Sea-Byeong, and Jeong) were designated. Sludge from sewage treatment plants and purified water treatment sludge were newly defined as wastes permitted for ocean dumping. The criteria applied to the centralized and dispersed dumping methods were also changed to classify wastes into solid and liquid phases and to set clear parameters around each criterion. After establishing a legal system for ocean dumping in November 1993, the Republic of Korea acceded to the London Convention.

With the establishment of the MOF in 1996, responsibility for ocean waste dumping was transferred from the Ministry of the Environment to the MOF. The duties of designating waste dumping sites, registering waste dumping companies, reporting waste imposition, and collecting marine environment improvement charges were in turn entrusted to the head of the Maritime Police Station. These tasks were later transferred to the regional ocean and fisheries offices in 2014 (Figure 2).

Based on Articles 3.1 and 3.2 of the London Protocol, the Act was amended to introduce the “polluter pays” principle in 2001, which holds the polluter responsible for paying the cost of the pollution they cause. A provision for a marine environment improvement charge was also included. In 2002, a new method for calculating this levy was established in the Enforcement Decree of the same act. This decree required payment of the marine environment improvement levy for marine dumping, and use of the levy to fund the research project titled “Development of the Best Practical Technology and Management Options for the National Disposal of Wastes at Sea.”

In 2008, with the transition from the Marine Pollution Prevention Act to “the Marine Environment Management Act,” a new article was enacted to give precedence to the international convention and hold polluters accountable as part of the efforts to protect the marine environment under the London Protocol. The Republic of Korea formally acceded to the London Protocol in 2009 after establishing a legal framework for its implementation.

Sewage treatment sludge and livestock manure, which accounted for 80% of total ocean dumping, were banned in 2012, and food waste leachate was banned in 2013. Furthermore, based on the precautionary principle of the London Protocol, the remaining 20% of sludge from wastewater treatment plants would only be dumped at sea if on-land treatment methods could not treat it.

TABLE 3 History of significant revisions to ocean dumping policy of the Rep. of Korea.

1977	1987	1991	1993	2001
<ul style="list-style-type: none"> <li>Enactment of the Marine Pollution Prevention Act</li> <li>Classification of industrial waste disposal method and designation for waste-dumping sites</li> </ul>	<ul style="list-style-type: none"> <li>Establishment of action lists and levels by waste type</li> <li>Designation of dumping sites by type</li> </ul>	<ul style="list-style-type: none"> <li>Specification of the method of dumping at sea (centralized, dispersed dumping)</li> <li>Classification of waste types (sludge, dredged material, etc.)</li> </ul>	<ul style="list-style-type: none"> <li>Accession to the London Convention</li> <li>Designation of current dumping sites</li> <li>The new addition of sewage sludge to the waste list of materials considered for dumping</li> </ul>	<ul style="list-style-type: none"> <li>Application of the “polluter pays” principle (Establishment of Marine Environmental Improvement Fund)</li> </ul>
2004	2006	2007	2008	2009
<ul style="list-style-type: none"> <li>Food waste leachate is added to the list of materials considered for dumping</li> </ul>	<ul style="list-style-type: none"> <li>Application of the London Protocol (Deletion of waste against the LP)</li> <li>Establishment of comprehensive measures for waste dumping at sea</li> </ul>	<ul style="list-style-type: none"> <li>Promulgation of the Marine Environment Management Act</li> </ul>	<ul style="list-style-type: none"> <li>Establishment of the priority principle of international conventions, and the principle of responsibility for polluters</li> <li>Reinforcement of pollution levels for dumping</li> </ul>	<ul style="list-style-type: none"> <li>Accession to the London Protocol</li> </ul>
2010	2012	2013	2016	2021
<ul style="list-style-type: none"> <li>Application of bioassay for dumping and establishment of beneficial use of dredged material</li> </ul>	<ul style="list-style-type: none"> <li>Prohibition of sewage treatment sludge dumping (including livestock manure)</li> </ul>	<ul style="list-style-type: none"> <li>Prohibition of dumping of food waste leachate</li> </ul>	<ul style="list-style-type: none"> <li>Prohibition of all types of sewage sludge dumping, including wastewater treatment sludge</li> </ul>	<ul style="list-style-type: none"> <li>Promulgation of the Marine Waste Management Act</li> </ul>

