PROBLEMY EKOROZWOJU – PROBLEMS OF SUSTAINABLE DEVELOPMENT
SUBMITTED: 29.09.23, ACCEPTED: 25.11.23, PUBLISHED ON-LINE: 8.01.24
2024, 19(1): 308-324
https://doi.org/10.35784/preko.5386

Evaluation of Perceived Environmental Risks of Residents' Life Under the Perspective of Environmental Public Opinion in China

Ocena postrzeganych zagrożeń środowiskowych dla życia mieszkańców w perspektywie środowiskowej opinii publicznej w Chinach

Fengjiao Ye*, Xueru Wang, Jun Lin*****

School of Information Engineering, No.1, Gufu 20th District, 362700, Quanzhou Ocean Institute, China
**E-Mail (Correspondence Author): 1317438599@qq.com, ORCID: 0009-0000-1320-9450*
***E-Mail: 435361682@qq.com*
****E-Mail: 51835889@qq.com*

Abstract

Population health, social development and the environment are important elements of sustainable development. This article uses the China People's Daily message board to collect environmental public opinion data, visualizes the public opinion hotspots of environmental based on word frequency statistics, and applies the Latent Dirichlet Allocations (LDA) topic model to analyze the spatial distribution of environmental risk perception dimensions. The conclusions are as follows: (1) in terms of the hotspots of environmental public opinion, the most frequent occurrences are the living environment, interest demands and noise pollution. (2) There is heterogeneity in the topic of environmental risk perception. The perception of pollution source types has the highest weight in environmental risk perception in the eastern, central, and western regions. Specifically, the types of pollution sources in the eastern that receive the most attention are garbage and noise pollution. In addition to paying attention to noise pollution, the central and western also have a higher perceived weight on the polluters. Residents in northeast are most concerned about changes in residents' health and living environment quality. (3) From the perspective of environmental risk perception, health perception has the highest proportion in northeast, followed by the eastern, and finally the central and western. Proportion of perception of interest demands is highest in the central region, perception of residential environment quality is highest in the northeast region, perception of pollution source types is highest in the eastern, central, and western regions, and lowest in the northeast region. Finally, some practical and feasible policy recommendations were proposed for different regions.

Key words: environmental risk perception; environmental public opinion; Latent Dirichlet Allocations (LDA) topic model; natural language processing; text analysis; China

Streszczenie

Zdrowie ludności, rozwój społeczny i środowisko są ważnymi elementami zrównoważonego rozwoju. W tym artykule wykorzystano tablicę ogłoszeń China People's Daily do gromadzenia danych dotyczących opinii publicznej na temat środowiska, wizualizowano najważniejsze punkty opinii publicznej na temat środowiska w oparciu o statystyki częstotliwości słów i zastosowano model Latent Dirichlet Allocations (LDA) do analizy przestrzennego rozkładu wymiarów postrzegania ryzyka środowiskowego. Wnioski są następujące: (1) jeśli chodzi o najbardziej aktywne punkty opinii publicznej w zakresie ochrony środowiska, najczęstszymi zjawiskami są środowisko życia, wymagania dotyczące zainteresowań i zanieczyszczenie hałasem. (2) Istnieje różnorodność w temacie postrzegania ryzyka środowiskowego. Postrzeganie rodzajów źródeł zanieczyszczeń ma największe znaczenie w postrze-

ganiu ryzyka środowiskowego w regionach wschodnich, centralnych i zachodnich. W szczególności źródłami zanieczyszczeń we wschodniej części kraju, którym poświęca się najwięcej uwagi, są śmieci i hałas. Oprócz zwracania uwagi na zanieczyszczenie hałasem, regiony środkowe i zachodnie również przywiązują większą wagę do sprawców zanieczyszczeń. Mieszkańcy północno-wschodniej części kraju najbardziej niepokoją zmiany w ich zdrowiu i jakości środowiska życia. (3) Z punktu widzenia postrzegania ryzyka dla środowiska, postrzeganie zdrowia ma najwyższy odsetek na północnym wschodzie, następnie na wschodzie, a na końcu w środkowej i zachodniej części. Proporcja postrzegania potrzeb odsetkowych jest najwyższa w regionie centralnym, postrzeganie jakości środowiska mieszkalnego jest najwyższe w regionie północno-wschodnim, postrzeganie rodzajów źródeł zanieczyszczeń jest najwyższe w regionach wschodnich, centralnych i zachodnich, a najniższe w regionie północno-wschodnim. Na koniec zaproponowano kilka praktycznych i wykonalnych zaleceń politycznych dla różnych regionów.

Słowa kluczowe: percepcja ryzyka środowiskowego; ekologiczna opinia publiczna; model ukrytych alokacji Dirichleta (LDA); przetwarzanie języka naturalnego; analiza tekstu; Chiny

1. Introduction

With China's rapid economic development in recent years, environmental pollution has become an important problem. Government environmental policies can effectively improve the ecological situation of a region, however, in the process of environmental pollution control, there are limitations in relying only on top-down control. Public participation plays an important role in promoting the governance of environmental pollution, and policymakers must be aware of public opinion in order to formulate effective policies, especially in highly polarized areas such as environmental policy. The sustainable development goals (SDGs) of the United Nations include Health (Goal 3) and Cities (Goal 11), and the sustainable development of communities is closely related to the health risks of residents. Integrating sustainable development goals into disaster reduction and adaptation at all levels and all policy action stages is crucial for the sustainability of our communities (Azadi et al., 2020). Presence of environmental beliefs, along with information regarding a sense of environmental deterioration, climate change and the consequences for the future, can predict the implementation of actions for sustainable development (Sierra-Barón et al., 2021). Ferguson and Wollersheim (2023) find that resilience is also articulated as a response to the failure of neoliberal sustainable development; as an integrating discourse of climate security and sustainable development; as a prerequisite for sustainable development; and as qualitatively different to sustainable development. United Nations Sustainable Development Goal 3 proposes to reduce premature deaths from non-communicable diseases by one third by 2030 through prevention, treatment and promotion of physical and mental health. In addition, strengthen the capacity of countries, particularly developing countries, for early warning, risk reduction and the management of national and global health risks. The United Nations sustainable development Goal 11 notes that the number of countries with national and local disaster risk reduction strategies has doubled since 2015. Furthermore, Goal 11 calls for the provision of safe, affordable, accessible and sustainable transport systems for all by 2030 and the improvement of road safety, in particular the expansion of public transport, with special attention to the needs of persons in vulnerable situations, women, children, persons with disabilities and older persons. In addition, by 2030, strengthen inclusive and sustainable cities and enhance capacity for participatory, integrated and sustainable human settlements planning and management in all countries. Provide universal access to safe, inclusive, accessible and green public spaces for all, especially women, children, older persons and persons with disabilities.

Digital surveillance holds the promise of monitoring environmental threats to the health of populations, as the quality of the living environment and human health are closely linked, and the public is increasingly concerned about the quality of life, which triggers varying degrees of perceived risk. Environmental risk perception is the public's subjective perception of environmental objectives and subjective judgment of environmental impacts. The public's risk perception of the environment not only affects their own sense of access to green well-being and happiness, but may also play a decisive role in the success or failure of environmental management policy implementation. Increasing the exposure of the government's environmental performance can stimulate the public to participate in pro-environmental behaviors, thus promoting the implementation of environmental policies that require citizen participation (Cheng et al., 2022). The evaluation of residents' health risk perception can effectively promote community governance and sustainable development. Encouraging residents to file environmental complaints is beneficial for environmental protection departments to manage environmental issues and mitigate the adverse effects of environmental pollution. Therefore, analyzing environmental risk perception is of great significance for the government to control environmental pollution. Based on the availability of data, this study mainly focuses on China (except for Hong Kong, Macao, and Taiwan), how to formulate environmental pollution control policies tailored to local conditions is an important issue that China needs to face at present, and it is also the starting point of this study.

Compared with existing studies, the innovation of this study has two main aspects. On the one hand, it is the innovation of research perspective. For a long time, researchers have mainly focused on the environmental risk perception of a single region, but less on considering regional differences and analyzing environmental opinion data based on different regions. On the other hand, it is the innovation of research content. In the research of environmental risk perception, most scholars mainly analyze a single environmental risk perception, this study not only comprehensively analyzes the heat of environmental public opinion, but also constructs a system of risk perception dimensions based on the theme of environmental risk perception.
This paper is organized into five parts. The second part reviews the literature on environmental risk perception and environmental opinion analysis. Then, the third part describes the research design, including the research methodology and data sources. The fourth part describes the spatial distribution of environmental public opinion hotspots and environmental risk perceptions, in addition, the perception dimensions are constructed for the themes of environmental risk perceptions in different regions to compare the spatial heterogeneity of environmental risk perception dimensions. The fifth part mainly summarizes the conclusions and proposes some countermeasures for different regions.

