Environmental Pollution Damage: Analysis of Recovery in Jangjeom Village, Korea

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ABSTRACT

Background and objective: Since industrialization, various communities worldwide have had to deal with the negative effects of pollution. Previous studies have investigated how communities affected by pollution can recover. However, few studies have explored the ways in which recovery takes place over time. This study examined the restoration process of the village of Jangjeom in Iksan, South Korea. The environmental contamination of the air and soil of this area, caused by a fertilizer factory, has been officially recognized. As such, its regional administration is planning its recovery with governmental support.

Methods: This study conducted a content analysis of the meeting minutes of the government–civilian committee on environmental emergency measures in the village, using time-series text mining. The main phases and problems in the process of environmental pollution recovery were analyzed.

Results: The results of the analysis show that, in the early days of this initiative, there were many discussions regarding the physical and environmental aspects of pollution and the legal framework required to investigate the sources of pollution. However, in later meetings, the focus shifted to how pollution affects the residents, covering topics such as residents’ health check-ups and consultations with experts and administrative agencies.

Conclusion: This study shows that for the long-term recovery of communities damaged by pollution, a human-centered approach that goes beyond the physical and environmental aspects of recovery is needed.

Keywords: contaminated communities, fertilizer factory, government–civilian committee, Iksan, time-series text mining

Introduction

Modern society is confronted with various environmental pressures related to industrialization. In addition to air, water, and soil pollution, communities suffer from the socio-economic effects of environmental pollution. For this reason, it is urgent to discuss the essential processes of recovery from the damages caused by pollution. Notably, the companies that cause such pollution tend to minimize or avoid responsibility instead of contributing to pollution mitigation and recovery. Simultaneously, the inhabitants of polluted regions, who are the main affected parties, are often unable to properly assess the damage due to a lack of scientific knowledge (Freudenburg, 1997). In addition, environmental management is often neglected due to the close relationship between some polluting companies and the government (Higginbotham et al., 2010). Recently, a number of studies on information preparation, recovery factors, and pollution management for regional communities at risk from pollution have been carried out.

Early studies on information-sharing have posited that the scarcity of information on pollution complicates pollu-
tion management. Researchers who have analyzed ecology and health to obtain accurate information on polluted areas believe citizens should investigate pollution independently, and communicate directly with experts (Burger et al., 2010; Mahajan et al., 2020). Additionally, one study called for the accurate investigation and mapping of the environmental, social, and economic impacts of pollution (Lanier et al., 2019). Another study indicated that the source, quality, and reach of the generated information should be clearly defined (Ramírez et al., 2019). These studies focus on the analysis of the pollution source, yet neglect the subsequent recovery process. In addition, Yang et al. (2020) attempted to create an aligned vision and direction through the participation of stakeholders in the restoration process. Although such an effort is necessary, it has limitations because it has not provided specific methods and action items for how this community should realize this vision.

Environmentally polluted communities suffer from a range of difficulties, including environmental and health damages, resulting in social anxiety and distrust (Vanclay, 2003). As such, it is necessary to investigate the damages suffered by such communities in depth, and to research the processes through which the perpetrators of such damage can compensate the communities for the damage caused, and the actions required to restore village environments and communities. Although prior studies have summarized potential actions for damaged communities across short-, medium- and long-term strategies (Sam and Zabbey, 2018), these steps have not been subject to empirical verification. Thus, there is insufficient evidence regarding the applicability of such discussions and actions.

The recovery of polluted communities is not immediate. Even when the source of pollution is removed, it takes a long time for the effects of pollution to disappear and for the original environment to be restored. Therefore, a temporal perspective is necessary (Sam and Zabbey, 2018; Oskarsson and Bedi, 2018). However, previous studies have discussed only the elements necessary for the recovery process, such as pollutant source investigation, information, and organization; no studies have addressed the recovery process of environmental pollution governance temporally regarding contexts that may be interlinked.

Accordingly, this study examines the restoration process of polluted communities using real cases. We examined the restoration process of Jangjeom village in Iksan, Korea, which suffered from environmental pollution caused by a fertilizer factory. The damage caused by such environmental pollution was legally recognized, and its regional government formulated a restoration plan with governmental support. The meeting minutes of the government-civilian committee on environmental emergency measures for Jangjeom village were analyzed to explore the village’s regional governance. We used time-series text mining, a content analysis method, to analyze the recovery process and to identify its main factors.