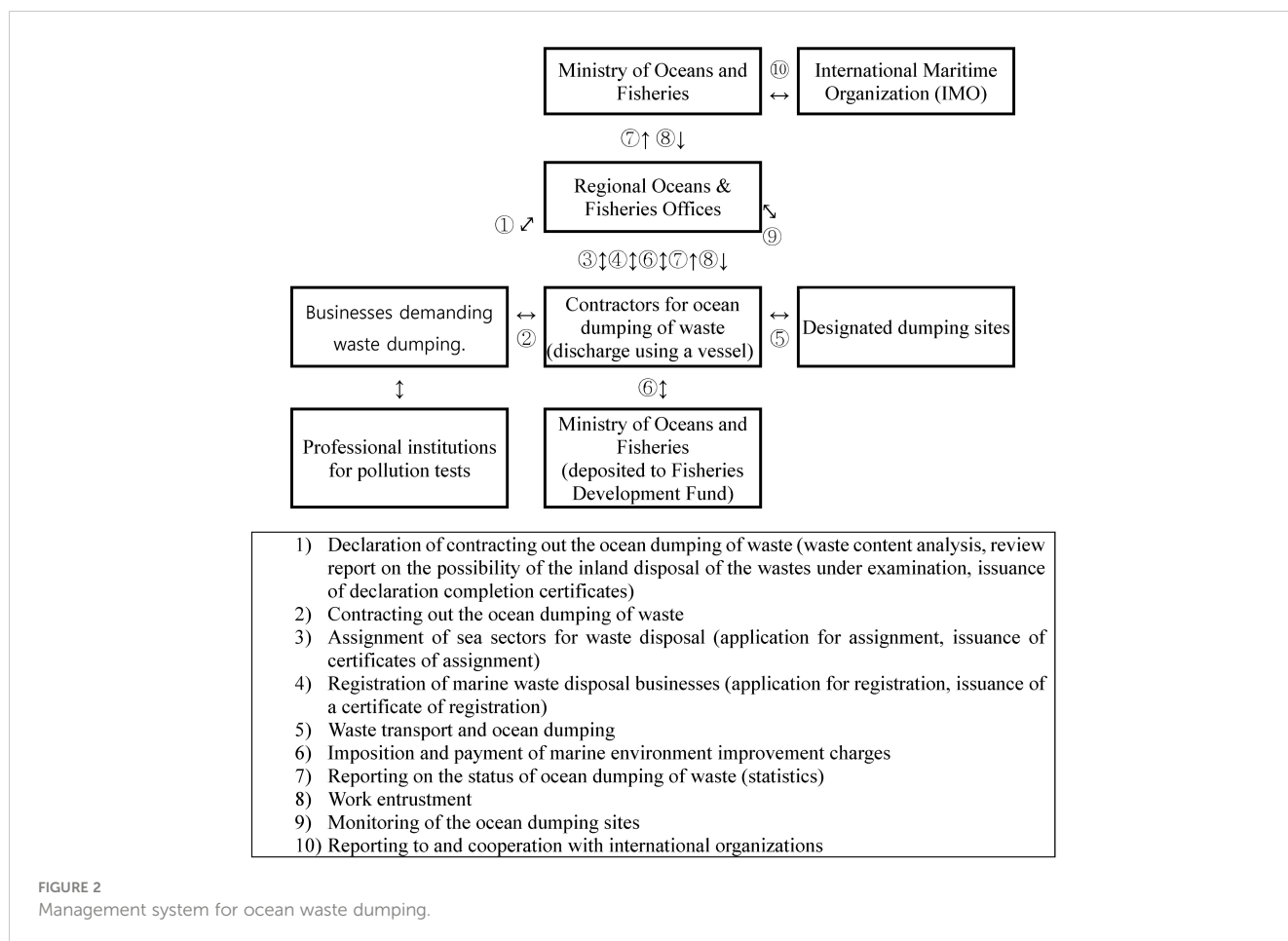


FIGURE 2 Management system for ocean waste dumping.