2. Literature review

2.1. Environmental risk perception

In the existing analysis of environmental risk perception, the main focus has been on the influencing factors and roles of environmental risk perception. For example, environmental awareness and social trust are the main predictive factors for risk perception. However, the relationship between environmental knowledge and risk perception is not significant (Choon et al., 2019). Zeng et al. (2020) explored how cultural bias affects environmental risk perceptions and behaviors, arguing that an individual's pro-environmental behaviors are not only influenced by environmental risk perceptions, but also by his or her cultural worldview. Environmental values have a significant positive effect on typhoon risk perceptions, and disaster threats and the government's disaster management capacity have a significant positive effect on typhoon risk perceptions (Yao et al., 2021).Yoo and Baek (2019) analyzed the socio-demographic factors that influence gender differences in a variety of environmental and health-related risks, with place of residence, gender, education, and income being the most important factors in explaining significant factors of risk perception (Balžekienė et al., 2022). Emotional responses can enhance residents' awareness and perception of ecological and environmental risks, and the dissemination of risk information can help them rationally assess ecological and environmental risks (Ma et al., 2021). Yang (2023) argues that trust in all central and local governments, trust in the majority of people in society, and trust in the media can help to reduce the perceived risk of living environments.
In terms of the role of environmental risk perception, risk perceptions significantly predict conservation behavior, civic action, and participation preferences at the individual level to varying degrees (Suldovsky and Frank, 2022). Zhou et al. (2020) developed a model describing the relationship between four dimensions of farmers' risk perceptions of soil contamination and their environmental protection of the soil in China, as well as the moderating effect of farmers' household income levels on these relationships. Environmental risk perceptions have less (more) influence on environmental control points and plastic-avoiding behavior when government trust is high (lower) (Wang et al., 2023). Ferguson and Wollersheim (2023) find that resilience is also articulated as a response to the failure of neoliberal sustainable development; as an integrating discourse of climate security and sustainable development; as a prerequisite for sustainable development; and as qualitatively different to sustainable development. Therefore, focuses on promoting awareness of effective ways to reduce anthropological burden and pollution and on providing valuable data that can be used in environmental monitoring assessments and lead to sustainable development (Gunjyal et al., 2023).

2.2. The role of environmental public opinion

There have been many achievements in the study of environmental public opinion, which indicates that environmental public opinion plays an important role in the government's formulation of environmental pollution policies. For example, individuals blame the government for environmental failures when evaluations of political institutions reflect perceptions of environmental risks (Verner, 2023). Sun and Zhu (2023) analyzed keywords in the Baidu Search Index (BSI) related to the public's risk perceptions and behavioral responses to outdoor air pollution, and the proposed framework can facilitate environmental risk management policy decisions by considering real-time public risk perception and behavioral response information, improving the efficiency of environmental risk management and facilitating environmental risk management policy decision-making. Environmental public opinion pressure has a significant positive impact on green innovation behavior of enterprises. Compared with incentive environmental regulations, mandatory environmental regulations make enterprises more sensitive to environmental public opinion pressure and have a more significant positive regulatory effect (Wang et al., 2022). The frequency of disasters greatly promotes public support for environmental spending, and different types of disasters have different impacts, with wildfires and severe winter weather events having the greatest impact (Soni and

Mistur, 2022). If policy makers wish to maintain public support for implementing environmental protection measures, they should prioritize low unemployment over economic growth (Kenny, 2020). Mandatory policies such as policy regulation, pollution control, and ecological protection can significantly reduce negative environmental effects (Qin et al., 2021). Environmental news exposure is positively associated with both air pollution knowledge and risk perception, and environmental news exposure indirectly affects risk perception through air pollution knowledge (Chen and Liu, 2021). Olowoporoku et al. (2021) through a questionnaire survey of 218 residents of Sapele, Ogara and Koko in Delta State found that situational amenities, environmental actions and socio-economic characteristics determine residents' perception of environmental hazards and risks. The role of government is not all-encompassing, and *haze management* and *public participation* have a significant impact on the public's concern to *participate in haze management* (Xu et al., 2021). Climate change information and residents' health risk perceptions have significant positive effects on residents' attitudes toward environmental complaints and willingness to file environmental complaints, and residents' health risk perceptions are also positively affected by climate change information (Wang et al., 2020). Teh et al. (2022) helped policymakers and the environmental community understand public perceptions of issues related to plastic pollution by analyzing social media data. There is an increasing focus on sustainability and marine environmental issues, as evidenced by prominent keywords related to construction, safety, plastic pollution, and ecosystem protection (Kang et al., 2023). Both information channel factors and cognitive appraisal factors significantly influence the public's progression from environmental risk perception to behavioral response (Gao et al., 2019).

In addition, scholars also analyze environmental public opinion from different perspectives. For example, Wang et al. (2022) used bibliometric analysis and Potential Dirichlet Allocation to analyze the progress of China's ecological civilization construction from both theoretical and practical levels. Berardo et al. (2020) compared the topics of public debates surrounding fracking in newspapers in nine U.S. states over an eleven-year period, with environmental risks being the most popular topic. Xiong et al. (2020) studied public opinions obtained through the Twitter social media platform and whether this information could help local governments to take emergency measures. Huang et al. (2020) analyzed the public's attention to GCs, emotional tendencies and hot topics based on Sina Weibo data. Huang and Yang (2020) explored how the media influences Chinese citizens' risk perception of air pollution based on the Social Amplification of Risk Framework (SARF).

To summarize, although some scholars have studied the role of environmental risk perception and environmental public opinion in governing the environment, fewer scholars have considered regional differences and constructed environmental risk perception dimensions based on environmental public opinion. Therefore, it is important to explore the spatial heterogeneity of the dimensions of environmental public opinion fervor and environmental risk perception, and to give policies and suggestions tailored to local conditions.

3. Research design

3.1. Research model

3.1.1 Latent Dirichlet Allocations (LDA) topic model

The Latent Dirichlet Allocations (LDA) topic model was proposed by Blei et al. in 2003. As a classic unsupervised learning algorithm, it is one of the commonly used models in the field of natural language processing. The LDA topic model in this article is not only a commonly used document topic generation model, but also a three-layer Bayesian probability model that includes a three-layer structure of keywords, topics, and documents. The LDA topic model is mainly used to infer the topic distribution of a document, which can give the topic of each document in the form of a probability distribution. The specific steps for generating a document in the LDA topic model are as follows.

Step 1: Select a document d_m with a prior probability $P(d_m)$;

Step 2: Sample the subject distribution θ_m of the generated document d_m, where θ_m obeys the hyperparameterized α Dirichlet distribution, i.e., $\theta_m \sim Dir(\alpha)$;

Step 3: Generate the topic $Z_{m,n}$ of the nth word of document d_m by sampling from the topic distribution θ_m, where $Z_{m,n}$ obeys a polynomial distribution of θ_m, i.e., $Z_{m,n} \sim Mult(\theta_m)$;

Step 4: Sample the word distribution $\varphi_{Z_{m,n}}$ of the generated topic $Z_{m,n}$, where $\varphi_{Z_{m,n}} \sim Dri(\beta)$;

Step 5: Generate $w_{m,n}$ from the word distribution $\varphi_{Z_{m,n}}$ with $w_{m,n} \sim Mult(\varphi_{Z_{m,n}})$;

Step 6: Repeat steps 2-step 5 for a total of N times, and finally generate a document d_m with a total number of N times.

3.1.2 Data acquisition methods

The way of obtaining data for this study is done by writing a program in python. The code is written to collect the message data through python and built-in packages and related functions. The specific steps are as follows.

Step 1: Install Pycharm and Crawler Library.

First, install Pycharm and configure environment variables. Then, install the libraries needed for the crawler. The libraries needed for this study include Requests and JSONPath, which can be installed via the pip command;
Step 2: Analyze the structure of the target page
Use the browser to open the People's Daily message board website, the web page shows the message information, the data type is json data;
Step 3: Data acquisition
Parsing the message board data, using the JSONPath module to extract the content of the message, and store the data into EXCEL.