### Communities affected by environmental pollution

A community affected by environmental pollution is made up of local residents who have suffered physically and mentally due to pollution; their degree of suffering is determined by social characteristics and the degree of the pollution (Cutter, 1981). Many early victims of environmental pollution are subject to geographical and environmental inequalities. Thus, the relatively vulnerable communities affected by environmental pollution inform the government of the local situation; however, such communities are often ignored and face difficulties in obtaining active governmental support. There are reports of local public servants being reluctant to intervene because of difficulties in solving an issue (Heigginbotham et al., 2010). In the process, the community affected by environmental pollution may further lose trust in the government. As the issue proliferates, the central government may become corrupt and unresponsive to the community’s continued requests, and eventually, the issue may become political in form. Relevant companies may discontinue their projects and work aimed at partial or complete environmental improvement.

To recover, communities affected by environmental pollution require organizations that can continuously advocate for improvement on their behalf (Tevapitak and Helmsing, 2019). Furthermore, it is important for such organizations to scientifically examine the pattern and restoration of environmental pollution damage, and to partner with experts who can design financial programs to aid the improvement projects (Senier et al., 2008). The participation of these
experts can raise awareness of environmental damage in the local community and lead to sophisticated monitoring. This also opens the door to more comprehensive partnerships, and leads to strong local community activity (Mahajan et al., 2020). Since the environmental restoration process includes various stakeholders, it can involve conflict; thus, conducting stakeholder analysis and research may be helpful. Stakeholder analysis effectively compares different perceptions in the area and identifies ways to cooperate. Tuler and Wevier (2009) concluded that health and safety protection are important from all viewpoints, even though perceptions vary regarding speed and ecology in the environmental restoration process. Based on this, a cooperative alternative of minimizing environmental and social impacts through life safety, stabilization, containment, and removal activities is established.

For the communities affected by environmental pollution, the provision of accurate information is the most critical element in the restoration process. Therefore, a specific template for information provision and periodic evaluation is required (Burger et al., 2010). The source of information should be clarified, and quality should be maintained. Additionally, the information should reach and cover a sufficiently large area (Ramrex et al., 2019). Maps can be used as an effective tool to provide such information (Lanier et al., 2019). Due to the unique nature of environmental data, they must be disseminated geographically and used as primary data to prepare environmental restoration project plans. Moreover, to effectively recover following damage from environmental pollution, various elements of plant pollutant purification, job creation in the purification process, cooperative formation, education and knowledge sharing, legislation, related trusts, and monitoring should be addressed. In addition, in the short term, environmental evaluations, education, funding, and schedule management are required; in the medium term, legalization, monitoring through indicators, and stakeholder management are needed; while in the long term, collaboration with related organizations should be carried out (Sam and Zabbey, 2018).

However, discussions about the restoration process of a community affected by environmental pollution are currently insufficient when it comes to the specific elements involved in the process. While attempts have been made to organize the tasks into short-, medium-, and long-term tasks (Sam and Zabbey, 2018), these are merely subjectively created temporal divisions made by the researcher. Thus, thorough analysis and verification of the contents of the actual process are required. Accordingly, we conducted an empirical study targeting Jangjeom village in South Korea, an area with a confirmed case of environmental pollution damage that is undergoing a restoration process.

**Time-series text mining as content analysis**

Heigginbotham et al. (2010) conducted qualitative research on the restoration process of communities affected by environmental pollution. Furthermore, Oskarsson and Bedi (2018) thoroughly examined communities affected by environmental pollution, while Sam and Zabbey (2018) attempted to organize its effects and the elements necessary for restoration. However, the organization may involve some subjectivity, and important items may be omitted; or the elements in the restoration process may be arranged in varying ways by different researchers. Thus, previous studies have limitations when it comes to the methods used to quantify and verify the restoration process. As an alternative, quantitative studies using surveys have been conducted. However, this approach has faced difficulty in confirming the overall process, as these studies addressed specific questions, such as how communication with experts is helpful (Mahajan et al., 2020). Furthermore, researchers have attempted to categorize various cases through content classification and statistically organize them. However, this method also is limited, in that it is difficult to confirm the contents that do not fall within the framework set by the researchers (Tevapitak and Helmsing, 2019).

