Article

Analysis of the Discriminatory Perceptions of Victims on Damage from Environmental Pollution: A Case Study of the Hebei Spirit Oil Spill in South Korea

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Abstract: Environmental pollution causes severe damage to local communities, which is perceived differently by different victims, that is, the damage is discriminatory. However, previous studies have not focused on this aspect. Here, we explored the perceptions of different victims of the Hebei Spirit oil spill incident of Korea. Additionally, we explored the importance of considering discriminatory aspects of damage when planning recovery governance. The damages from the oil spill were analyzed using a text mining technique for each subject based on factor analyses. Women and residents older than 60 years were interested in the social relations of the village community; residents in their 40s, who were raising children and teenagers, were interested in the economic aspects; boat fishermen, who had discontinued fishing to participate in the pollution response activity in the early stages of the incident, were interested in disaster prevention; and women divers were interested in health issues. Hence, restoring the economy and environment and reversing indirect social damages are essential for recovery from pollution damage. Furthermore, governance for recovery must not exclude specific victims based on the discriminatory aspects of damages. A political process is necessary to secure the validity of governance and alternatives by involving different victim groups.

Keywords: environmental pollution; Hebei Spirit oil spill; pollution damage; local fishing communities; damage recovery; discriminatory aspects

1. Introduction

Industrialization has resulted in unparalleled exponential economic prosperity. However, it has also led to small- and large-scale environmental pollution incidents, which have caused biophysical damages to the environment, and fatal damages to humans and society, including irreversible damages to physical health, contractions in economic activities, social conflict, and psychological stress [1–3]. These consequences affect the victims of environmental pollution differently according to their socioeconomic conditions [4,5]. Differences in the degree of damage to work and health undermine the relationships among community members and may cause conflicts [6,7]. Therefore, the different detrimental effects of environmental pollution on stakeholders should be investigated [8,9].

Identifying the types of discriminatory damages affecting victims is essential not only for comprehensively understanding the social impact of environmental pollution incidents on humans, but also for developing policies for post-disaster recovery. However, the majority of previous studies have focused only on the participation and cooperation of victims [10–12], failing to expand their research scope to include the types of damages experienced by different people and how different perceptions of damage affect the recovery process. Damage from environmental pollution reinforces pre-existing inequality [13] as it can tremendously affect socially weak people, who require more time for recovery. Thus, damage is discriminatory depending on the socioeconomic conditions of the victims. The

recovery approach focuses on the majority of the population, creating inequalities among minorities, thus leading to local conflicts [14].

Within this context, the purpose of this study was to analyze the different perceptions of damage among victims of a large-scale marine oil spill incident that occurred in the west sea of Korea in December 2008. Perceptions of damage were analyzed through the text mining of victim interviews to identify potential recovery measures and governance suggestions. The communities living near the location of the incident suffered severe damages from the marine pollution as they were highly dependent on marine resources [15], resulting in various damages to the fishery and tourism industries, and conflicts in the process of compensation. The fishing village of Sowon-myeon (Chungcheongnam-do), which is located near the oil spill site, suffered the most severe damages [16]. We examined the different aspects of the damages using transcripts of in-depth interviews conducted with the residents of Sowon-myeon. The text mining technique used was based on factor analysis and was used to analyze the transcripts of each victim to identify the characteristics of each stakeholder [17]. Through this technique, we aimed to identify stakeholders with different victim characteristics, and to suggest ways to pace the post-disaster recovery process with their cooperation and strong policy modifications based on the perceptions of victims.

2. Materials and Methods

2.1. Study Sites

On 7 December 2007, a Hong Kong-registered crude oil tanker, Hebei Spirit (146,848 tons), collided with a crane barge owned by Samsung Heavy Industries (11,828 tons) off the coast of Taean-gun, spilling oil that spread 12,547 kilometers into the sea [18–22]. The oil spill caused severe environmental pollution in the coastal waters of Taean-gun, on the west coast of Korea. In particular, the Sowon-myeon area close to the accident site suffered the most serious damage. The peninsula region is famous for various primeval fishing and tourism businesses.

