Title

The Noah's Ark effect: Radicalization of social meanings of disaster preparedness introduced by the estimation of a massive disaster[1]

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[1] List of abbreviations:

SNS	Social networking services

Abstract

This study proposed and demonstrated the “Noah’s Ark effect,” a concept in which massive disaster scenarios generated radicalized effects on disaster preparedness within local communities, as opposed to the cry wolf effect. The study setting was Kuroshio town in Kochi Prefecture, Japan, where the largest tsunami was expected to hit based on the Cabinet Office’s New Estimation in March 2012. The study quantitatively analyzed Japanese newspaper articles on “disaster prevention” in Kuroshio through text mining and conducted a comparison between the tsunami disaster caused by the Tohuku earthquake and the expected tsunami devastation in other areas. The results revealed that the Noah’s Ark effect is characterized by five features: (1) increasing the number of articles to the same level as that of tsunami-affected areas; (2) focusing on preventing a disaster or a hazard itself (disaster as an event) rather than preparing for issues brought about by a disaster (disaster as a process); (3) understanding changes as gradual “shifts” rather than sudden changes observed in the affected areas; (4) being typically characterized by the resident voluntary action (e.g., evacuation training) rather than their dependence on government measure; and (5) promoting specific issues and simplifying less relevant issues. The study proposed the need to consider not only the cry wolf effect, in which disaster forecasts decline disaster prevention measures, but also the Noah’s Ark effect, in which estimations of a massive disaster urge people to radically accelerate (e.g., evacuation training) and/or decrease (e.g., recovery, mourning) the degree of specific disaster prevention programs.

Keywords

Noah’s Ark Effect, Disaster Preparedness, Text Mining, Japan, Tsunami

O man of Shuruppak, son of Ubar-Tutu:
Tear down the house and build a boat!
Abandon wealth and seek living beings!
Spurn possessions and keep alive living beings!

Tablet XI, "Epic of Gilgamesh"

1 Introduction

1.1 Emphasis on tsunami estimations and their effect on disaster preparedness

Unlike estimation failure, an emphasis on estimation has led to the emergence of new problems, which the present study calls the "Noah's Ark" effect. In the aftermath of the 2011 earthquake off the Pacific coast of Tohoku (henceforth the 2011 Tohoku earthquake), the Committee for Modeling the Nankai Trough Megaquake (*Nankai Trough Kyodai Jishin Model Kentoukai*) announced the so-called New Estimation (*Shin-Soutei*) in the Cabinet Office in 2012 (see also Goda et al., 2021). The New Estimation seeks to calculate the most devastating scenario that Japan will experience to avoid underestimating the ensuing damages, and it aims to provide rich information with the local communities to prepare for a tsunami event.

The enigma of perception and behavior has prompted controversial discussions in disaster science. Previous studies have highlighted the rational man model as a dominant framework to understand laypeople's disaster preparedness. That is, traditionally, rational behavior theory (Ajzen & Fishbein, 1980) and the theory of planned behavior (Ajzen, 1991) state that a person who is not prepared for disasters has yet to form an intention to do so using their attitudes, norms, and behavioral control. Similarly, protection motivation theory (Maddux & Rogers, 1983) considers that an individual's motivation to take protective action must be triggered by the threat appeal. These theories indicate that if people fully understand disaster or risk information, they must take some defensive actions; as such, while the New Estimation intends to accelerate communities' disaster preparedness, the actual situation in Kuroshio tells a more complex story of disaster preparedness mixed with abandonment and thoroughness.

Studies have also revealed that along with positive effects, risk information also leads to negative outcomes. When forecast or prediction failure is considered under the risk of natural hazards, the cry wolf effect or false alarm effect (Breznitz, 1984) is a typical consequence. The cry wolf effect explains that if a forecast or prediction is too frequently inaccurate, the public would eventually ignore it, as what happened in the story "The Boy Who Cried Wolf." The cry wolf effect has been studied, and controversy persists as to whether it is an emphasis or a good predictor (i.e., Trainor et al., 2015). However, generally, most scholars believe that disaster preparedness is affected by the false alarm ratio (e.g., Kajiya et al., 2018; LeClerc & Joslyn, 2015; Trainor et al., 2015). The typology of a false alarm has been used by the New Estimation to generate potential actions. A tsunami event is not observed but rather forecasted; that is, it appears to fall under a "false alarm" in that the possibility remains that the event does not occur. This means that cases of infrequent events such as tsunamis are not well understood by traditional warning systems mainly because the associated forecasts or predictions are rarely verified.

The effect of the New Estimation on residents' disaster preparedness, however, remains unclear. Studies on tsunami response, such as Urata and Hato (2013), have found that people with higher tsunami risk awareness decline their evacuation behaviors in that they support others before evacuating from a tsunami. Scholars have also indicated that evacuations were conducted by fewer people who have been victims of past tsunamis but have not sustained any serious injuries as opposed to those who have been more severely affected (Fujimoto et al., 2012; Kanai & Katada, 2012;), which is consistent with other tsunami evacuation findings (Katada et al., 2005). A study on tsunami estimation areas after the 2011 Tohoku earthquake found that people in nonaffected areas underestimate the fatal height of tsunamis because of the large-scale tsunami caused by the earthquake (Oki & Nakayachi, 2012). However, evacuations are implemented not in a singular and linear way but in a more collective and complex manner (Riad et al., 1999), and a few studies have examined the effect of large-scale estimations on disaster preparedness.