3.2. Data Sources

The research area of this study is the administrative division of China. According to the definition of the National Bureau of Statistics, China's 34 provincial-level administrative units can be divided into 5 regions, namely the eastern, central, western, northeast, and Hong Kong, Macao, and Taiwan. People's Daily is the organ of the Central Committee of the Communist Party of China (CPC), as well as China's number one newspaper, and was named one of the world's top ten newspapers by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1992. The China *People's Daily* has the important responsibility of communicating social sentiment and public opinion, and guiding public emotions. The data in this article comes from the leadership message board section under the *People's Daily*, which mainly includes feedback on issues encountered by residents in their daily lives and suggestions for government governance. Therefore, the data in this paper can not only intuitively reflect the residents' most direct perception of the environment, but also reflect the residents' demands and suggestions for managing the environment. The data for this article was selected from January 2022 to July 2023, and the entire study was completed in September 2023. The content of the messages are all suggestions and complaints given by residents about the environment. Due to data availability, the data used in this paper does not include Hong Kong, Macao and Taiwan, so it is mainly analyzed for the eastern, central, western and northeast regions. In addition, only the categories of message content were screened in this study when collecting data, and only environmental protection and environment-related content was selected. In order to ensure the scientific rationality of the data, there was no sampling in the message population, all messages about the environment and environmental protection during the study period were included. That is to say, the message residents include all the people in China (except Hong Kong, Macao and Taiwan), and the message information comes from all over China, and there is no restriction on gender, education, region, ethnicity and other factors.
The data volume of message content is shown in Table 1, considering the uneven distribution of regional provinces, and calculating the average message volume of the region. Table 1 shows that the message volume in the east, center, west and northeast are 6468, 3746, 6573 and 2020 respectively, and the total data volume of this paper is 18807. Visualizing the regional data as Figure 1, it can be seen the average message volume difference in the region is relatively small, with the highest average message volume in the northeast (673.33) and the lowest in the western (547.75).

Table 1. Number of messages from different regions (own computing)

Number of messages	Eastern	Central	Western	Northeast
Frequency	6468	3746	6573	2020
Regional average frequency	646.8	624.33	547.75	673.33

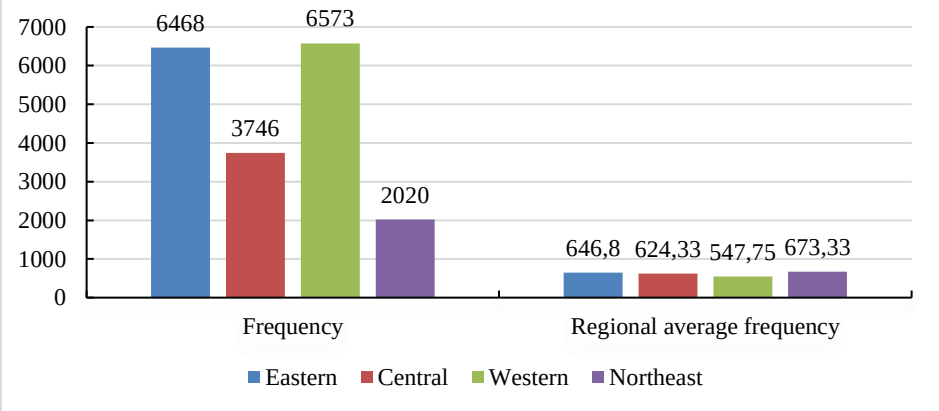


Figure 1. Number of messages in different regions (own computing)

4. Results

4.1. Spatial distribution of environmental public opinion hotspots

The data type of this study is text data, and the data processing and analysis are done by python software programming. Based on the special characteristics of text data, the data need to be divided into words, de-digitized, and de-suspended words during data pre-processing. After the end of the word division, the frequency of each word is calculated, and then sorted according to the word frequency, the Top 20 keywords in different regions are shown in Table 2. In addition, the Top 50 keywords in different regions are visualized in Figure 2, where the larger the font of the keywords, the more frequent they appear, and vice versa.

The frequency of keywords reflects the hotspots of environmental public opinion. As can be seen from Figure 2, overall, environmental public opinion hotspots are spatially heterogeneous. Specifically, the top 1 keyword in different regions is *community*, but starting with the Top 2 keyword, it varies from region to region. For example, the Top 2 keyword for both eastern and northeast is *resident*, while central and western are *leadership* and the Top 3 keyword is the opposite. Although the keywords for different regions in Top 4 are *environment*, in Top 5, the keywords for the eastern and western are *noise*, while the keywords for the central and northeast are *contaminated* and *solve*, respectively.

Keywords reflect the heterogeneity of environmental public opinion. For example, *community* reflects the living environment, while *residents, rest*, and *disturb the residents* are usually related to human health. *Leadership* and *solve* express the hope that the problem can be solved, while *noise, garbage*, and *lampblack* reflect the types of environmental pollution sources. As shown in Table 2, considering only the type of environmental pollution, *noise* is the most frequently mentioned in different regions, indicating that different regions are most affected by noise pollution. However, on the whole, the hotspots of environmental public opinion in different regions are not consistent, nor is there any obvious pattern. Therefore, it is necessary to further explore the types of environmental risk perceptions of residents in different regions.

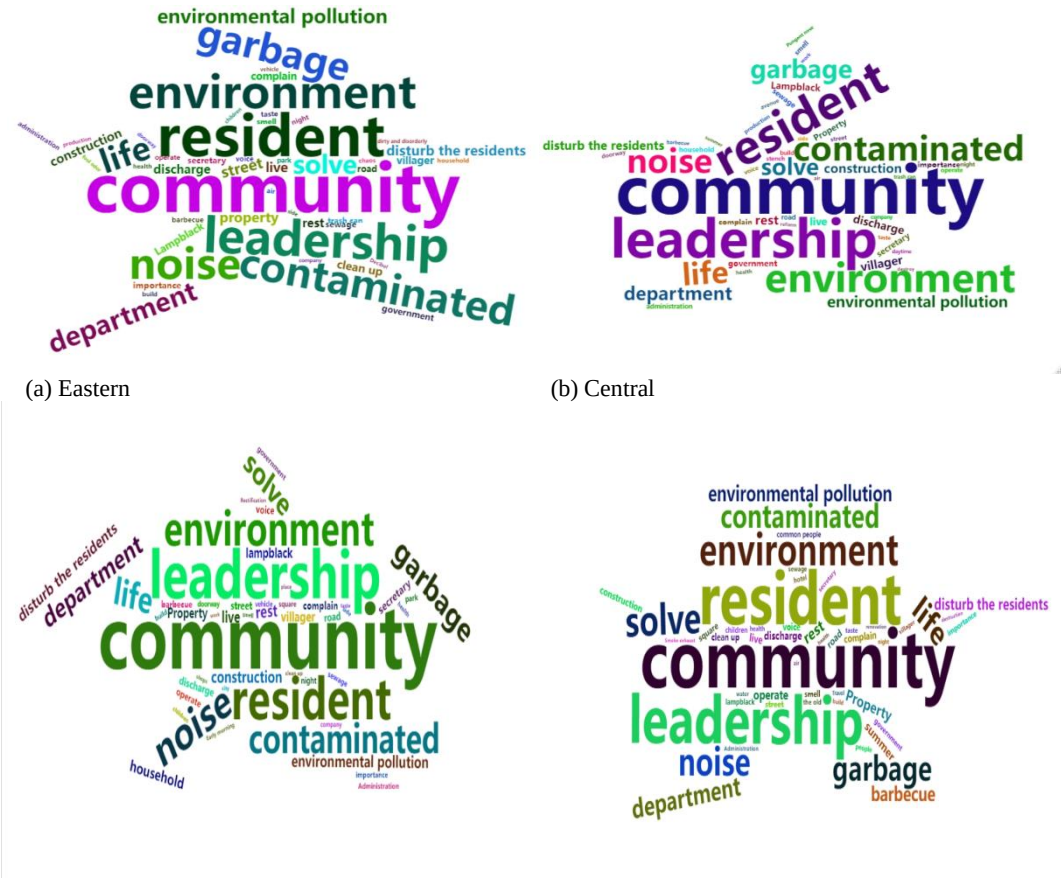
Table 2. Top 20 keywords by region (own computing)