The study sites (Figure 1) included three fishing villages: Uihang, Mohang, and Gauido. The wide tidal flats on the east coast of Uihang supported the development of shellfish hand-fishing, such as oysters and clams. The majority of the residents depend on hand fishing for their livelihoods as boat fishing has been developed on a smaller scale. In contrast, small tidal flats occur in Mohang, and boat fishing has been developed near the port. Thus, Mohang is one of the representative boat fishing areas in the northern region of Taean. Additionally, multiple Korean fisherwomen called haenyeos live near the port. Gauido is an island village located 5 km away from the coast. Despite the absence of tidal flats or ports, the village depends on the hand fishing of seaweed, such as sea mustard on coastal rocks. Tidal flats and coastal rocks, which are major fishing grounds for Uihang and Gauido residents, serve as common resources shared among the neighboring residents. As these regions are located near the oil spill site, residents of the three villages suffered severe environmental damages resulting from oil reaching the coastline, and multiple social disasters due to the disruption of traditional economic activities that depended on marine resources [15].

2.2. Research Methodology

In-depth interviews with residents belonging to the three fishing villages and with different socioeconomic backgrounds were conducted to explore the discriminatory aspects of damages caused by the Hebei Spirit oil spill. Subsequently, transcripts were analyzed using text mining to understand the victim characteristics of each stakeholder. Previous text mining analyses have either focused on analyzing interviewees' opinions as one [23,24], or on investigating only the socioeconomic conditions of the stakeholders previously classified by the researcher [25,26]. However, these analysis techniques were limited as the opinions of minorities, who were not selected by the researchers, were not revealed. Thus, in this study, text mining was used for each subject to analyze the words commonly used by each victim group.
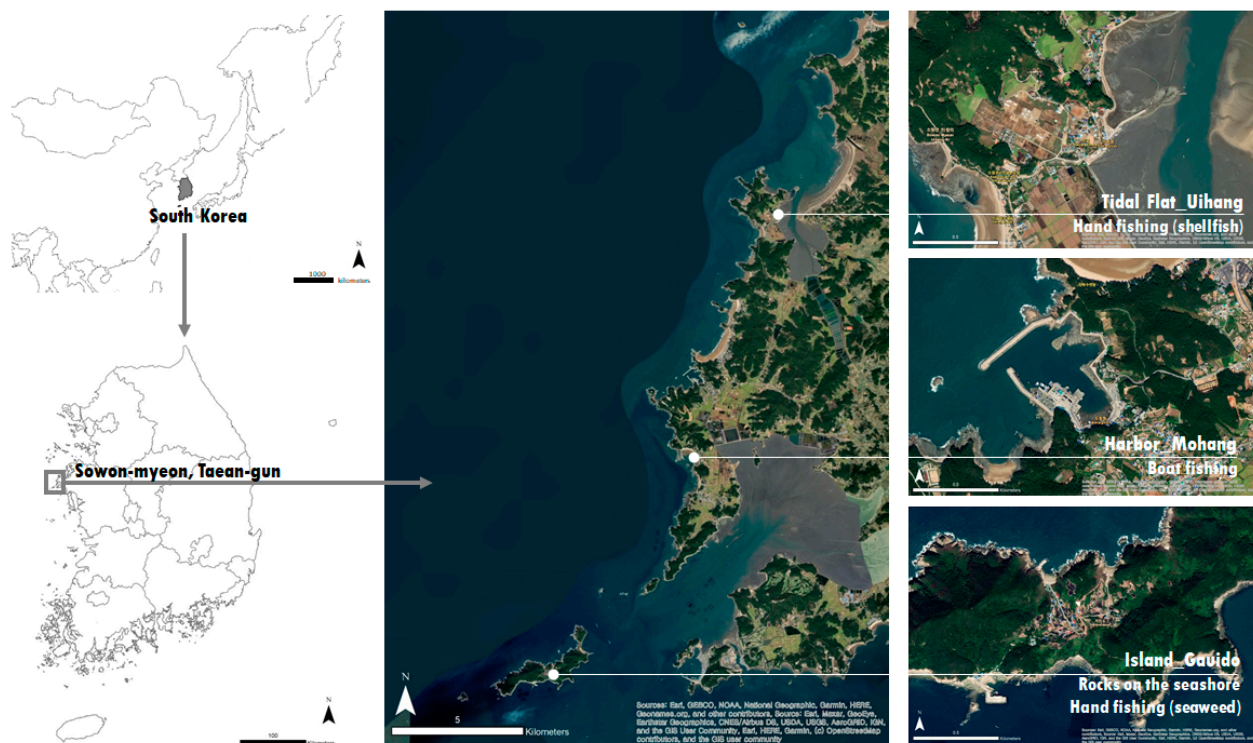
Figure 1. Geographical location of the study sites.