Recent review studies, providing a critical perspective in that traditional rational frameworks are too simplified to understand public disaster preparedness, have questioned "how" a person understands risk. In fact, quite a few cases have revealed the opposite; that is, even people with higher risk

perception do not take preparedness seriously, which is known as the risk perception paradox (Wachinger et al., 2013). Concurrently, Eiser et al. (2012) reviewed contemporary studies on risk perception and response and criticized the rational man model for being insufficient in understanding disaster preparedness; they also stressed the importance of recognizing how people's interpretations are shaped by their experiences, feelings, contexts, and others. This transition from "what" to "how" is also understood from a learning perspective (Kitagawa, 2020); while previous studies are likely to focus on "teaching" from the teachers' viewpoint, it is also important to view the experience of "learning" from the lens of the students.

1.2 Research objectives

The present study aims to focus on how disaster preparedness issues changed before and after the New Estimation, considering social discourse change dynamics from learners' (residents') sociopsychological perspective. To investigate the effects of the New Estimation, the present study devised a typology that refers to the perception of situated learners (Eiser et al., 2012).

Therefore, the false-alarm typology (c.f., Trainor et al., 2015) (or traditional signal detection theory) must be revised considering the expectation of events from estimation data on the following points; while the typology in the study by Trainor et al. (2015) used a classification axis of whether the disaster was forecasted, this typology changes it to whether the forecast of the disaster was greater than expected. Thus, the modified typology consists of (1) whether an event has been observed and (2) whether a prediction of an event was expected (or more than expected) (Figure 1). In the case of a disaster's occurrence, if the estimation is lower than residents' expectations, they would "feel" hit; meanwhile, if it is higher, they would "feel" spared. In the case of an estimated disaster, if the estimation is lower than residents' expectations, they would "feel" as if it was a false alarm; however, if it is higher, they would "feel" as if the disaster was indeed catastrophic.

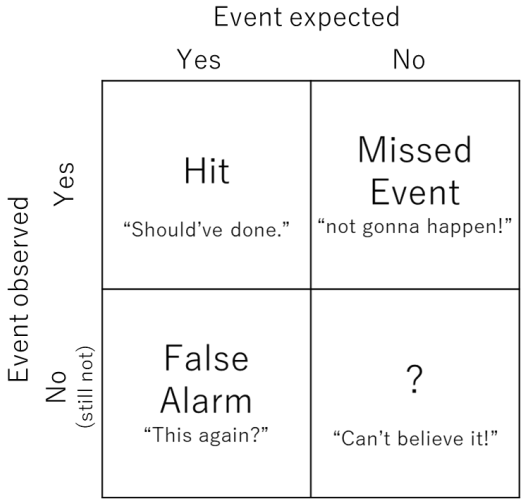

Figure 1. The typology in the present study (modified the typology in Trainor et al., 2015)

Thus, among areas that experienced severe shock from the New Estimation, Kuroshio town falls under the lower right column of Figure 1, which the present study calls the Noah's Ark effect explained in the next section. This study will use the typology of infrequent events and investigate what associated topics are often discussed.

This study focuses on Kuroshio Town in Kochi Prefecture, which is expected to be severely affected by Nankai Trough earthquake and tsunami according to the New Estimation of earthquake threat. Furthermore, the study examines how the social discourse on disaster preparedness has changed. In addition, it compares Kuroshio Town with the cities in the affected areas of the Tohoku Earthquake, where recovery and lessons learned were repeatedly discussed. In other words, the media analysis will be conducted to clarify the tendency of the words mentioned by the local community regarding disaster prevention, depending on regional differences of the region (actual disaster or expected disaster) and the event (occurrence of tsunami disaster or announcement of tsunami estimation).

2 Research context and research questions

Here, this study reviews the literature from four perspectives to examine the research questions. First, the social impacts are investigated (damage, impact on policy, political discourse, and society, and impact on disaster preparedness) of the Tohoku earthquake and tsunami as well as of the Fukushima nuclear power plant accident. Then, the contents of the New Estimation issued by the government are examined in relation to the review. Third, the applicability of analyzing newspaper article datasets to capture social impacts will be discussed. Finally, the story of Noah's Ark used in

this study will be explained in contrast with the cry wolf effect. Finally, three research questions will be presented for consideration in this study.