Thus, this study uses text mining, a technique to quantify qualitative data. Text mining has been used in many sociological studies, as it effectively confirms the content and structure of a discussion based on the occurrence frequency and relationships among words (Park and Leydesdorff, 2013; Shi et al., 2017; Fitzgerald and Doerfel, 2004). Recently, it has been effectively used to organize discussions with residents and stakeholders in the fields of environment and forestry (Lee, 2019; 2021; Lee et al., 2022; Ulibarri et al., 2019). Furthermore, this study con-
ducted time-series text mining to examine the process of environmental pollution damage in depth. By analyzing the minutes of the relevant public-private council meetings through time-series text mining, this study identifies the topics of discussion that appear and disappear with the passage of time, and the specific elements of the restoration process.

**Research Methods**

**Study area**

This study selected the village of Jangjeom in Iksan, Korea, as the study target. In this village, 26 residents have died of or are battling cancer due to the release of tobacco-specific nitrosamines (TSNAs) from a nearby fertilizer plant (Kim, 2021) (Fig. 1). The fertilizer plant began operating in October 2001; it caused significant environmental pollution such as soot, odor, and wastewater for 15 years until it was shut down in April 2017. Immediately after the plant began operating, smoke and odor problems emerged. However, it became clear that the severity of this pollution had sharply increased when a group of fish died in a nearby reservoir due to the discharge of wastewater. Over time, the inhabitants also complained of various skin diseases, and the number of people who died from or struggled with cancer increased sharply. As the seriousness of environmental pollution and the mass outbreak of cancer were reported through the media, the government-civilian committee for environmental emergency measures (hereinafter, the government-civilian committee), an organization made up of local governments, villagers, local non-government organizations (NGOs), and experts, was established in Jangjeom village, Iksan. Subsequently, a petition for an epidemiologic investigation of health effects was submitted to the Ministry of Environment. The Ministry accepted the petition and conducted an epidemiologic investigation. As a result of the investigation, it was determined that TSNAs released during the processing of tobacco leaf residue, which was used as a raw material for organic fertilizers in the fertilizer plant, were the main cause of residents’ cancer. Tobacco leaf residue is what remains after making tobacco and is generated during the production of cigarettes. When this material is disposed of through burning, carcinogens are emitted, identical to what occurs when smoking cigarettes. The case of Jangjeom village’s epidemiological investigation attracted nationwide attention, as it was the first case in Korea in which an epidemiological link between environmental pollution and cancer, a non-specific disease, was recognized. The prime minister apologized personally for the incident, and ordered a nationwide investigation into similar cases (Table 1).

**Methods**

The government-civilian committee led the core discussion on environmental pollution damage and recovery measures. This study verified the main issues involving the recognition of environmental pollution and the associated recovery process by analyzing the committee’s meeting minutes. Time-series text mining a content analysis method was used to analyze the meeting minutes. This method was preferred as it can confirm the process of changes in various issues over time; that is, the study confirmed the main issues discussed in the government-civilian meetings and the committee’s response to these changing circumstances.

The meetings were held every month from 2017 until 2022. The contents of all monthly meetings (May 2017-February 2020) were analyzed through a review of their respective minutes. Thirteen stakeholders (residents, related researchers, reporters, lawyers, and public officials) participated in the first meeting. On average, approximately 10 people participated, and the discussion continued for approximately two hours each time.