Sort	Eastern	Central	Western	Northeast
1	community(3046)	community(2128)	community(3793)	community(1129)
2	resident(2586)	leadership(1684)	leadership(2831)	resident(1012)
3	leadership(2178)	resident(1515)	resident(2497)	leadership(918)
4	environment(2073)	environment(1282)	environment(2085)	environment(633)
5	noise(1941)	contaminated(1095)	noise(1986)	solve(601)
6	contaminated(1859)	noise(1055)	contaminated(1756)	noise(552)
7	garbage(1745)	life(963)	life(1581)	garbage(493)
8	life(1488)	garbage(813)	garbage(1487)	life(483)
9	department(1216)	solve(742)	solve(1369)	contaminated(468)
10	solve(1153)	department(600)	department(1189)	department(377)
11	environmental pollution(877)	rest(409)	rest(736)	environmental pollution(309)
12	street(683)	construction(406)	construction(720)	barbecue(284)
13	disturb the residents(622)	disturb the residents(384)	environmental pollution(719)	rest(231)
14	property(618)	villager(379)	disturb the residents(712)	disturb the residents(224)
15	live(598)	discharge(354)	live(678)	property(221)
16	construction(565)	live(331)	household(672)	operate(183)
17	discharge(546)	lampblack(302)	villager(591)	summer(183)
18	rest(535)	environmental pollution(489)	property(580)	discharge(160)
19	clean up(510)	property(272)	lampblack(577)	live(158)
20	villager(470)	secretary(268)	secretary(515)	road(148)

4.2. Spatial distribution of environmental risk perceptions

4.2.1. Topic division of environmental risk perceptions

This study applies the LDA topic model to divide text data into topics. The number of LDA topic models is usually determined by the values of complexity and coherence, and the number of topics is generally determined based on the minimum value of complexity or the maximum value of coherence. In this paper, we use coherence to determine the number of themes in each region, and the number of iterations is 500. Finally, the northeast is divided into 6 topics, and other regions are divided into 7 topics. Figure 3 reflects the topic distance of different regions, as shown in Figure 3, the distance of different topics is larger, and there is less repetition between topics. Therefore, this paper is better in the effect of topic division.



(a) Eastern (b) Central

(c) Western (d) Northeast

Figure 2. Top 50 keywords by region (own computing)

4.2.2. Spatial distribution of environmental risk perception topics

This study divides the topic of environmental risk perception into 4 dimensions based on the actual meaning of the text and the United Nations Sustainable Development Goals (SDGs), namely perception of interest demands, health perception, perception of residential environment quality, and perception of pollution source types. Specifically, concept of interest demands mainly refers to suggestions or complaints from residents to the government, with the main keywords being *leadership*, *attention* and *resolve*. Health perception reflects residents' perception of risks to life and health, with the main keywords being *health*, *rest*, and *the old*. Perception of residential environment quality mainly refers to the risk perception of residents towards changes in the quality of their living environment, with representative keywords including *community*, *pungent*, and *unpleasant odor*. Perception of pollution source types includes two major categories of pollution sources, one is specific pollution source types, such as *noise*, *lampblack*, and *air*, and the other is the main body that causes pollution, such as *company*, *pig farm*, and *coal mine*.

Table 3 lists the relationship between environmental risk perception dimensions and the United Nations SDGs. As shown in Table 3, residents' perception of risk in the residential environment is a major component of the UN SDGs. For example, Perception of interest demands corresponds to Goal 16 (Promote just, peaceful and inclusive societies), where residents need to have peaceful, just and effective institutions to help solve problems. Perception of residential environment quality corresponds to urban sustainability, where the goal of sustainable urban development proposes to reduce negative environmental impacts per capita in cities, including a special focus on air quality and urban waste management, etc. Perception of pollution source types includes natural sources of environmental pollution, such as water pollution and air pollution. Health perception reflects the population's demand for a healthy environment, as well as the SDG of ensuring healthy lives and promoting well-being for all at all ages.

Table 3. Resident risk perception dimension and SDGs (own computing)

Perception dimension	Sustainable development goals
Perception of interest demands	Goal 16: Promote just, peaceful and inclusive societies
Perception of residential environment quality	Goal 11: Make cities inclusive, safe, resilient and sustainable
Perception of pollution source types	Goal 6: Water and sanitation; Goal 13: Climate action
Health perception	Goal 3: Health

(a) Eastern (b) Central

(c) Western (d) Northeast

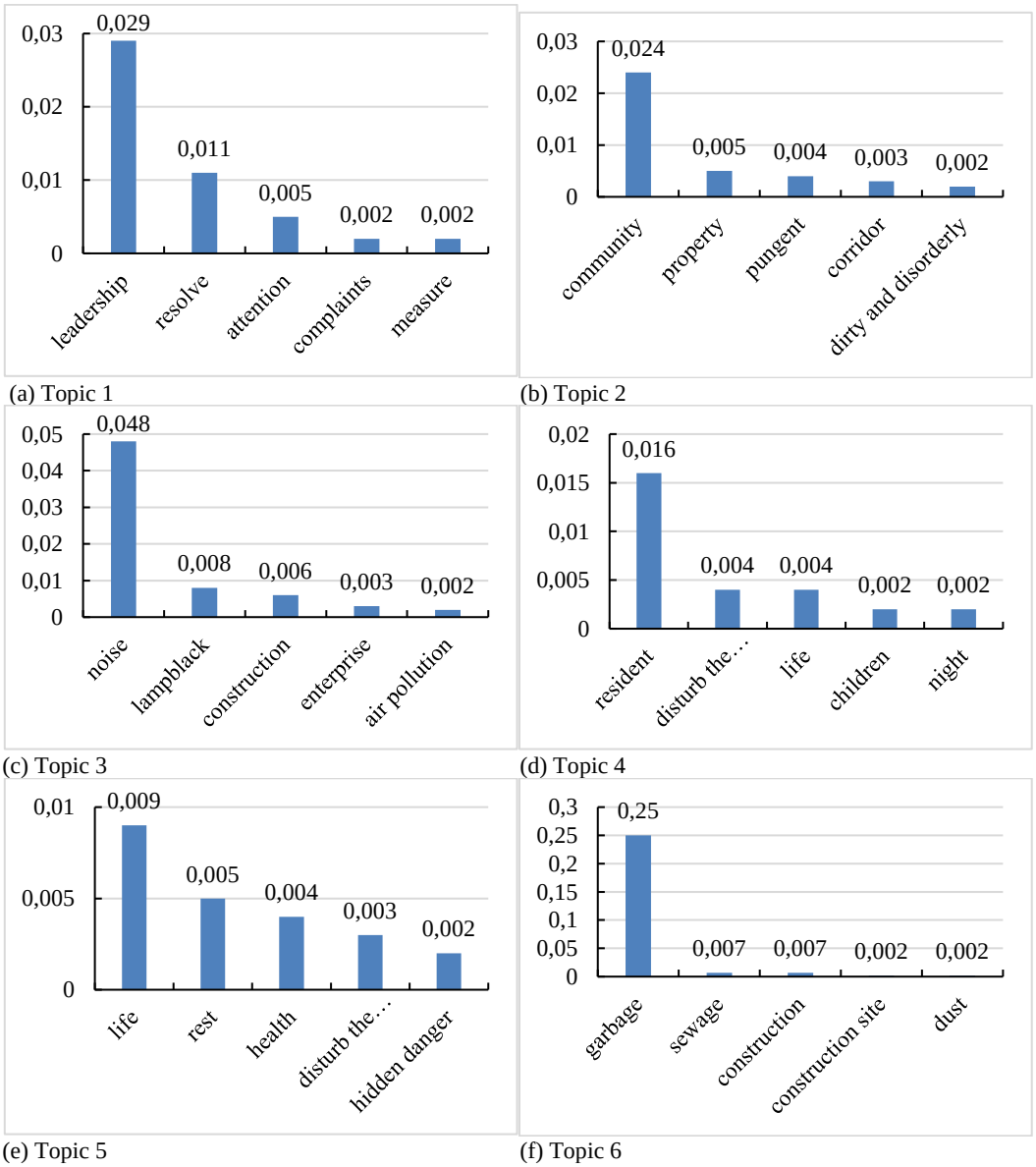
Figure 3. Topic division distance in different regions (own computing)

Tables 4 to 7 list the results of topic segmentation for different regions, including representative keywords with higher weights and their weights under different topics. Figures 4 to 7 select 5 representative keywords with higher weights from different regions for visualization.