2.1 The extreme impact of the 2011 Great Tohoku earthquake, tsunami, and Fukushima nuclear power plant accident

The earthquake that struck off the Pacific coast of Tōhoku at 2:46 p.m. on March 11, 2011 was the largest earthquake ever recorded in Japan, with a magnitude of 9.0 on the Richter scale (Cabinet Office, 2011). According to Fire and Disaster Management Agency (2021), as of March 2021, 19,747 people were reported dead and 2,556 people were missing, making it the deadliest disaster in Japan since the Pacific War. The total amount of damage is estimated to be between 16 and 25 trillion yen (≈ $160 to 250 billion; calculated at 100 yen to the dollar), and the damage has significantly impacted not only human lives and buildings but also social infrastructure such as roads, levees, ports, railways, and electricity (Kazama & Noda, 2012). This compound disaster has become known in Japanese society as the Great East Japan Earthquake (hereafter the Tohoku Earthquake, for the sake of simplicity).

However, the Tohoku Earthquake was not only characterized by the damage it caused. In addition, the present study reviews the impact of the disaster on Japanese society to form the social acceptance of the disaster preparedness for coming catastrophes from three perspectives: the impact on policy and political discourse, societal response, and changes in disaster preparedness prior to the announcement of New Estimation.

The policy implications and impact on political discourse were significant. The Tohoku Earthquake was the first and only time that an Extreme Disaster Management Headquarters (*Kinkyu Saigai Taisaku Honbu*) was established by a government (Disaster Management, Cabinet Office, 2019). Furthermore, the national response came in the form of the Basic Act on Reconstruction in Response to the Great East Japan Earthquake, which was enacted on June 20, 2011. This law included the establishment of the Reconstruction Agency, the issuance of reconstruction bonds, and the creation of a System of Special Zones for Reconstruction (Iwasaki, 2011). Following this, a framework was established in November 2011 to support reconstruction through a so-called “reconstruction tax” (Special Income Tax for Reconstruction) that was added to the income tax, along with a scheme to support the reconstruction of disaster-stricken areas by the entire nation emerged. This reflects the uniqueness of the Tohoku earthquake, which led to the support of the entire nation for a specific disaster (Iokibe, 2021). In addition to policy change, the Tohoku Earthquake impacted political discourse. The recovery (reconstruction) of the areas affected by the Tohoku Earthquake was superimposed on the recovery of the country in a symbolic sense, as stated by then Prime Minister Noda: “Without the recovery of Fukushima, there will be no recovery of Japan” (Mainichi Newspaper, 2011), and similar slogans were passed on to the second Abe cabinet and subsequent cabinets and were repeatedly used. The Tohoku Earthquake led “recovery” to become a politicized term (Terashima, 2021).

Next, in addition to the effects of the disaster, the Tohoku Earthquake affected Japanese society as a whole in the form of voluntary-restraint (*Jishuku*), civic activism, the passing on of the lessons, and the dawning of a new era. Initially, the Tohoku Earthquake was seen as a voluntary-restraint (*Jishuku*) (Nishi, 2020) in which the entire nation mourned, including the voluntary cancellation of events and festivals even outside the affected areas (Matsubara, 2021). Simultaneously, there was a massive outpouring of support for the affected areas (approximately 3.5% of Japanese residents volunteered in the affected areas, and 67.4%, or two out of three, donated money) (Daimon & Atsumi, 2018). Not only did the Tohoku Earthquake revitalize civic activities as a form of the support activities (Yamashita, 2014) but also impacted subsequent social movements in Japan (Machimura et al., 2015), as the demonstrations over the Fukushima nuclear accident and the elimination of the nuclear power plant were the largest in Japan for over half of a century (Williamson, 2012). Then, the Tohoku Earthquake become a subject that should be recalled in society based on its lessons, and the importance of conveying its memories and lessons has been repeatedly stated (e.g., Kanayama, 2020; Sakamoto, 2012; Sato et al., 2018; Shibayama, 2019). This influence on society was expressed by Dr. Mikuriya, who served as acting chairman of “The Reconstruction Design Council in response to the Great East Japan Earthquake” using the expression “post-disaster,” which emphasizes that Japanese society was in a new phase, moving the from post-war to the post-disaster period (Mikuriya, 2011). On the whole, the disaster was described as and dawn of a new era as well as the solidarity of the Japanese society (Mikuriya, 2011; Tanaka, 2013).

The Tohoku Earthquake was not only unique in terms of national scheme of policy, politicized practice of recovery, and reaction of society but also in terms of subsequent disaster preparedness and the prevention paradigm (Raby et al., 2015; Sun et al., 2013; Tanaka, 2013; Yamori, 2017) and tsunami simulations (Baba et al., 2019; Mulia et al., 2017; Woessner & Jalali, 2020). Sun et al. (2013). Referring to previous studies and documents from government agencies and local governments, we can summarize the impact of the Tohoku Earthquake on disaster preparedness in three ways; first, the realization of tsunami evacuation issues, such as the concentration of casualties among the elderly and the deaths that occurred during evacuation by car due to traffic congestion and damage to road surfaces; second, the extremely low evacuation rate in areas that were not damaged (6% of all evacuees evacuated to designated shelters) at the time of the Tohoku Earthquake; third, a review of the estimation made by the national and local governments.