The steps were as follows (Figure 2): First, in-depth interviews on the damage patterns of the oil spill incident were conducted with the affected residents of the three above-mentioned villages. Interviews were conducted in February 2008, immediately after the accident, after one year, and between February and March 2019. Entire interviews were recorded and their transcripts were prepared manually using a computer. Many different, but synonymous, words used by the interviewees were unified by the researcher for consistency, and the minutes of the sessions were organized.
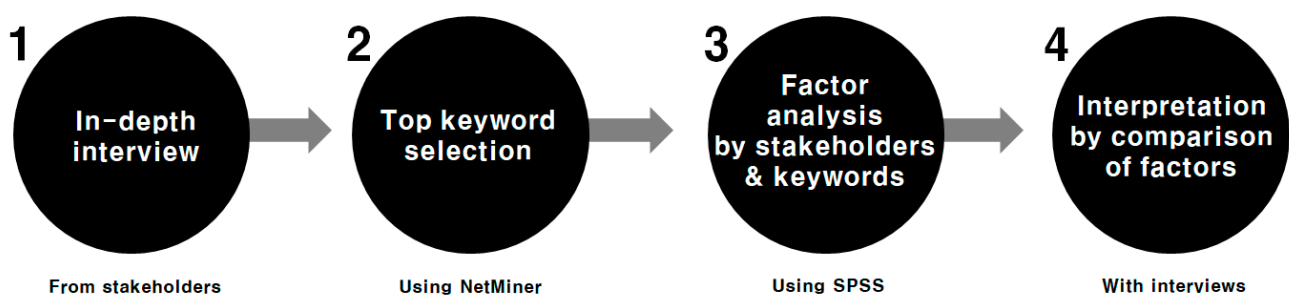
Figure 2. The text mining process.

Second, the morphemes from the summarized interview transcripts were analyzed. In this analysis, nouns that were frequently used and could have a meaning alone were determined for their main meaning in the discussion [27], and the words among the top 10% frequently used words were selected as keywords. This step was executed with NetMiner 4.3, which can be used to conduct Korean morpheme analysis.

Third, factor analysis was conducted by converting the number of occurrences of the keywords of the stakeholders into a matrix. Factor analysis for text mining by subject was used to identify the keywords mainly used by each stakeholder and to calculate the ratio of

keywords to the length of the entire interview. The SPSS 22.0 software was used to execute factor analysis.

Fourth, interpretation of the differences in the perception of damage by stakeholders was performed by comparatively analyzing the message characteristics for each major factor and the relevant stakeholders. By examining the actual interview sentences together, it was possible to sufficiently confirm the meaning of the discussion by each stakeholder. Based on this, the different aspects of damage according to the stakeholder, customized recovery alternatives, and the direction of recovery governance were estimated according to their interview responses.

3. Results

All participants provided informed consent. The Hebei Sprit oil spill accident disrupted the main industries of the region, such as fishing and tourism. Oysters, clams, sea cucumbers, and abalone farms using the natural conditions of the west coast were destroyed, and fish caught by fishing boats were also polluted. In addition, restaurants and lodging facilities near the beach were also closed. The in-depth interviews involved discussions with the local residents who lived on islands, tidal flats, and ports that were affected by such damage and were engaged in fishing and tourism. A few environmental nongovernmental organization (NGO) activists and public officials who participated in the recovery process were also included in the interviews. The major occupations of the victims affected by the Hebei Spirit oil spill, who participated in the study, are shown in Table 1.