In 2021, “the Marine Waste and Marine Polluted Sediment Management Act” (aka “Marine Waste Management Act”) was enacted to manage ocean waste dumping efficiently, specifying the beneficial use of dredged materials and the remediation of contaminated sediment.

### 3.2 Stakeholder conflict management and public relations

Strengthening of regulations is inevitable to minimize the environmental impact caused by ocean waste dumping and to improve the regulatory framework’s compliance with the London Protocol. However, stakeholders’ conflicting opinions are always present in the policy-making process.

Stakeholder conflict management to improve the legal system involves analyzing conflict factors (Table 4); collecting the reasons for preferring ocean dumping over land treatment, and analyzing the relevant best practices of local governments that have overcome barriers to ocean dumping (Table 5); making efforts to resolve conflicts and achieve consensus, such as by providing a preparation period for a soft landing to reduce ocean dumping, and reaching an agreement through stakeholder participation and communication.

As shown in the institutional history of ocean waste dumping in Table 3, the MOF established a comprehensive plan for waste ocean dumping management in 2006. This plan aimed to end the ocean dumping of sewage sludge and set a specific target year for the banning of ocean dumping for each type of waste over the next ten years, giving stakeholders a reasonable preparation period. Finally, ocean dumping of all types of sewage sludge was banned as of 2016.

The MOF also promoted exemplary land treatment cases by local governments, maintained legal and policy cooperation with other government ministries, and supported the development of new alternative technologies that could replace ocean dumping by securing related budgets.

### 3.3 Policy that led to the ban on sewage sludge ocean dumping

Applying the precautionary principle, the London Protocol stipulates that wastes exceptionally permitted for ocean dumping in Annex 1 must follow the step-by-step evaluation procedure set out in Annex 2. Additionally, there is also a notable domestic and international trend toward using waste as a resource rather than a target for disposal. To comply with the London Protocol on the Principle of Land Treatment, an analysis of the preference factors for ocean dumping and cooperation among government ministries facilitated waste recycling (Table 6). This ultimately became the basis for the 2016 ban on the ocean dumping of sewage sludge.

## 4 Discussion and conclusion

The London Protocol emphasizes more stringent measures surrounding ocean dumping and the prevention and elimination of

TABLE 4 Conflict factors for stakeholders regarding ocean dumping (Chung and Hong, 2016).

Stakeholders	Critical issues
Businesses contracting out ocean dumping (ocean dumping waste generators)	High costs for changeover to inland treatment
	Lack of technologies for inland treatment
	Insufficient inland treatment/disposal facilities
	Lack of a legal system for inland treatment
Businesses engaged in ocean dumping with their vessels	Bankruptcy risks due to the banning of ocean dumping
	Government compensation issues for accepting the policy
Fisheries	Government support for transition to other businesses
	Banning ocean dumping to secure the catch of fishery products
Businesses engaged in inland treatment/disposal	Compensation for damage caused by contamination of fishery products
	Banning ocean dumping
Environmental organizations/ international environmental treaties (LC & LP)	The firm commitment of the government to inland treatment
	Banning the ocean dumping of waste to comply with the LC/LP
	Compliance with the principle of inland treatment

pollution, and highlights the precautionary approach as part of its “General obligations.” The Republic of Korea is surrounded by seas on three sides and is economically dependent on marine resources and marine space, including aquatic resources. Recognizing that compliance with the provisions of the London Protocol was an essential step toward curbing ocean waste dumping, the MOF established a comprehensive plan for waste dumping at sea in 2006

TABLE 5 Significant barriers to ocean dumping and local governments’ troubleshooting of these barriers (Chung et al., 2016).