The impact on the third issue (Sun et al., 2013) is closely related to the first one reported in this paper, as seen in other studies that emphasized that the Tohoku Earthquake exposed the situation of "Unexpected" (Kagan & Jackson, 2013; Tanaka, 2013). Yamori (2017) explained that the reason why large numbers of people were dead and missing in the Tohoku Earthquake is that the consequences of disasters beyond the expected force are more catastrophic, although the average death toll was lower due to improved disaster management that was developed from 1968 to 1990. The argument that people should look at the possibility of reality even if it is outside of our expectations—a kind of contradiction in terms: expecting things beyond the expected—was welcomed as a new scope of disaster preparedness and its management (Tanaka, 2013).

2.2 The New Estimation of tsunami hazard in in Japan

On March 31, 2012, the so-called "New Estimation" concerning the Nankai Trough earthquake was announced (Committee for Modeling the Nankai Trough Megaquake, 2012). This estimation was made by the Committee for Modeling the Nankai Trough Megaquake within the Central Disaster Management Council established in the Cabinet Office, which is composed of academic experts and cabinet ministers (for a detailed description of the organizational structure and relations of disaster management in Japan, see Ishiwatari, 2021). The committee was established after the Tohoku Earthquake in anticipation of a major earthquake in the Nankai Trough based on the interim report of the Expert Committee on Earthquake and Tsunami Countermeasures Based on Lessons Learned from the Tohoku Earthquake of the Central Disaster Management Council (Disaster Management, Cabinet Office, 2013). Subsequently, the Nankai Trough Mega Earthquake Countermeasures Study Working Group was set up as a superior organization to the Committee for Modeling the Nankai Trough Megaquake was established, and estimations based on the new model were announced by the working group twice, in March and August 2012. The present paper considers the beginning of impact of New Estimation as this first announcement of the assumption on March 31, 2012.

The New Estimation was based on the principle that "the probabilistically largest earthquakes and tsunamis should be considered, taking into account all possibilities," (p.1); the moment magnitude using the tsunami fault model was changed to 9.1, and the largest tsunami height was estimated from the superposition of 11 cases (Disaster Management, Cabinet Office, 2013). Mr. Kawata of Kansai University, who actually chaired the working group, recalled that in announcing the New Estimation, he kept in mind that even if the shoreline was struck it would not cause damage beyond estimation (Kawata, 2013). The maximum tsunami height indicated by the new assumption was 34.4 meters, which caused a great stir nationwide (Asahi Newspaper, 2012). The 34.4-meter tsunami was estimated to hit Kuroshio Town in Kochi Prefecture, which is the subject of this study, and its height was 4.3 times higher than the 7.91 meters estimated for the Kochi Prefecture event in 2004. At the second announcement in August 2012, the damage estimates were released, indicating that the number of houses totally destroyed or lost would range from 940,000 to 2.38 million, and the death toll ranged from 32,000 to 323,000, far exceeding the 19,747 dead (2,556 missing) in the Tohoku Earthquake (Central Disaster Management Council et al., 2012).

A set of tsunami risks has compelled the establishment of preparedness activities for residents (e.g., Sento, 2019; Takabatake et al., 2020) and scientists (Takabatake et al., 2020). In fact, there were only 47 tsunami evacuation towers before the Tohoku earthquake (Kanai et al, 2017). This number was increased to 427 towers as of August 2018 (Cabinet Office, 2018). Designated tsunami evacuation buildings also increased from 1,876 buildings in 2011 (Cabinet Office and MILT) to 14,903 buildings

in 2018 (Cabinet Office, 2018). Ironically, however, scenarios of massive death (Goda et al., 2021) and tsunami (Goda et al., 2020), on the other hand, had an ambivalent impact on Kuroshio (Matsuda, 2013; Onishi, 2018; Sun et al. al., 2017). Sun et al. (2014) mentioned that some Kuroshio residents ignored evacuation measures in response to the New Estimation because the worst case is that the tsunami would hit in less than 10 minutes. For some residents, such as the handicapped, this scenario means there was simply no time to evacuate. However, the town also developed tsunami countermeasures (e.g., Hatayama & Nakai, 2020; Nakano et al., 2020; Sun, 2020). As Kuroshio is now considered an "advanced disaster prevention area" in Japan, it has coordinated elaborate evacuation drills; after the announcement of the New Estimation, more than 1,200 disaster preparedness activities have been conducted with 60,000 Kuroshio residents participating (Onishi, 2018). Such developments in disaster prevention, including preparations for disaster prevention plans for all areas, have also been conducted by residents themselves.

As noted above, the Tohoku Earthquake was not only problematic and controversial because of the magnitude of the earthquake, tsunami, and nuclear accident but also because of its unique impact on policy, politics, and society in terms of the particular ways in which recovery and lessons learned are recounted; therefore, it created a new ground for disaster preparedness and a social condition that accepts it. The Tohoku Earthquake can be considered as a national trauma (c.f., Alexander et al., 2004), which strongly supports the discourse of disaster preparedness and prevention, and the New Estimation, which was announced to prepare for future tsunami disasters, caused a huge stir in the Pacific coastal areas where a huge Nankai Trough earthquake is expected. Among these, the greatest attention was paid to Kuroshio Town, where the largest tsunami was expected to hit.