Table 1. Major economic activities of affected residents who participated in the in-depth interviews.

Division	Number of People	Major Occupations
Tidal Flats	34	Hand fishing, bed and breakfast, raw fish restaurants, other restaurants, pastors, etc.
Harbor	43	Boat fishing, hand fishing, lodging, agriculture, haenyeos diving, etc.
Island	23	Boat fishing, hand fishing, bed and breakfast, agriculture, etc.
Others	6	Environmental NGO, officers, employees of disaster prevention companies, special committee, etc.

In-depth interviews were conducted, and frequently used nouns were extracted as keywords by analyzing the morphemes in the summarized interview transcripts. In this process, general words that lacked detailed information [27] and those that were difficult to understand individually were excluded. Consequently, the word "village" appeared 85 times, and nouns that appeared nine times (corresponding to 10% of the number of appearances of "village") or more were extracted as keywords (Table 2).

Table 2. Main keywords.

Rank	Keyword	Frequency	Rank	Keyword	Frequency	Rank	Keyword	Frequency
1	Village	85	14	Sisterhood	27	26	Health	14
2	Resident	63	14	Conflict	27	28	Expense	12
3	Livelihood	62	16	Operation	25	28	Organization	12
4	Disaster prevention	54	17	Opinion	24	30	Current status	11
5	Work	49	18	Performance	22	30	Problem	11
6	Pay	40	19	Activity	20	32	Recovery	10
6	Change	40	20	Compensation	18	32	Fishing village fraternity	10
8	Damage	38	20	Issue	18	35	Fishing vessel	10
9	Relationship	35	22	Kindness	16	35	Difficulty	9
10	Haenyeo	33	22	Fairness	16	35	Labor	9
10	Living expenses	33	22	Countermeasure	16	33	Public	9
12	Samsung	33	25	Fishing	15			
13	Participation	32	26	Income	14			

As a result of factor analyses (Table 3), 20 factors with a factor loading of 1 or higher were extracted. However, as multiple factors can cause difficulty in analysis, in this study, we extracted four factors with a factor loading of 7 or higher, below which the factor score rapidly decreases [28,29]. Additionally, research subjects with a significant factor loading ($p < 0.01$) of 0.4644 or higher were analyzed to investigate the distribution of stakeholders by each factor [30,31].

The four factors that were derived were as follows: Factor 1, a group that showed interest in the village community; Factor 2, a group interested in disaster prevention; Factor 3, a group concerned with the threats to livelihood; and Factor 4, a group interested in health issues. Thus, the following different aspects of environmental pollution damage were revealed: the village community represents social relations, including conflict between residents and psychological distance after the incident; disaster prevention work indicates environmental remediation; threat to livelihood reflects economic aspects; and haenyeos highlighted physical health issues. Table 4 (Appendix A Table A1) presents more details regarding the aspects revealed.

Figure 3 presents the distribution of stakeholders by the extracted factor. In terms of gender, the results indicate that women showed more interest in Factor 1 (village community) than men, that is, they expressed more concern about the weakening of the community after the accident, including damage to the social relations between neighbors. In terms of age, residents in their 40s were highly interested in the economic aspects of Factor 3 (threat to livelihood), while those in their 60s showed interest in the environmental aspects of Factor 2 (disaster prevention). Residents older than 60 years were concerned about the social relations of Factor 1 (village community). Furthermore, residents in their 40s were directly responsible for the education and rearing of children, and those older than 60 considered the damages to the ancient community relationships as direct damages from the incident.