Time-series text mining is a technique that analyzes how different texts are derived according to changes over time. In this study, factor analysis was performed by creating a time-text matrix such that the main keywords for each round could be identified (Taminiau et al., 2016). Time-series text mining was conducted as presented in Fig. 2. First, the content of the meeting minutes was morphologically analyzed. All discourse content in the minutes of the 28th session was analyzed using Netminer 4.4, which has a Korean morpheme analyzer function. Second, from the words extracted through the morpheme analysis, the top
10% of the nouns for which independent meanings could be identified were selected as the main keywords. It would have been preferable to analyze all words, but we determined that the derived words were relatively more important, so the analysis was performed for the top 10% of the nouns (Luhn, 1958). Third, a matrix was created by determining the frequency of the most important keywords for each round. Fourth, a factor analysis of the most important keywords for each round was conducted. Factor analysis follows a standardization process and has the ad-

![Fig. 1. Study’s target area.](image-url)
Results and Discussion

Results of time-series text mining towards the recovery in Jangjeom Village

Through the morphological analysis, it was determined that approximately 17,369 words were used, and a total of 1,759 nouns were used 12,617 times. Among them, 1,033 words were used more than once. Morphologically analyzing the meeting minutes of over 30 rounds and se-
lecting the top 10% of the nouns yielded various keywords, such as *pollution*, *investigation*, *inhabitants*, *villages*, *health*, *samples*, and those related to the impact on the health of the inhabitants (Table 2).

By counting how many times the selected keywords were mentioned, a matrix was created between the keywords and the round, and a factor analysis was performed with these results. Subsequently, six factors greater than one were extracted (Table 3).

Through our keyword analysis of the meeting minutes, we identified various keywords, such as *pollution*, *investigation*, *inhabitants*, *villages*, *health*, *samples*, and those related to the impact on the health of the inhabitants (Table 2).

### Table 2. Selected keywords

| Ranking | Keyword          | Frequency | Ranking | Keyword          | Frequency | Ranking | Keyword          | Frequency |
|---------|-----------------|-----------|---------|-----------------|-----------|---------|-----------------|-----------|
| 1       | Investigation   | 193       | 13      | Expert          | 36        | 23      | Pollution       | 26        |
| 2       | Residents       | 105       | 13      | Effects         | 36        | 23      | Professor       | 26        |
| 3       | Village         | 73        | 15      | Check-up        | 34        | 23      | Cancer          | 25        |
| 4       | Health          | 73        | 16      | Discussion      | 33        | 28      | Law             | 23        |
| 5       | Samples         | 67        | 16      | Results         | 33        | 29      | Epidemiology    | 22        |
| 6       | Ministry of the Environment | 64 | 18 | Inspection | 32 | 29 | Facility | 22 |
| 7       | Collection      | 58        | 19      | Budget          | 31        | 29      | Litigation      | 22        |
| 8       | Data            | 49        | 19      | Plant           | 31        | 32      | Important       | 21        |
| 9       | Basic           | 49        | 21      | Workplace       | 29        | 32      | Service         | 21        |
| 10      | Meeting         | 47        | 22      | Substance       | 28        | 34      | Closure         | 20        |
| 11      | Administration  | 42        | 23      | Conference      | 26        |         |                 |           |
| 12      | Member          | 39        | 23      | Region          | 26        |         |                 |           |

### Table 3. Meeting distribution (loading capacity of 1 or more)

| Factor/Keyword | Meeting round | Factor value | Key remarks |
|----------------|---------------|--------------|-------------|
| Factor 1 (Investigation) | 18th | .927 | (18th) PAH (polycyclic aromatic hydrocarbon) contaminants, such as naphthalene, were found in the groundwater of Jangjeom village during a preliminary investigation by the local government. There is a need to check whether the source of pollution has affected the village of Jangjeom by conducting a full investigation into landfill waste. Accordingly, a full investigation should be conducted by a specialized third-party institution. |
| Factor 1 (Investigation) | 16th | .927 | |
| Factor 1 (Investigation) | 19th | .909 | |
| Factor 1 (Investigation) | 5th | .791 | |
| Factor 1 (Investigation) | 12th | .789 | |
| Factor 1 (Investigation) | 21st | .788 | |
| Factor 1 (Investigation) | 1st | .779 | |
| Factor 1 (Investigation) | 2nd | .749 | |
| Factor 1 (Investigation) | 15th | .614 | |
| Factor 2 (Check-up) | 25th | .589 | |