2.3 The availability of newspaper article databases

Media content analysis can be a useful tool to capture the implicit context behind the community (i.e., social representation theory: Moscovici, 2000; cultural trauma: Eyerman, 2015). Eyerman (2015), for example, in considering post-disaster social discourse, pointed out that Hurricane Katrina was more than a "terrible storm," but a social disaster and a social catastrophe that was etched in the collective memory of American society, and that careers groups such as the media, politicians, professionals, and artists played an important role in the background. Eyerman (2015) focused on qualitative analysis, but in recent years, in disaster studies, with the development and accessibility of technology, many studies have performed text mining (e.g., Hasan et al., 2019; Sasaki, 2019; Sasaki et al., 2020; Yamada, 2020) to understand the context of disaster management. Recently, several scholars have focused on social media to explore the emotional expression of social responses (e.g., Huang & Xiao, 2015; Miura et al., 2015, 2016; Mohanty et al., 2021; Pourebrahim et al., 2019; Wang et al., 2016; Xiao et al., 2015) and methodological implementation (e.g., Hao & Wang, 2020; Rexiline Ragini et al., 2018; Rossi et al., 2018; Xiao et al., 2015). There is a certain rationale for capturing media discourse in capturing the transformation of social discourse.

Newspaper articles are considered materials for text mining as a new-old tool (Ewart & Mclean, 2015; Fukutoku, 2011; Kanda et al, 2014; Tekeli-Yesil et al., 2019; Uchida et al., 2015) and have the advantages of enabling disaster data analysis especially in longitudinal studies and promoting good accessibility as opposed to official publications, interviews, and expert knowledge surveys (Noguchi et al., 2021). Newspapers are sometimes criticized for largely reporting the fact such as a disaster's impact and response and recovery activities and for its limited ability to promote communication of risk awareness (Tekeli-Yesil et al., 2019; Uchida et al., 2015). However, this study considers fact reporting as an advantage because its analysis is for the long term (around 20 years) and focuses on data. The present study adopted newspaper articles as research objects.

2.4 Contextualized The Noah's Ark effect

The Noah's Ark motif introduced in the present study is to be applied to contemporary Japan as an anecdote that was somewhat different from the original story as explained in the Bible. To clarify the difference and contextualize it, this section first recalls the Noah motif from Dupuy (2005/2015) in "A Short Treatise on the Metaphysics of Tsunamis." Second, the Noah's Ark anecdote is created to contrast with the cry wolf effect (Here, there are no considerations of God's plans or actions that attract or escape punishment in different religious traditions).

Dupuy (2005/2015, pp. 2-3) presented the story of the Noah with ashes that the German Jewish philosopher Günther Anders quoted from the bible with his original arrangements. The main character,

Noah, who was based on the biblical Noah, walked the streets covered with ashes, which was only allowed while in mourning for a beloved child or spouse, because no one believed his story of the coming flood. The main difference between the original Noah's Ark and this version is that Noah acts as if the catastrophe had already occurred to make his belief in it more vivid. Noah focuses how to change residents' behavior to avoid a possible catastrophe by introducing the "time after it has already happened" (Dupuy, 2005/2015) (disaster preparedness practices that introduce this anecdote are detailed in Yamori, 2016 and Yamori and Sugiyama, 2015). Unlike the hindsight bias in which people perceive the events as more predictable when it happened (i.e., Freeman, 2010) and the cry wolf effect, in which people tend not to act when those around them perceive events as less predictable, this explains that people are likely to act when people perceived as if the events must occur in the near future. Noah plays a role of informing people about the catastrophe as useful information.

The present study focuses on the point that Noah does not save himself but tries to save people together; in other words, he encourages the survival of people by transmitting information. The anecdote of Noah's Ark was introduced to contrast with the anecdote of "the Boy Who Cried Wolf" (Table 1). As already mentioned above, Noah and the act of building the ark can be seen as a metaphor for the boy and behavior in opposition to the cry wolf effect, which may also reflect disaster preparedness behavior. Noah here is playing the role of the government or experts who are seeking to transfer information, where this behavior refers to the disaster preparedness behavior prompted by people's belief that something will certainly happen. In other words, Noah's Ark here shows Noah's behavior making people voluntarily believe in a threat and further actively encouraging them to take action to prepare for the coming catastrophe. This is in contrast with the cry wolf effect, where repeated transmittal of false information causes people to stop believing the information and stop taking action for preparedness. This study follows the social discourse to understand the content of the effect, Noah's Ark effect.

Table 1. Difference between the cry wolf effect and the Noah's Ark effect in the study

	Cry Wolf effect	**Noah's Ark effect**
Who announce the information	Expert and administration (as Boy in the story)	Expert and administration (as Noah in the story)
To whom	Residents in a community	Residents in a community
Information	Failure	Overwhelming
Attitude change	Stopped believing it	Started to believe it
Behavior change	Being reluctant to take preparedness, and focus on daily life	Willing to take preparedness, and put aside daily life

2.5 Research questions

Thus, the present study will focus on the social discourse in Kuroshio and investigate the following three research questions (RQ):

RQ1: To what degree did the extent of "disaster preparedness" increase after the New Estimation?
RQ2: What topics emerged more frequently after the New Estimation?
RQ3: What topics were more and less discussed after the New Estimation compared with those on affected areas after the actual tsunami?