Regarding the type of fishing, hand-fishing residents who shared tidal flats and coastal rocks frequently mentioned Factor 1 and Factor 3, boat fishing residents traveling to sea to catch fish spoke frequently about Factor 2, and haenyeos mentioned Factor 4. As tidal flats used for hand fishing are a shared resource, residents engaged in hand fishing developed a strong communal relationship by working together. Although boat fisherpeople could go to less polluted sea areas on fishing vessels, hand fisherpeople working on tidal flats could not resume work until the tidal flats were cleaned. Therefore, hand fisherpeople were relatively more sensitive to the damage to social relations and threats to livelihood than other fisherpeople were.

Boat fisherpeople showed interest in Factor 2 because of their active participation in disaster prevention work immediately after the oil spill. During the early stages of the incident, the government encouraged active involvement from fishing vessels near the oil spill area, as removal of the spilled oil based solely on disaster prevention capability was difficult. As this was an emergency, the costs of participating in disaster prevention work instead of continuing fishing were not discussed in advance. Therefore, boat fisherpeople who helped during the early stages of the incident expected fair compensation of their work.

Notably, haenyeos frequently mentioned Factor 4. As they collect seafood underwater without oxygen tanks, the majority suffered from decompression sickness even before the oil spill. Furthermore, as the haenyeos had developed a strong psychological relationship with the sea by working in deep waters without diving equipment for a long time, damage to the sea invoked a strong sense of helplessness in them. Consequently, haenyeos complained of stronger psychological stress compared with other victim groups.

In summary, women older than 60 years, and residents fishing by hand in the shared resources of tidal flats and coastal rocks were relatively more interested in the village community, that is, social relations, than other residents were. Boat fisherpeople, who stopped fishing and actively participated in disaster prevention work in the initial days of the incident, were more interested in disaster prevention. Lastly, women-only haenyeos showed greater interest in health issues.

Table 3. Factor analysis results.

Component	Initial Eigenvalue			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative Rate (%)	Total	% of Variance	Cumulative Rate (%)	Total	% of Variance	Cumulative Rate (%)
1	17.024	17.920	17.920	17.024	17.920	17.920	12.780	13.453	13.453
2	8.940	9.410	27.330	8.940	9.410	27.330	11.491	12.096	25.549
3	8.304	8.741	36.072	8.304	8.741	36.072	9.473	9.971	35.521
4	7.375	7.763	43.835	7.375	7.763	43.835	7.898	8.314	43.835

Table 4. Main keywords of each factor.