| Factor 2 (Check-up) | Meeting round | Factor value | Key remarks |
|---------------------|---------------|--------------|-------------|
| Factor 2 (Check-up) | 26th | .882 | (26th) The villages of Jangjeom, Janggojae, and Walin have always been like a single village, and their current cancer rates are similar. Accordingly, personnel from the public health center should visit and interview residents of these villages. Further, medical examinations are being conducted through an agreement between Wonkwang University Medical Center and Jangjeom village. The elderly are undergoing check-ups, but some are being constantly declined in health. The health center can improve how it guides the residents. |
| Factor 2 (Check-up) | 28th | .833 | |
| Factor 2 (Check-up) | 22nd | .826 | |
| Factor 2 (Check-up) | 3rd | .680 | |
| Factor 2 (Check-up) | 20th | .525 | |
### Table 3. (continued)

| Factor (Category) | Eigenvalue |Keyword | Load | Meeting round | Factor value | Key remarks |
|-------------------|------------|--------|------|---------------|--------------|-------------|
| **Factor 3** (Pollution) | 2.677 | Pollution | 4.179 | 8th | .796 | (8th) Pollution of agricultural products has substantial psychological effects. Among eco-friendly production groups, it is potentially easy to tell whether crops are contaminated. However, for private farms, we do not know whether they are contaminated. This matter should be investigated further by requesting inspections from the Agricultural Products Quality Control Center, but we do not know whether agricultural products are contaminated at present, so we should refrain from making empirical comments. |
| | | Results | 1.768 | 14th | .774 | |
| | | Village | 1.733 | 7th | .737 | |
| | | Inspection | 1.143 | 9th | .624 | |
| | | | | 23rd | .507 | |
| **Factor 4** (Consultation) | 2.182 | Meeting | 3.827 | 24th | .860 | (24th) Acceptance of the results is important, and a joint committee was established with the Ministry of Environment, but there has been no communication since the last meeting in July of last year. This means that the Ministry of Environment will proceed according to their own protocols. We do not know if it is correct to accept this result. It is reasonable to make efforts to increase the acceptability of the results. It would be better to make a request to the Ministry of Environment on this matter during a government-civilian meeting today. We would like to gather opinions on whether we should attend a briefing session after the final advisory meeting with the experts, or proceed with opinions drawn from the Ministry of Environment’s joint committee to increase acceptability. |
| | | Conference | 1.343 | 13th | .715 | |
| | | Residents | 1.251 | 11th | .607 | |
| | | Ministry of Environment | 1.185 | | | |
| | | Results | 1.100 | | | |
| | | Epidemiology | 1.073 | | | |
| **Factor 5** (Administration, law) | 1.626 | Administration | 2.599 | 6th | .771 | (6th) In conclusion, we requested that the administration directly enter and collect samples. In the process, the Iksan government was told that there was a legal problem of entering the workplace without the permission of the fertilizer factory. The service team of the Iksan government was discussing whether to collect samples only around the village or to use the samples gathered from the city in advance. In the end, the sample from the city was analyzed. When there is a new finding as it progresses until the 5th meeting, it must be shared with the members of the government-civilian committee. If it is not shared, there is a communication problem with the Iksan government. |
| | | Law | 1.692 | 4th | .448 | |
| | | Samples | 1.515 | | | |
| | | Collection | 1.428 | | | |
| | | Residents | 1.296 | | | |
| **Factor 6** (Involved persons) | 1.117 | Members | 2.906 | 27th | .867 | (27th) It would be convenient to discuss a follow-up management plan with a local expert, but since there will be a committee organized by the Ministry of Environment, it would be best to negotiate with them first and prepare a plan in advance. |
| | | Residents | 1.842 | | | |
| | | Experts | 1.796 | | | |
| | | Ministry of Environment | 1.111 | | | |
“investigation” was derived as the top keyword for factor 1. Notably, investigations on pollution levels of water, soil, and air were mentioned frequently. This referred to basic investigations to determine the pollutants that were emitted by the facility and how they were absorbed into the body. For factor 2, “village,” “inhabitants” and “investigation” were the most important keywords. After checking the pollutants discharged from the plant and the state of environmental pollution, health check-ups for cancer and the main skin diseases suffered by residents began to be discussed as key issues.