3 Methods and dataset

3.1 Areas for analysis

3.1.1 Kuroshio town

This study focuses on Kuroshio, a coastal town west of Kochi Prefecture, Japan, and facing the Pacific Ocean and the Nankai Trough, which has the potential risk of a mega-tsunami. Kuroshio town comprises approximately 11,000 population, of which 44% was aged 65 years or older. As explained above, the New Estimation highlighted Kuroshio town as being hit by a 34.4-meter tsunami, the highest in Japan (Table 2). The tsunami height, proposed in the New Estimation, considerably impacted the town (Onishi, 2018) and its residents (Sun et al., 2017), as evidenced by the relocation of the town office, fire department, and social (public) housing to higher ground and the construction

of six tsunami evacuation towers, one of which being 22 meters high.

Table 2. Events in Kuroshio town related to disaster prevention

Year	Event
1707	Hoei earthquake.
1854	Ansei earthquake.
1946	Showa–Nankai earthquake: Thirty people either dead or missing in Ogata town and two in Saga town. In Ogata, 264 houses either completely collapsed or were lost.
2006	Town merger. Saga town and Ogata town were merged and become Kuroshio town on March 20.
2010	Onishi Katsuya was elected mayor.
2011	2011 Tohoku earthquake: Issued major tsunami warnings in Kuroshio: Susaki City (2.8 meters) and Yoshimizu (1.3 meters), both in Kochi Prefecture. City office dispatched staff to the affected areas in the Tohoku region.
2012	**New Estimation**: Announced by the Cabinet Office on March 31. The maximum tsunami height in Kuroshio town, 34.4 meters, was the highest in Japan. The town adopted the slogan "Never give up. Run away as fast and safe as the earthquake happens" in response to the New Estimation.
	The Ministry of Land, Infrastructure, Transport and Tourism explained "Act on Regional Development for Tsunami Disaster Prevention" and "Public project of the promotion to collective relocations for disaster prevention and integrated urban disaster prevention."
2013	The Zero Program of Tsunami Evacuation Vulnerable Residents (henceforth the Zero Program). Construction of tsunami evacuation routes and towers.
	The household evacuation *Karte* (medical chart) initiated workshops for all households and discussed evacuation routes.
	A series of study meetings on the relocation in the Ideguchi District was held by the town office in October, November, and December.
	The Act of Urban Planning for Tsunami Prevention Bases and Buildings was passed by the city planning council of Kuroshio town. It explains the total cost of projects, national support for the budget, and land expropriation by the Kochi prefectural government.
2014	Hata-Higashi complex urban plan: Adopted the basic plan for higher relocation in the first and second Mangyo complex.
	Iyonada earthquake: Occurred on March 14 at 2:06 a.m. No tsunami and damages were observed in Kuroshio. Some residents who were expecting a tsunami evacuated.
	Fourth study meeting in the ideguchi District.
2015	The Community Disaster Management Plan was created in every district.
	The Symposium on Community Disaster Management in Kuroshio began on November 5 (World Tsunami Awareness Day) and has since been held annually.
2016	Construction of the new Kuroshio town office building.
	Completion of management manuals for all 43 evacuation shelters in Kuroshio.
2018	Completion of the new town office building.
2019	Completion of all evacuation routes and tsunami evacuation towers under the Zero Program.
	Informational session on the relocation of municipal housing in Mangyo District.

Kuroshio has experienced several large tsunamis (i.e., Ishibashi, 2004). The oldest earthquake and tsunami in Kuroshio was historically reported in 684, and the most devastating one is known as "Hoei earthquake" in 1707 (see also Baranes et al., 2016), which wiped out five villages and devastated five others in Irino-Goh in Kuroshio. The "Ansei earthquake" in 1857 was the next largest; the Kamo shrine in Kuroshio has a stone monument to commemorate the tsunami. The most recent large-scale tsunami was caused by the Showa–Nankai earthquake in 1946, which some Kuroshio residents remembered and provided several lessons about evacuation. Kuroshio's history explains the shock brought about by the New Estimation to the townspeople, who are used to tsunami disasters.

3.1.2 Other areas for comparison

To control for the effect in Kuroshio, this study compared three different areas, choosing an estimation scale from large to moderate and examining the tsunami experience in terms of being physically affected or virtually predicted (Figure 2). Two tsunami-affected areas, Noda and Otsuchi in Iwate Prefecture, were struck by the 2011 Tohoku earthquake and tsunami, and one tsunami estimation area, Muroto in Kochi Prefecture, is set to be hit by the Nankai Trough earthquake and tsunami. Such selections considered similarities in population density (approximately 50/km^2) as well as rurality, especially considering distance to urban or city (1–1.5 hours to the prefecture capital with no direct connection to metropolitan areas) and industrial areas (firm and fishery). To compare using the estimation scale, this study considered the geographical features of coastal areas within the same prefecture and the scale of estimations and damages. Especially in the tsunami-affected areas, differences between the actual tsunami inundation areas and those estimated by the latest hazard map before the 2011 Tohoku earthquake hit were examined. The inundation areas in Otsuchi were far larger than the hazard map expected, while those in Noda almost covered the actual inundation areas.