Barriers	Troubleshooting
Inhabitants’ objections	<ul style="list-style-type: none"> <li>PR for the installation of treatment facilities</li> <li>Local bidding of proposals and residents’ participation</li> <li>Endeavors to address local complaints (reduction of odors, etc.)</li> </ul>
Improper facility design (lower operation efficiency)	<ul style="list-style-type: none"> <li>Selection of qualified contractors</li> <li>Enhanced supervision and inspection</li> </ul>
Insufficient alternatives to replace ocean dumping	<ul style="list-style-type: none"> <li>Use of the existing facilities under local conditions (e.g., sewerage, facilities belonging to other local governments, local government-owned landfill sites, private incineration facilities)</li> </ul>
Insufficient budget	<ul style="list-style-type: none"> <li>Strive to secure budgets (persuading relevant ministries and local councils)</li> </ul>

**TABLE 6** Examples of cooperation with related authorities to facilitate the recycling of sewage sludge.

Related ministries	Revisions
Ministry of Environment	<ul style="list-style-type: none"> <li>- Enables the use of sewage sludge as a substitute for coal in thermal power plants (within 5% of total fuel consumption) (August 2008/Enforcement Rule Annex 5)</li> <li>- Enables the use of sewage sludge as raw material for green soil on slopes (January 2010/Enforcement Rule Attached Table 5)</li> <li>- Organic sludge and food wastes are allowed to be used as supplementary fuel for cement kilns, for soil cover at landfill facilities or as land improvement agents, as adsorbents after the carbonization of food, as well as for organic waste energy recovery and anaerobic digestion (September 2011) ⇒ In 2011, “waste recycling standards and specific recycling methods (Appendix 5-2)” were newly enacted to concretize recycling rules.</li> <li>- Reduction of waste from the source itself is targeted by implementing the volume-based food waste system (fees are charged according to the amount of waste)</li> <li>- Prohibited use of kitchen waste shredder is introduced (1995) ⇒ Permission for a pilot project (2009) ⇒ Permission to use a certified product (2012/Ministry of Environment Notice: When more than 80% of solids are recovered)</li> </ul>
Ministry of Agriculture, Food and Rural Affairs	<ul style="list-style-type: none"> <li>- Deletion of exemption from the installation of treatment facilities when all livestock manure is entrusted to marine dischargers (September 2009)</li> <li>- Introduction of quality standards and inspection standards for compost and liquid manure (water manure) made from livestock manure: The compost and liquid manure produced to turn livestock manure into recycling resources is prescribed by Presidential Decree (February 2014)</li> <li>- Added compost fertilizer made from livestock manure to be used on golf courses and in forests (July 2011)</li> </ul>

to improve the existing laws and systems and pave the way for acceding to the London Protocol in 2009. Along with these efforts, the Korean government, in cooperation with the Ministry of Environment, has been pushing for continuous revision of regulations to induce a soft landing in terms of the demand for recycling (Table 6).

Since 2012, the ocean dumping of sewage sludge, which accounts for the majority of the ocean waste dumped, has decreased. In 2016, the ocean dumping of all types of sewage sludge was banned. The success of these policy directives in Korea was due to the swift and rigorous application of policies that strengthened the level of surveillance, close cooperation

between governments, and the formation of a consensus among stakeholders and local communities. In addition, the MOF has continuously monitored dumping sites to observe the recovery process in contaminated areas.

Finally, The Republic of Korea’s cessation of ocean dumping of sewage sludge in 2016 accelerated the revision of Annex 1 of the London Protocol, which aims for the complete banning of ocean dumping of sewage sludge. The complete ban was enacted at the London Convention/Protocol meeting of contracting parties in October 2022 (IMO, 2022).

## Author contributions

C-JK: Conceptualization, Writing – original draft. CC: Conceptualization, Project administration, Writing – original draft. K-HS: Writing – review & editing. K-YC: Writing – original draft, Writing – review & editing.

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