From the 20th session’s minutes onward, a sincere discussion about the health check-up of the residents began. The keywords “pollution,” “result,” “village” and “inspection” for factor 3 appeared significantly in the minutes of the meeting. The meeting concerned pollution damage, as members complained about the strong smell of smoke from the plant, headaches and nausea caused by it, and a purple moss on the plants. Thus, the council requested a professional inspection of these issues. Factor 4 included keywords for the consultation such as “meeting,” “conference,” “residents,” “Ministry of Environment,” “outcome” and “epidemiology,” which appeared during the middle and end of the meetings. During this period, the key figures in local politics from the affected communities joined the government-civilian committee, establishing themselves as a social coordination body. They raised the issue in the National Assembly so that consultations with the Ministry of Environment could begin in earnest. In factor 5, the keywords “administration” and “law” surfaced frequently in the beginning. Legal and administrative problems related to investigating pollutants were addressed. The Ministry of Environment and local authorities began to take a serious interest in the source of pollution and the recovery process. To support this, a discussion was held on the laws and administration related to pollution before the regulatory method, the Odor Pollution Prevention Act, the Clean Air Act, the Persistent Organic Pollutants Management Act, and the Environmental Health Act. For factor 6, a story about the people involved appeared mainly in the second half of the minutes. The government-civilian committee recruited professors involved in environmental engineering, atmospheric environment, and dynamics verification from local communities. Researchers from various research institutes participated in the pollution inspection and discussed the role and participation of experts. Based on these results, the recovery process of Jangjeom village began with this investigation (factor 1); it aimed to elucidate the administrative and legal framework relevant to pollution (factor 5), help the community recover from pollution (factor 3), offer local residents check-ups (factor 2) performed by experts (factor 6), and carry out a consultation (factor 4) in the recovery process.

The minutes of the first few meetings addressed several topics related to the administrative and legal framework (factor 5) relevant to the pollution investigation (factors 1 and 3). In contrast, discussions on resident-specific issues, such as the counseling process (factor 4), the investigation (factor 2), and caregivers (factor 6) became more common in later meetings. This suggests that the pollution not only caused extreme damage to the physical environment, but also impacted the social environment, such as the health of the affected residents. Thus, the residents needed a consultation with relevant institutions and experts in the second half. The analysis of the minutes demonstrated that, in the initial stage, the investigation of the source of pollution and support from the administration and the law were important; however, subsequently, a structure in which the affected people could participate in a consultation with the institution became important for the health of the local residents. Initially, the focus was on the physical and environmental aspects of pollution sources; subsequently, interest regarding resident-related issues, such as health check-ups and recovery, grew. When addressing environmentally polluted areas, support should be provided to remove simple pollution, promote recovery, and ensure that the local community has sufficient opportunities to consult experts to help the community recover completely (Fig. 3 and Table 4).

**Meaning of the recovery process for pollution-affected communities**

To identify the most important tasks that pollution-affected communities must undertake for recovery, this study conducted a time-series text mining analysis of the minutes of the government-civilian committee meetings for envi-
Fig. 3. Number of occurrences for each factor (selecting a value of 0.4644 or higher according to the significance level of factor analysis). Blue and gray indicate issues related to the physical environment, yellow and red indicate issues related to people. The horizontal axis is the number of meetings, and the vertical axis is the z-value.