As shown in Table 4 in the eastern, topic 1 is classified as concept of perception of interest demands based on high weighted representative keywords, while topic 2 is classified as concept of perception of residential environment quality. Perception of pollution source types and health perception contain more number of topics. Perception of pollution source types includes topics 3, 6, and 7, while health perception includes topics 4 and 5. As shown in Figure 4, the representative keywords for different topics of the same risk perception dimension vary. For example, the highly weighted keywords in Figure 4(c) are *noise* and *lampblack*, the highly weighted keywords in Figure 4(f) are garbage and sewage, and the highly weighted keywords in Figure 4(g) are *noise* and *light pollution*. In conclusion, in the eastern, the greatest weight in the perception of environmental risk is the perception of pollution source types, and, the pollution source types of most concern are garbage and noise pollution. Therefore, the eastern should make more efforts to control noise pollution, deal with domestic sewage and oil smoke emissions, improve the technology of harmless garbage treatment, and improve the health of residents' life.

Table 4. Topic division in the eastern (own computing)

Topics	Keywords	Weight	Perception dimension
Topic1	leadership	0.029	Perception of interest demands
	resolve	0.011	
	attention	0.005	
Topic 2	community	0.024	Perception of residential environment quality
	property	0.005	
	pungent	0.004	
Topic 3	noise	0.048	Perception of pollution source types
	lampblack	0.008	
	construction	0.006	
Topic 4	resident	0.016	Health perception
	disturb the residents	0.004	
	life	0.004	
Topic 5	life	0.009	Health perception
	Rest	0.005	
	health	0.004	
Topic 6	garbage	0.25	Perception of pollution source types
	sewage	0.007	
	construction	0.002	
Topic 7	noise	0.027	Perception of pollution source types
	light pollution	0.009	
	garbage	0.005	

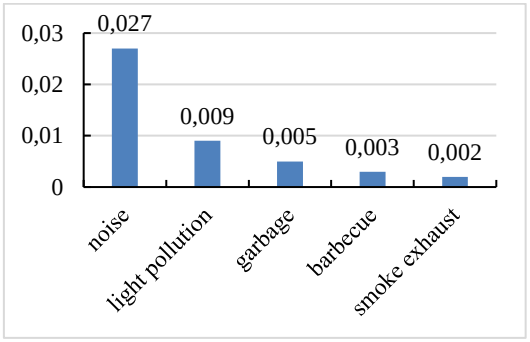


(a) Topic 1 (b) Topic 2

(c) Topic 3 (d) Topic 4

(e) Topic 5 (f) Topic 6

Figure 4. Representative keyword weights for various topics in the eastern (own computing)



(g) Topic 7

Figure 4 (continuation). Representative keyword weights for various topics in the eastern (own computing)

As shown in Table 5, in the central, perception of pollution source types contains Topic 1, Topic 2 and Topic 4, health perception and perception of residential environment quality contain Topic 3 and Topic 6, respectively, and Topic 5 and Topic 7 belong to perception of interest demands. As shown in Figure 5, in perceptions of pollution source types, Topic 1 and Topic 4 mainly describe different types of pollution (noise, garbage, air pollution) and sources of pollution (barbecue, construction), and Topic 2 mainly describes sources of environmental pollution (company, coal mine, pig farm). In conclusion, the greatest weight of perceived environmental risk in the western is perception of pollution source types, followed by perception of interest demands. Therefore, the central region should pay attention to residents' demands and formulate policies for barbecue stalls, companies and pig farms that address the sources of environmental pollution, for example, by controlling the operating hours of barbecue stalls near residential areas, improving the level of technological innovation in companies and rural farming, increasing the amount of household waste run, and reducing noise and air pollution.

Table 5. Topic division in the central (own computing)

Topics	Keywords	Weight	Perception dimension
Topic 1	noise	0.07	Perception of pollution source types
	barbecue	0.06	
	air pollution	0.04	
Topic 2	company	0.03	Perception of pollution source types
	coal mine	0.03	
	pig farm	0.03	
Topic 3	resident	0.018	Health perception
	life	0.015	
	rest	0.007	
Topic 4	noise	0.027	Perception of pollution source types
	garbage	0.005	
	construction	0.005	
Topic 5	leadership	0.024	Perception of interest demands
	solve	0.01	
	importance	0.007	
Topic 6	community	0.033	Perception of residential environment quality
	taste	0.004	
	air quality	0.002	
Topic 7	govern	0.1	Perception of interest demands
	department	0.016	
	government	0.005	

As shown in Table 6, the most weighted environmental risk perception in the western is perception of pollution source types, which contains Topic 1, Topic 4, and Topic 5. followed by perception of residential environment quality, which contains Topic 2 and Topic 6. The least weighted were health perception and perception of interest demands, which contained Topic 3 and Topic 7, respectively. As shown in Figure 6(a), Figure 6(d) and Figure 6(e), Topic 1 and Topic 4 mainly describe the source of pollution and the type of pollution (construction, garbage), and Topic 5 mainly describes the type of pollution (noise, sewage). As shown in Figure 6(b) and Figure 6(f), in perception of residential environmental quality, Topic 2 mainly describes the change of environmental perception quality (unpleasant odor), and Topic 6 mainly describes the change of the quality of the residential environment (community, green). Therefore, the western government should formulate policies for construction units to stipulate the construction time, improve the technology of waste disposal, and focus on the treatment of noise pollution and water pollution.