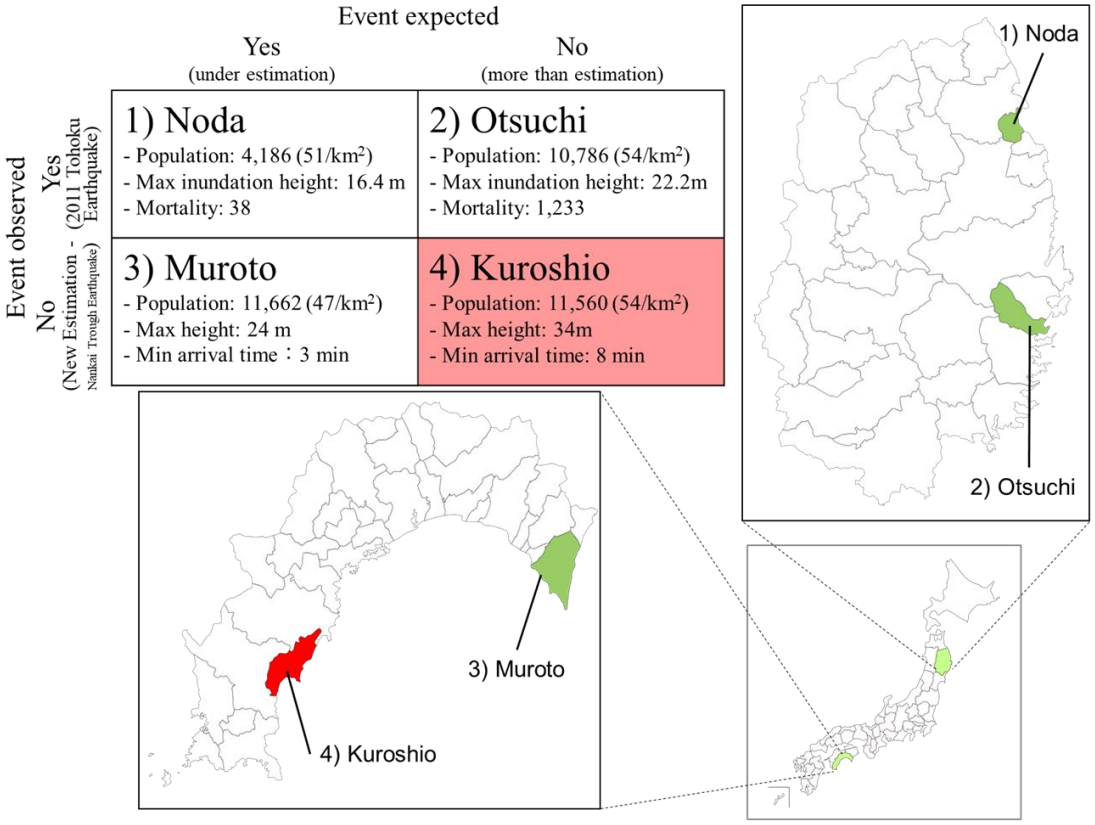

Figure 2. Information of four analysis areas

3.2 Materials and methods

The study adopted text mining to analyze Japanese national newspaper articles related to "disaster preparedness/prevention" (*Bosai*) in the disaster estimation and affected areas. The text of newspaper articles was analyzed using KH Coder 3, a text mining software specialized for the Japanese language

(Higuchi, 2016a) and widely accepted in the disaster-related journal (e.g., Fukutoku, 2011; Sasaki, 2019; Sasaki et al., 2020; Yamada, 2020).

The two-step approach, proposed by the developer of the KH Coder (Higuchi, 2016a, 2017), was applied. The approach aims to combine the two traditional but historically separated approaches of contents analysis, dictionary-based approach (Osgood et al., 1957) and correlational approach (Iker & Harway, 1969). The first step extracts the meaningful words statistically and helps understand the whole structure of the data to avoid analysts' biases and subjectivities, and the second step focuses on constructing the specific coding rules referring to the extracted data of the Step 1 with the line of the dictionary-based approach. The approach helps perform objective interpretation based on statistical results.

3.2.1 Data

The dataset in Table 3 was analyzed in the study. The target articles were from the *Yomiuri Shimbun*, the *Asahi Shimbun,* and the *Mainichi Shimbun*, which are the three largest newspapers in Japan and which used the phrase "disaster preparedness/prevention" (*Bosai*) and mentioned the location name, such as "Noda village," "Otsuchi town," "Muroto City," or "Kuroshio town" either in their headlines or texts. The base dates were set at the disaster date (March 11, 2011) for Noda and Otsuchi and the New Estimation announcement date (March 31, 2012) for Muroto and Kuroshio. To make a comparison before and after the event, the study selected articles from 10 years before the base date to August 31, 2020, as the research dataset. As for Kuroshio, since it was formed by the merger of Ogata and Saga in 2006, articles referring to the two towns were adopted as part of those before the merger.