| Factor	Keywords	Z Value	Interviews
Factor 1 (Village community)	Village	5.16921	After the oil spill incident, everyone is living on the edge. The fishing village fraternity suffered a lot. Those in charge, including the village head, worked a lot. They lost their temper due to hard work. They had to travel constantly between the district office and Suhyup. Since the incident, the residents do not really help each other. Very stingy, nobody would care if I died. (A woman living near tidal flats.)
Factor 2 (Disaster prevention)	Disaster prevention Work Participation Pay Resident Relationship Sisterhood	2.28808 2.06937 1.30789 1.09171 1.08656 1.07258 1.00133	When the crude oil spilled, we were completely helpless. The most practical solution was to use an emulsifier to push the oil down. Blue crabs are usually caught at approximately 30 m underwater. Crude oil inside their body indicates that oil has been deposited. In areas with tidal differences, the amount of deposition is significant. We were given labor wages for 20 days only for disaster prevention. The total amount of damage and disaster prevention cost exceeded KRW 300 billion.They had to provide KRW 300 billion by reducing some percentage of the disaster prevention cost. That is why they cannot pay wages now. (Men living near the port.)
Factor 3 (Threat to livelihood)	Resident Damage Livelihood Issue	3.30339 2.56108 2.51501 1.30707	Here, everything that comes out of the fishing ground is money; clams and oysters, they are money; 99% is cash. But after the accident, our means of livelihood have completely disappeared. (A man living near tidal flats.)
Factor 4 (Health)	Haenyeo Issue Health Disaster prevention	3.97013 1.52811 1.32 1.06222	I participated in disaster prevention work. There was nothing that I can do apart from that. However, I have not been paid yet. The oil smell is nauseating; it makes me vomit and dizzy. My health is failing. I keep getting phlegm, and my vision has suddenly gone bad. I participated in disaster prevention work. I came here to work, but since the accident occurred, I hoped to help. I got paid for the work as well. (Haenyeo living near the port.)
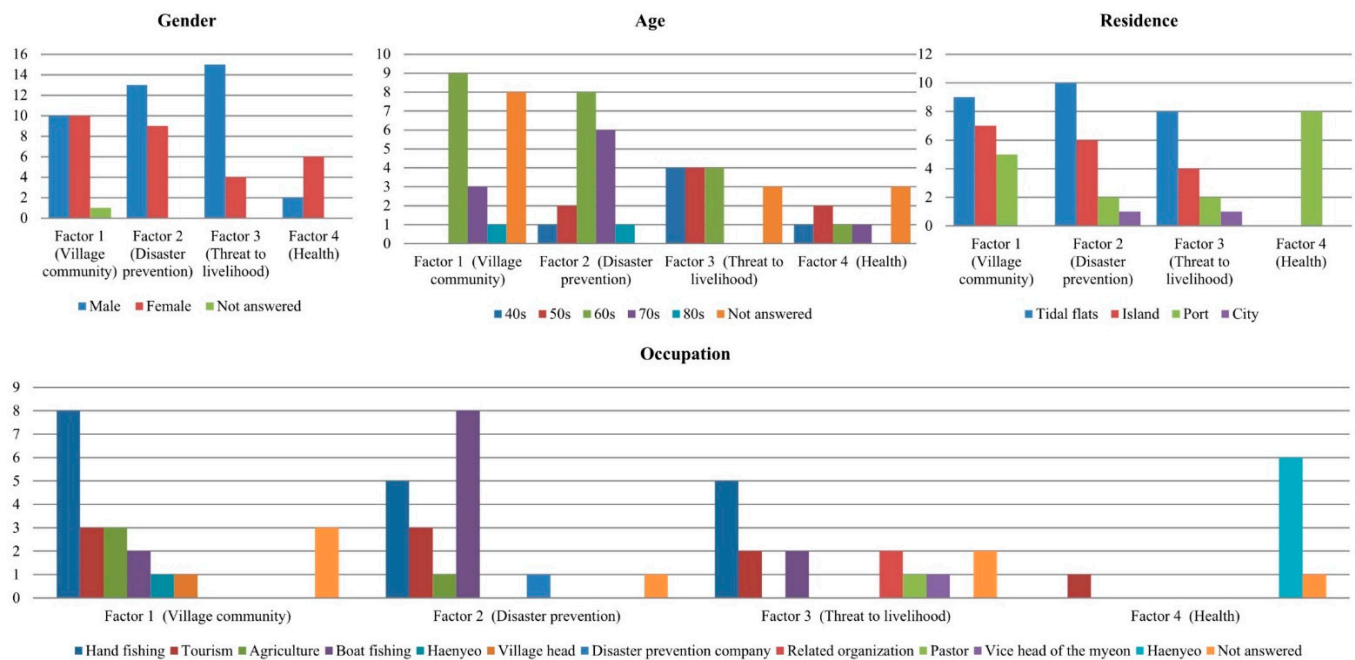
Figure 3. Distribution of stakeholders by factors.

4. Discussion

As environmental disasters are based on a specific environmental change, developing alternatives in response to different damage patterns that reflect regional conditions is necessary. The text mining results (Table 4 and Figure 3) indicate that the victims experienced discriminatory damage after the incident. The text mining analysis for each stakeholder revealed that the damage from the oil spill in Taean incorporated all aspects of sustainability [32,33], including the physical aspects [34,35], the social aspects of the village community, the environmental aspects of disaster prevention, and the economic aspects of the livelihood loss of residents. Additionally, haenyeos mentioned that they suffered significant damage to their physical health. Furthermore, each subject experienced different aspects of damage. Previous studies have highlighted similar results. As women are more emotional than men are, they experience more damage to the social aspects [36,37]. Boat fisherpeople working within a wide range of natural environments experience more damage to the environment [38,39]. Young people with relatively high costs of living experience more damage to the economic aspects [40,41]. Haenyeos working as laborers experience high levels of damage to their health [42].