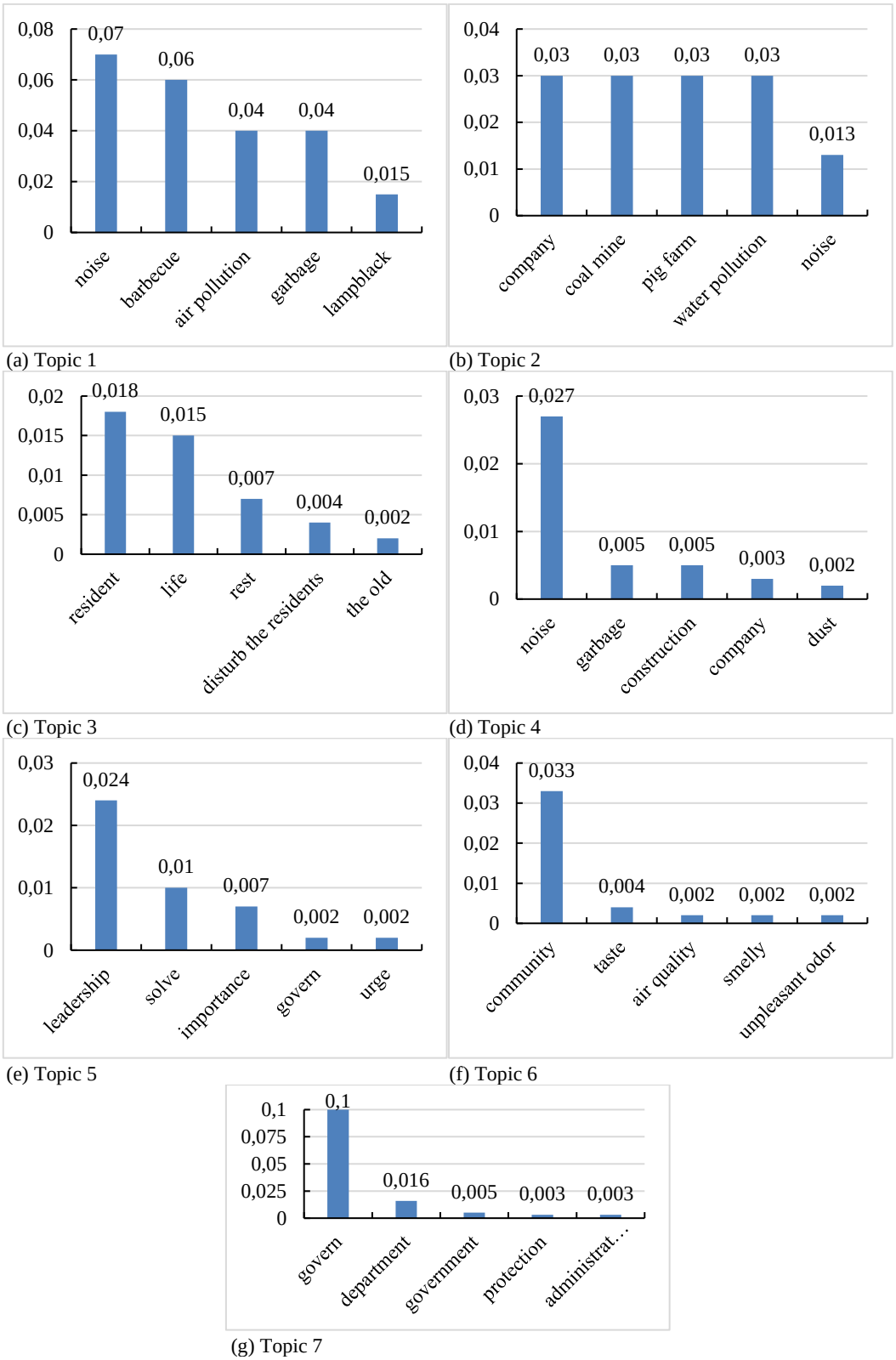


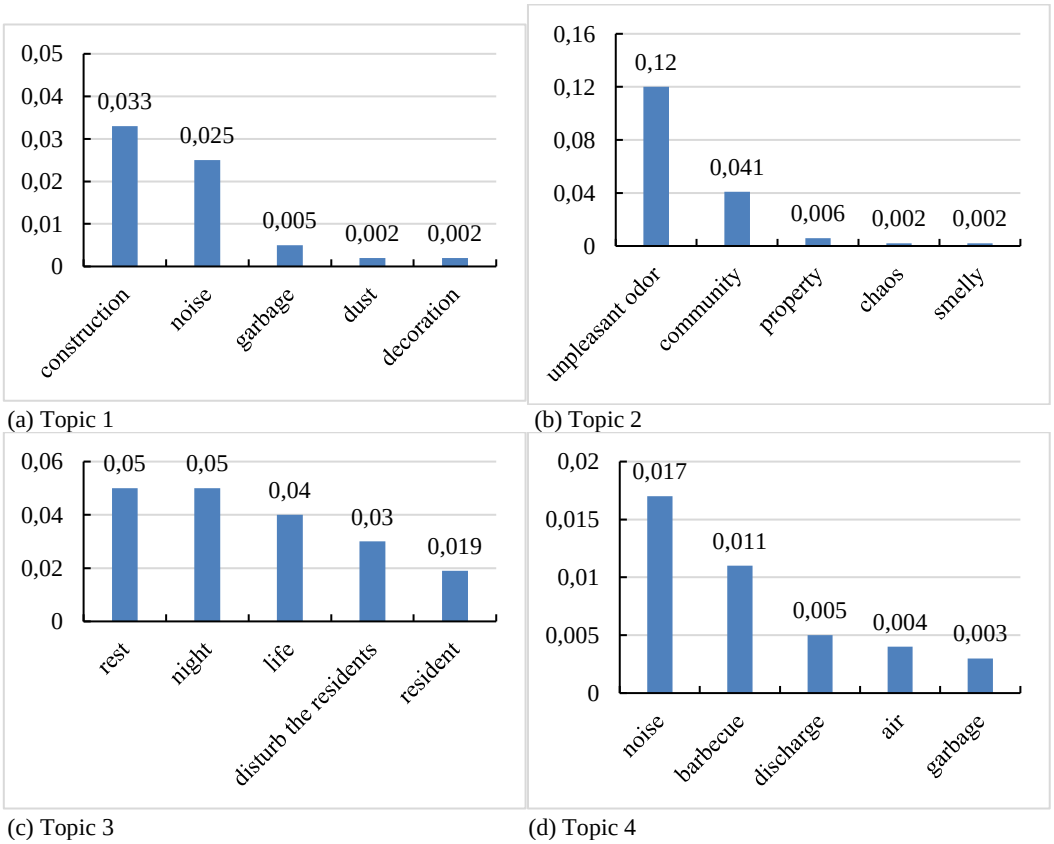
Figure 5. Representative keyword weights for various topics in the central (own computing)

As shown in Table 7, the northeastern region differed from the other regions in perceptions of interest demands and perceptions of pollution source types, which had the lowest weights and contained Topic 2 and Topic 4, respectively. Health perception and Perception of residential environment quality both contain two topics with the highest weights. As shown in Figure 7(a) and Figure 7(e), on health perception, Topic 1 mainly describes the relationship between residents' life rest and health (rest, distribution the residents) and Topic 5, in addition to describing the health of life, also mentions natural disasters (life, fire). It shows that the residents of the northeast

are most concerned about changes in residents' health and the quality of their living environment. Therefore, the Government should make greater efforts to manage the living environment of the residents and can formulate complete preventive and curative measures against natural disasters, so as to protect the residents' life and rest and improve their health.

Table 6. Topic division in the western (own computing)

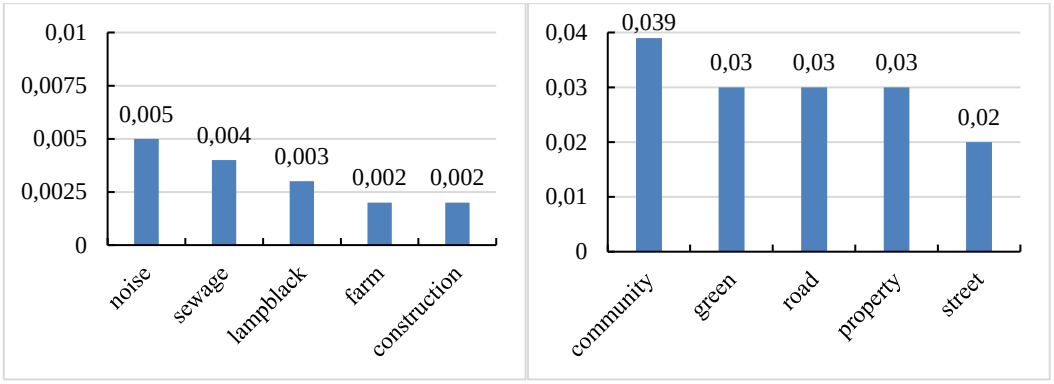
Topics	Keywords	Weight	Perception dimension
Topic1	construction	0.033	Perception of pollution source types
	noise	0.025	
	garbage	0.005	
Topic2	unpleasant odor	0.12	Perception of residential environment quality
	community	0.041	
	property	0.006	
Topic3	rest	0.05	Health perception
	night	0.05	
	life	0.04	
Topic4	noise	0.017	Perception of pollution source types
	barbecue	0.011	
	discharge	0.005	
Topic5	noise	0.005	Perception of pollution source types
	sewage	0.004	
	lampblack	0.003	
Topic6	community	0.039	Perception of residential environment quality
	green	0.03	
	road	0.03	
Topic7	solve	0.09	Perception of interest demands
	complain	0.05	
	importance	0.03	



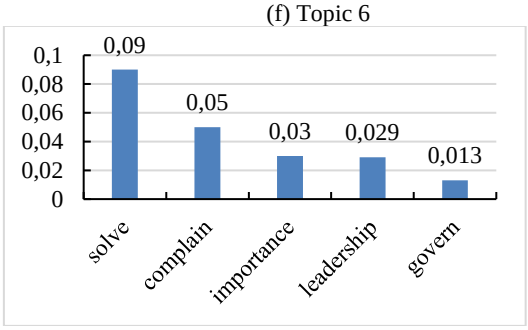
(a) Topic 1 (b) Topic 2

(c) Topic 3 (d) Topic 4

Figure 6. Representative keyword weights for various topics in the western (own computing)



(e) Topic 5 (f) Topic 6

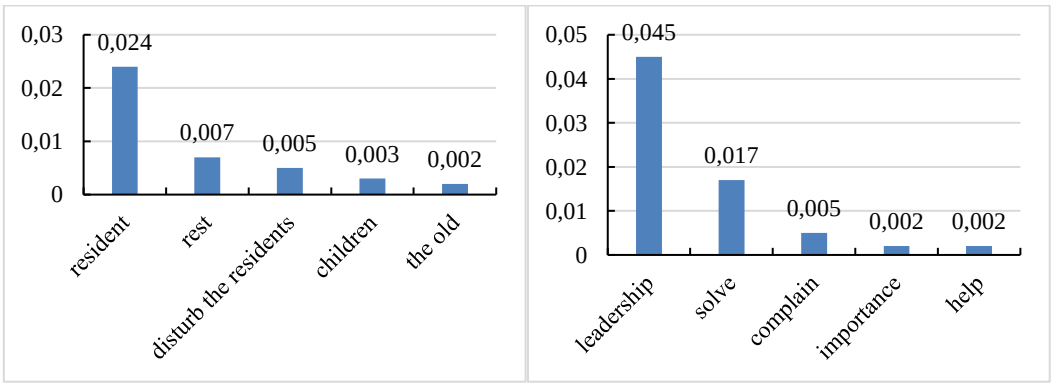


(g) Topic 7

Figure 6 (continuation). Representative keyword weights for various topics in the western (own computing)