Table 4. Frequency of the main keywords per meeting

| Meeting | Investigation | Check-up | Pollution | Consultation | Administration | Experts |
|---------|---------------|----------|-----------|--------------|----------------|---------|
| 1       | 67            | 14       | 10        | 4            | 4              | 5       |
| 2       | 54            | 2        | 2         | 6            | 5              | 16      |
| 3       | 32            | 11       | 1         | 3            | 4              | 15      |
| 4       | 11            | 8        | 1         | 5            | 19             | 1       |
| 5       | 28            | 0        | 13        | 1            | 6              | 0       |
| 6       | 11            | 0        | 4         | 12           | 34             | 2       |
| 7       | 6             | 0        | 13        | 0            | 6              | 0       |
| 8       | 4             | 1        | 22        | 0            | 4              | 2       |
| 9       | 2             | 0        | 7         | 0            | 0              | 0       |
| 11      | 5             | 0        | 4         | 1            | 2              | 0       |
| 12      | 16            | 0        | 3         | 5            | 0              | 0       |
| 13      | 11            | 2        | 1         | 1            | 1              | 0       |
| 14      | 4             | 0        | 10        | 2            | 0              | 0       |
| 15      | 13            | 0        | 5         | 7            | 0              | 0       |
| 16      | 43            | 0        | 12        | 1            | 0              | 7       |
| 18      | 43            | 0        | 12        | 1            | 0              | 7       |
| 19      | 24            | 0        | 3         | 1            | 2              | 0       |
| 20      | 7             | 0        | 1         | 0            | 5              | 0       |
| 21      | 21            | 1        | 3         | 2            | 3              | 0       |
| 22      | 6             | 6        | 2         | 2            | 5              | 0       |
| 23      | 8             | 0        | 8         | 7            | 4              | 5       |
| 24      | 4             | 0        | 1         | 8            | 0              | 2       |
| 25      | 19            | 0        | 5         | 0            | 1              | 0       |
| 26      | 1             | 4        | 0         | 1            | 1              | 0       |
| 27      | 1             | 1        | 2         | 2            | 0              | 3       |
| 28      | 8             | 4        | 2         | 0            | 0              | 0       |
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Environmental emergency response in Jangjeom village. This case demonstrates that the affected community must first understand the reality of the pollution through a thorough investigation of the site (Burger et al., 2010; Mahajan et al., 2020; Ramírez et al., 2019) and establish administrative procedures for this. Furthermore, expert consultation is necessary (Tevapitak and Helmsing, 2019; Senier et al., 2008), and a program to identify and improve residents’ health should also be developed (Oskarsson and Bedi, 2018; Tuler and Webler, 2009).

This process can be conducted by establishing a consultation network, connecting experts from various fields, and developing a resident check-up and health recovery program. The distribution of topics by time period indicates the context of the detailed projects that the government must undertake to allow communities to recover from pollution (Figs. 3 and 4). These results show that news reports on environmental pollution are connected to a soil pollution level inspection. After the public-private council was established, the plan for a resident health impact survey was charted. When the result of the investigation acknowledges the epidemiological relationship between environmental pollution and cancer, the administration prepares pollution-related recovery measures through a meeting of related organizations, in which more specialists participate over time (Table 1).

These results show that the restoration of environmental pollution damage and the health check and recovery of people due to pollution should be carried out together to restore the community that has been damaged by environmental pollution. Furthermore, pollution sources must be scientifically analyzed, and administration and consultation processes must be supported. In other words, our analysis of this community shows that proper restoration of communities damaged by environmental pollution can be achieved only when environmental science elements and governance are met. Therefore, in the future, in efforts to restore contaminated areas, the government should include and consult with experts who can support both scientific and social aspects.

Previous studies have suggested specific restoration factors for environmentally polluted areas. Various studies have claimed that important elements of the contaminant recovery process, such as contingency planning, ecological resources, health and safety, and community, must be identified. Above all, human life and stability should be ensured, and the environmental and social effects of pollution should be minimized (Tuler and Webler, 2009). Prior studies have shown specific strategies to combat pollution, such as the purification of pollutants emitted by plants and living beings, soil replacement, and washing (Sam and Zabbey, 2018). However, these studies did not address the actors who must initiate this recovery process.

Fig. 4. Diagram illustrating the restoration process of the environmentally polluted area of Jangjeom village in Iksan.
be performed. This study is significant, as it fills this gap by analyzing a case in which environmental pollution restoration governance was organized according to a specific process. However, this study has limitations in terms of generalization of its findings because only one case was analyzed. Nevertheless, it is clear that Iksan Jeonseong village is a good reference case for the environmental pollution restoration process.

Conclusion

To present the complete recovery process in a pollution-affected area, this study used time-series text mining to analyze the meeting minutes of the governmental and civil advisory board of Jangjeom village, Iksan, South Korea. The analysis demonstrated that administration and laws were initially needed to investigate the pollutants, but later, the focus shifted to medical check-ups for affected residents and consultation with experts. This indicates that the polluted community should be viewed from environmental and physical perspectives, as well as from the perspective of its inhabitants. Real recovery of the area affected by environmental pollution can be achieved when environmental, physical, human, and sociological factors for people and communities are fully considered.

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