Based on the results, women should be encouraged to engage in the restoration of social relations, boat fisherpeople should be encouraged to participate in environmental monitoring, young people should be provided with childcare support, and specialized fisherpeople, such as haenyeos, should be provided with medical support. Environmental disasters result in multiple major damages to victims in the community. As damage perceptions differ, conducting recovery depending on these perceptions is preferable. Efficient governance for damage recovery is possible by the proactive participation of stakeholders with each aspect of the recovery process by communicating their needs and, subsequently, helping to develop recovery initiatives [43,44].

According to the post hoc discussion on the Taean oil spill, the government had been working to restore the region by providing compensation and organizing a cooperative. However, the cooperative, which was established primarily by male leaders of the community in a top-down governance approach, could not pay the funds, because of constant

conflict among the members. However, if governance had been established based on the mutual understanding among stakeholders and individual characters, the cooperative could have operated more efficiently. Understanding the characteristics of local victims and creating a bottom-up governance design that secures participatory inclusiveness based on mutual understanding will strengthen communication among local stakeholders [45–47].

The results of this study on how the stakeholders of Sowon-myeon, Taean, perceived damages cannot be generalized. However, this approach revealed that the damage experienced by each stakeholder is different and that recovery alternatives must be prepared by considering these differences. Therefore, a political process, which includes stakeholder investigation based on the experienced differences of the victim, is necessary. Moreover, developing governance based on these differences, and suggesting recovery alternatives based on governance, are required [48]. Future research should investigate differences in individual damage from comparatively more diverse environmental disaster cases and develop detailed processes and alternatives that reflect the needs of each subject [49].

5. Conclusions

In this study, we analyzed in-depth interviews with stakeholders of the Hebei Spirit oil spill in Taean to examine the differences in damages experienced by each subject. Women, boat fisherpeople, young residents, and haenyeos suffered damages in terms of the community, environmental, economic, and health aspects, respectively. The discriminatory aspects of damages are significant considerations as they suggest the need to develop governance and alternatives for environmental disaster recovery through a bottom-up approach. The results show the scope of damage recovery by confirming the impact of the damage caused by environmental disasters on human society from the biophysical environment. In addition, analyzing the responses of stakeholders to the environmental disaster can be used to initiate discussions about the scope and roles of cooperative governance in the recovery process. This methodology can be used as an important protocol that encourages inclusive governance of damage recovery in societies experiencing environmental disasters in the future. This would facilitate increased preparedness for similar potential accidents. Future studies can focus on establishing governance and alternatives for environmental disasters based on regional characteristics to provide relevant data for recovering disaster sites.

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Appendix A

Table A1. Z values of the factors (raw data used for Table 4).