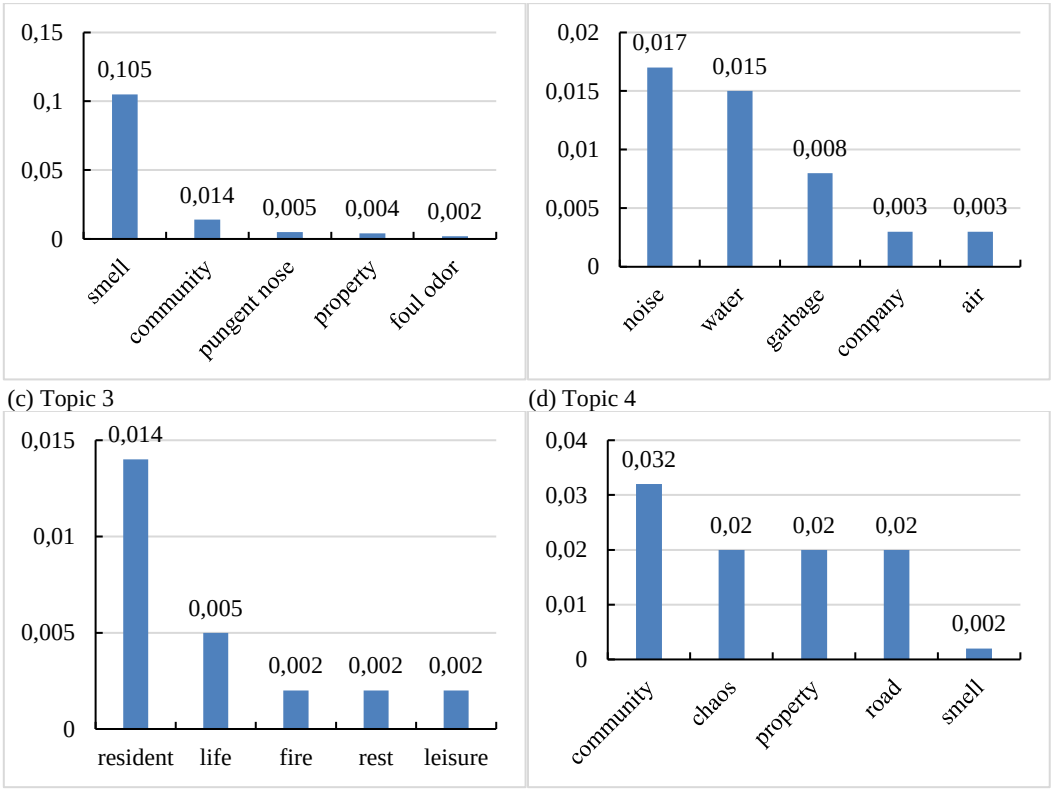
Table 7. Topic division in the northeast (own computing)

Topics	Keywords	Weight	Perception dimension
Topic 1	resident	0.024	Health perception
	rest	0.007	
	disturb the residents	0.005	
Topic 2	leadership	0.045	Perception of interest demands
	solve	0.017	
	complain	0.005	
Topic 3	smell	0.105	Perception of residential environment quality
	community	0.014	
	pungent nose	0.005	
Topic 4	noise	0.017	Perception of pollution source types
	water	0.015	
	garbage	0.008	
Topic 5	resident	0.014	Health perception
	life	0.005	
	fire	0.002	
Topic 6	community	0.032	Perception of residential environment quality
	chaos	0.02	
	smell	0.002	



(a) Topic 1 (b) Topic 2

Figure 7. Representative keyword weights for various topics in the northeast (own computing)



(c) Topic 3 (d) Topic 4

(e) Topic 5 (f) Topic 6

Figure 7 (continuation). Representative keyword weights for various topics in the northeast (own computing)

4.3. Evaluation of environmental risk perception dimensions

According to the results of regional topic division, there is spatial heterogeneity in environmental risk perception, so it is necessary to further compare the distribution differences of perception dimensions in different regions. Calculate the proportion of perception dimensions in different regions based on the number of topics included in different perception dimensions. The proportions of perception dimensions in different regions are presented in Table 8, as shown in Table 8, Health perception has the highest proportion in the northeast (33.333), followed by the eastern (28.571), and lastly, the central and western (14.286). Perception of interest demands was highest in the center (28.571) and perception of residential environment quality was highest in the northeast (33.333). Perception of pollution source types was highest in the eastern, central and western regions (42.875) and lowest in the northeast (16.667).

Table 8. Environmental risks perception dimension proportion of different regions (own computing)

Region	Health perception	Perception of interest demands	Perception of residential environment quality	Perception of pollution source types
Eastern	28.571	14.286	14.286	42.857
Central	14.286	28.571	14.286	42.857
Western	14.286	14.286	28.571	42.857
Northeast	33.333	16.667	33.333	16.667

Figure 8 shows the spatial distribution of environmental risk perception dimensions. As shown in Figure 8, there are differences in environmental risk perception dimensions among regions. In general, the governments of the eastern, central and western regions need to formulate policies to address the sources and types of environmental pollution, while the northeastern region needs to improve the quality of the environment in which residents live, mainly in accordance with their aspirations, and to formulate practical and feasible preventive and control measures for natural disasters.

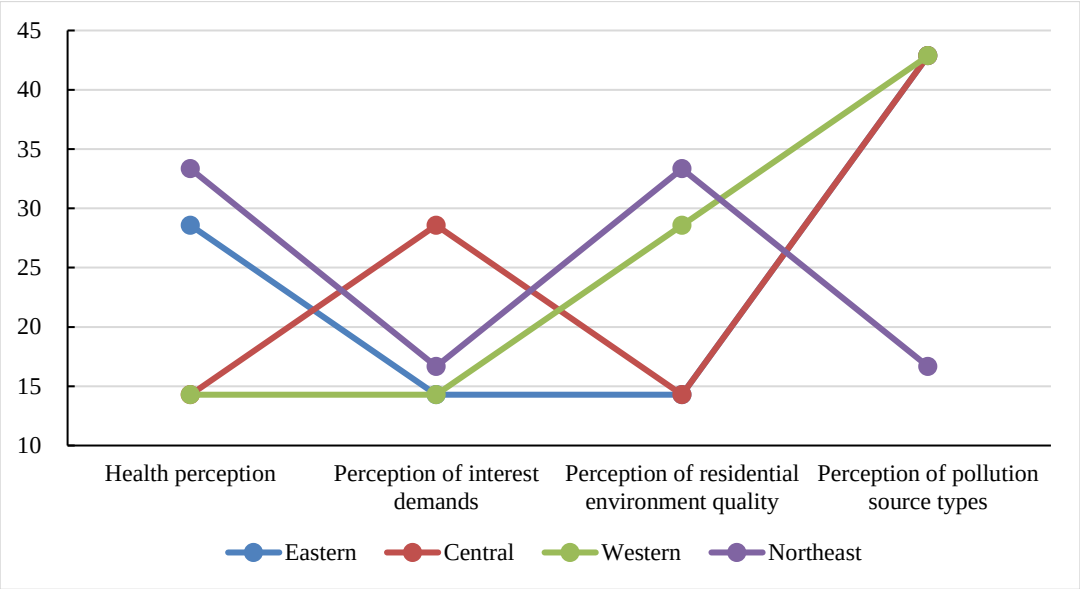


Figure 8. Environmental risks perception dimension proportion of different regions (own computing)

5. Conclusion

This article takes the United Nations Sustainable Development Goals as the starting point, using the message board of China's *People's Daily*, this paper collects environmental opinion data from 31 provinces (excluding Hong Kong, Macao, and Taiwan) and analyzes the spatial distribution of environmental opinion hotspots and environmental risk perception dimensions. The main conclusions are as follows. Firstly, environmental public opinion hotspots have spatial heterogeneity. Overall, the most frequent occurrences are in the residential environment, interest demands, and noise pollution. Secondly, there are differences in environmental risk perception topics among different regions. The perception of pollution source types has the highest weight in environmental risk perception in the eastern, central, and western. Specifically, the types of pollution sources in the eastern region that receive the most attention are garbage and noise pollution. In addition to paying attention to noise pollution, the central and western also have a higher perceived weight on the polluters. Residents in the northeast are most concerned about changes in residents' health and living environment quality. Thirdly, from the perspective of environmental risk perception, health perception has the highest proportion in the northeast, followed by the eastern, and finally the central and western regions. Perception of interest demands was highest in the central, perception of residential environment quality was highest in the northeast, and perception of pollution source types was highest in the eastern, central, and western regions and lowest in the northeast.