Rank	Keyword	Factor 1	Factor 2	Factor 3	Factor 4	Variance	Average
1	Village	5.16921	−0.1892	−0.52751	0.15833	7.248309	1.152708
2	Resident	0.61753	1.08656	3.30339	−0.32883	2.37001	1.169663
3	Livelihood	0.75057	0.60569	2.51501	−0.89968	1.952443	0.742898
4	Disaster prevention	0.30021	2.28808	−0.18388	1.06222	1.161059	0.866658
5	Work	0.15135	2.06937	−0.39843	0.75828	1.1247	0.645143
6	Pay	0.37716	1.09171	−0.41848	0.02499	0.406907	0.268845
7	Change	0.35726	0.80251	0.09829	−0.93151	0.54079	0.081638
8	Damage	−0.27931	−0.86216	2.56108	0.84039	2.26994	0.565
9	Relationship	−0.28297	1.07258	0.76549	0.89815	0.372846	0.613313
10	Haenyeo	−0.44421	−0.23635	−0.71485	3.97013	4.956277	0.64368
11	Living expenses	0.27533	0.84867	−0.59112	−0.16188	0.379088	0.09275
12	Participation	0.32908	1.30789	−0.98623	0.7825	0.963427	0.35831
13	Conflict	0.18485	−0.41436	0.99699	−0.3248	0.418785	0.11067
14	Sisterhood	−0.96714	1.00133	−0.24059	−1.64134	1.278789	−0.46194
15	Opinion	−0.49417	0.78243	−0.63321	−1.13862	0.667855	−0.37089
16	Operation	0.55721	−1.78526	−0.28197	−0.07756	0.984352	−0.3969
17	Activity	0.42463	−2.09514	0.4056	−0.97974	1.478237	−0.56116
18	Performance	−0.57432	0.46518	−0.39019	−1.41198	0.592965	−0.47783
19	Compensation	−0.54875	−0.60467	0.28043	0.43391	0.295158	−0.10977
20	Issue	−0.91402	−0.11948	1.30707	1.52811	1.360582	0.45042
21	Kindness	0.49456	−0.39093	−1.20273	−0.33733	0.480645	−0.35911
22	Fairness	−0.29856	0.28077	−0.77241	−0.59752	0.213392	−0.34693
23	Fishing	0.23968	−1.04595	−0.46676	0.17185	0.365235	−0.2753
24	Income	0.3067	−0.75621	−0.30437	−0.06097	0.198761	−0.20371
25	Health	−0.49957	−0.4236	0.06641	1.32	0.70739	0.11581
26	Current status	−0.35444	−0.49534	−0.26648	0.09534	0.063507	−0.25523
27	Expense	−0.09827	−0.38245	−0.64001	−0.12689	0.064167	−0.31191
28	Organization	0.17483	−1.14905	−0.56663	−0.14351	0.32776	−0.42109
29	Problem	−0.89266	−0.589	0.13528	0.08326	0.256709	−0.31578
30	Recovery	−0.70612	−0.32537	−0.47877	0.08299	0.110435	−0.35682
31	Fishing village fraternity	−0.30503	−0.79955	−0.1305	−0.19915	0.091587	−0.35856
32	Fishing vessel	−0.09266	−0.92137	−0.57247	0.07975	0.208006	−0.37669
33	Samsung	−0.78066	0.95613	−0.21771	−1.42185	1.018927	−0.36602
34	countermeasure	−0.51556	−1.29087	0.40771	−0.57252	0.484902	−0.49281
35	Labor	−0.39699	0.32972	−0.8697	−0.30002	0.24339	−0.30925
36	Public	−0.39699	0.32972	−0.8697	−0.30002	0.24339	−0.30925
37	Difficulty	−0.86777	−0.44202	−0.11804	−0.33447	0.099262	−0.44058

Appendix B

Table A2. Distribution of stakeholder by factors (raw data used for Figure 3).

Factor	Gender	Number of People	Age	Number of People	Occupation	Number of People	Region	Number of People
Factor 1 (Village community)	Male	10	60s	9	Hand fishing	8	Tidal flats	9
	Female	10	70s	3	Tourism	3	Island	7
	Not answered	1	80s	1	Agriculture	3	Port	5
			Not answered	8	Boat fishing	2		
					Haenyeo	1		
					Village head	1		
					Not answered	3		
Factor 2 (Disaster prevention)	Male	13	60s	8	Boat fishing	8	Tidal flats	10
	Female	9	70s	6	Hand fishing	5	Island	6
			50s	2	Tourism	3	Port	2
			40s	1	Agriculture	1	City	1
			80s	1	Disaster prevention company	1		
					Not answered	1		
Factor 3 (Threat to livelihood)	Male	15	40s	4	Hand fishing	5	Tidal flats	8
	Female	4	50s	4	Boat fishing	2	Island	4
			60s	4	Related organization	2	Port	2
			Not answered	3	Tourism	2	City	1
					Not answered	2		
					Pastor	2		
					Vice head of the myeon			
Factor 4 (Health)	Male	2	50s	2	Haenyeo	6	Port	8
	Female	6	40s	1	Tourism	1		
			60s	1	Not answered	1		
			70s	1				
			Not answered	3				

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