Based on this, the following practical recommendations are made for the different regions. The eastern region should make greater efforts to combat noise pollution, deal with domestic sewage and fume emissions, and improve technology for harmless waste treatment. The central region should pay attention to the demands of residents, formulate policies on barbecue stalls, businesses and pig farms to address the sources of environmental pollution, improve technological innovation in companies and rural farming, increase the amount of domestic garbage run, and reduce noise and air pollution. The government of the western region should formulate policies for the construction unit to stipulate the construction time, improve the garbage treatment technology, and focus on the treatment of noise pollution and water pollution. The northeast region should make more efforts to control the living environment of the residents, can formulate complete preventive and control measures against natural disasters to protect the residents' life and rest, and improve the health level of the residents.

References

1. AZADI H., PETRESCU D. C., PETRESCU-MAG R. M., OZUNU, A., 2020, Special issue: Environmental risk mitigation for sustainable land use development, *Land Use Policy*, 95, 104488.
2. BALŽEKIENĖ A., TELEŠIENĖ A., MORKEVIČIUS V., 2022, Spatial dependencies and the relationship between subjective perception and objective environmental risks in Lithuania, *Sustainability*, 14(7): 3716.
3. BERARDO R., HOLM F., HEIKKILA T., WEIBLE C. M., YI H., KAGAN J., CHEN C., YORDY J., 2020, Hydraulic fracturing and political conflict: News media coverage of topics and themes across nine states, *Energy Research & Social Science*, 70: 101660.

4. CHEN Y., LIU X., 2021, How do environmental news and the *under the dome* documentary influence air-pollution knowledge and risk perception among Beijing residents?, *SAGE Open*, 11(2): 215824402110157.
5. CHENG H., BIAN Q., MAO Q., 2022, How can internet use and environmental risk perception encourage pro-environmental behaviors? The mediating role of governmentperformance perception, *Polish Journal of Environmental Studies*, 31(6): 5621-5631.
6. CHOON S.-W., ONG H.-B., TAN S.-H., 2019, Does risk perception limit the climate change mitigation behaviors?, *Environment, Development and Sustainability*, 21(4): 1891-1917.
7. FERGUSON P., WOLLERSHEIM L., 2023, From sustainable development to resilience? (Dis) continuities in climate and development policy governance discourse, *Sustainable Development*, 31(1): 67-77.
8. GAO S., LI W., LING S., DOU X., LIU X., 2019, An empirical study on the influence path of environmental risk perception on behavioral responses in China, *International Journal of Environmental Research and Public Health*, 16(16): 2856.
9. GUNJYAL N., RANI S., ASGARI LAJAYER B., SENAPATHI V., ASTATKIE T., 2023, A review of the effects of environmental hazards on humans, their remediation for sustainable development, and risk assessment, *Environmental Monitoring and Assessment*, 195(6): 795.
10. HUANG H., LONG R., CHEN H., SUN K., LI Q., 2022, Exploring public attention about green consumption on Sina Weibo: using text mining and deep learning, *Sustainable Production and Consumption*, 30: 674-685.
11. HUANG J., YANG J. Z., 2020, Beyond *under the dome*: An environmental documentary amplified public risk perception about air pollution in China, *Journal of Risk Research*, 23(2): 227-241.
12. KANG H. J., KIM C., KIM S., KIM C., 2023, A study on environmental trends and sustainability in the ocean economy using topic modeling: south Korean news articles, *Processes*, 11(8): 2253.
13. KENNY J., 2020, Economic conditions and support for the prioritisation of environmental protection during the Great Recession, *Environmental Politics*, 29(6) 937-958.
14. MA Y., MA Y., CAO Z., LI S., LV B., RUAN Z., WANG L., YU H., LU Z., 2021, Residents' cognition and behavior related to eco-environmental risks from the development of large coal power plants: a case study in Xilinhot, Inner Mongolia, *Sustainability*, 13(14): 7813.
15. OLOWOPOROKU O., DARAMOLA O., ODUNSI O., 2021, Determinants of residents' perceived environmental hazards and risks in coastal towns of Delta State, Nigeria, *International Journal of Disaster Risk Reduction*, 56: 102094.
16. QIN M., SUN M., LI J., 2021, Impact of environmental regulation policy on ecological efficiency in four major urban agglomerations in eastern China, *Ecological Indicators*, 130: 108002.
17. SIERRA-BARÓN W., NAVARRO O., AMÉZQUITA NARANJO D. K., TERES SIERRA E. D., NARVÁEZ GONZÁLEZ C. M., 2021, Beliefs about Climate Change and Their Relationship with Environmental Beliefs and Sustainable Behavior: A View from Rural Communities, *Sustainability,* 13(9): 5326.
18. SONI A., MISTUR E. M., 2022, Flirting with disaster: Impacts of natural disasters on public support for environmental spending, *Global Environmental Change*, 75: 102552.
19. SULDOVSKY B., B. FRANK L., 2022, Strengthening public engagement on environmental hazards: Insights from cross-disciplinary air pollution research, *Environmental Hazards*, 21(3): 218-234.
20. SUN Z., ZHU D., 2023, Surveillance of public risk perceptions on outdoor air pollution: Evidence from online search behaviours in China, *Journal of Environmental Planning and Management*, https://doi.org/10.1080/09640568.2023.2183822.
21. TEH P. L., PIAO S., ALMANSOUR M., ONG H. F., AHAD A., 2022, Analysis of popular social media topics regarding plastic pollution, *Sustainability*, 14(3): 1709.
22. VERNER M., 2023, Political trust and ecological crisis perceptions in developing economies: Evidence from Ecuador, *Latin American Politics and Society*, https://doi.org/10.1017/lap.2023.14.
23. WANG B., HAN S., AO Y., LIAO F., WANG T., CHEN Y., 2022, The impact of public opinion pressure on construction company green innovations: The mediating effect of leaders' environmental intention and the moderating effect of environmental regulation, *Frontiers in Psychology*, 13: 936058.
24. WANG B., LIU B., LI Y., 2023, A dark side of trust: examining the influence of environmental risk perception on citizens' plastic-avoiding behavior, *IEEE Transactions on Computational Social Systems*, https://doi.org/10.1109/TCSS.2023.3297747.
25. WANG N., GUO J., ZHANG J., FAN Y, 2022, Comparing eco-civilization theory and practice: Big-data evidence from China, *Journal of Cleaner Production*, 380: 134754.
26. ANG S., JIANG J., ZHOU, Y., LI J., ZHAO D., LIN S., 2020, Climate-change information, health-risk perception and residents' environmental complaint behavior: An empirical study in China, *Environmental Geochemistry and Health*, 42(3): 719-732.
27. XIONG J., HSWEN Y., NASLUND J. A., 2020, Digital surveillance for monitoring environmental health threats: A case study capturing public opinion from twitter about the 2019 Chennai water crisis, *International Journal of Environmental Research and Public Health*, 17(14): 5077.
28. XU S., SUN K., YANG B., ZHAO L., WANG B., ZHAO W., WANG Z., SU M., 2021, Can public participation in haze governance be guided by government? – Evidence from large-scale social media content data mining, *Journal of Cleaner Production*, 318: 128401.
29. YANG X., 2023, The influence of trust on the public's environmental risk perception: Evidence from China, *Local Environment*, 28(6): 728-738.
30. YAO L., SHEN J., ZHANG F., GU X., JIANG S., 2021, Influence of environmental values on the typhoon risk perceptions of high school students: A case study in Ningbo, China. *Sustainability*, 13(8): 4145.
31. YOO E., BAEK K., 2019, Gender differences in environmental and health-related risk perception in Korea, *Asian Women*, 35(4): 47-67.

32. ZENG J., JIANG M., YUAN M., 2020, Environmental risk perception, risk culture, and pro-environmental behavior, *International Journal of Environmental Research and Public Health*, 17(5): 1750.
33. ZHOU Z., LIU J., ZENG H., ZHANG T., CHEN X., 2020, How does soil pollution risk perception affect farmers' pro-environmental behavior? The role of income level, *Journal of Environmental Management*, 270: 110806.