Table 3 presents the details of the dataset, which comprised 392 articles on Noda, 1,912 articles on Otsuchi, 466 articles on Muroto, and 725 articles on Kuroshio (including Ogata and Saga before the merger). Appendix Table 1 presents the 50 most frequently occurring words.

Table 3. Dataset for analyses

Analytical software	KH Coder 3 (3.Beta.01)
Newspaper	*Yomiuri Shimbun*, *Asahi Shimbun*, *Mainichi Shimbun*
Used Databases	*Yomidas Rekishikan (Yomiuri Shimbun), Kikuzo II Visual (Asahi Shimbun), Maisaku (Mainichi Simbun)*[2]
Target page and text	All pages and text
Extracted words in preprocess	"disaster preparedness/prevention [Bosai]" and each town name, i.e., "Noda village [Noda-mura]," "Otsuchi town [Otsuchi cho]," "Muroto City [Muroto-shi]," or "Kuroshio town," either in the article title (headline) or text*
Research 1 and 2	
Period	April 1, 2002–August 31, 2020 (Kuroshio and Muroto), March 12, 2001–August 31, 2020 (Otsuchi and Noda)
Extracted article	725 (Kuroshio), 466 (Muroto), 1,912 (Otsuchi), 392 (Noda)
Included forced words	Tohoku earthquake [東日本大震災], Nankai Trough [南海トラフ], preparedness conscientious [防災意識], evacuation tower [避難タワー], temporary house [仮設住宅], victim [犠牲者], survivor [被災者], evacuation shelter [避難所], higher relocation [高台移転], collective relocation [集団移転], voluntary disaster prevention organization [自主防災組織], and the municipality names in Iwate and Kochi Prefectures
Excluded forced words	N.A.
Morpheme count	3,143,521 (1,214,896 for analysis)
Morpheme type count	48,231 (38,499 for analysis)

[2] The databases are accessible in the following links: https://database.yomiuri.co.jp/about/en/ (Yomidas Rekishikan); https://database.asahi.com/help/eng/help.html (Kikuzo II Visual); https://mainichi.jp/contents/edu/maisaku/rule_e.html (Maisaku)(accessed in February 25, 2021)

Research 3	
Period	April 1, 2012–August 31, 2020 (Kuroshio and Muroto), March 12, 2012–August 31, 2020 (Otsuchi and Noda)
Extracted article	616 (Kuroshio), 246 (Muroto), 1,367 (Otsuchi), 231 (Noda)
Included forced words	Same as Research 1
Excluded forced words	disaster preparedness/prevention [防災], Kuroshio [黒潮町], Muroto [室戸市], Otsuchi [大槌町], Noda [野田村]
Morpheme count**	2,023,249 (823,626 for analysis)
Morpheme type count	36,254 (30,166 for analysis)

* Articles on Kuroshio included those on Ogata and Saga, which merged with Kuroshio in 2006.
** In the preprocess, the raw data were cleaned, excluding stopped words, the variations in words, punctuation, etc. The number of words in brackets presents those before the preprocess.

3.2.2 Analytical methods

The data was processed through a two-step procedure (Higuchi, 2016a, 2017) and utilized in the three studies presented in this paper. In Step 1, to capture the whole picture of the transition of the articles and investigate RQ1, capture the overall tendency of the articles, and compare the increase (decrease) of the number of articles, this study normalized the number of articles using the average for each town throughout all years and rounded down the number of years elapsed based on the event date. The ratio between the average article counts per year during and after the events to that before the events was also calculated.

Next, the coding list in Table 4 was constructed mainly referring to the 50 most frequently occurring words (Appendix Table 1). The coding list was created via the following process: (1) sorting and creating groups by similar words referring to frequent words (see Appendix Table 1), (2) creating subcategories (codes) using the groups and generating higher categories unified by the subcategories if possible, and (3) devising the code list including the categories and subcategories (codes) and adding possible words in the subcategories (codes), if needed. The coding list was first prepared by the first author, and the second, third, and fourth authors discussed the coding list and made revisions to the coding files to increase their validity. The list comprised 13 categories and 42 codes (subcategories) in Table 4.

Table 4. Coding list

Category	**No.**	**Code**	**Words**
Disaster	1	Disaster	earthquake disaster (Shinsai), Great Earthqauke Disaster (Dai-Shinsai), disaster, Nankai trough, Great East Japan Earthquake
	2	Damage	damage, flood damage (Suigai), flooded, affection
Hazard	3	Hazard	tsunami, earthquake
	4	Scale (size)	mega, maximum, high, worst, large, enormous (jin-dai)
	5	Earthquake information	magnitude, intensity, epicenter
Information	6	Prediction	estimation, prediction, possibility, probability, forecast
	7	Communication	forecast, announce, issue, public communication (hasshin), public relation, [news] report
	8	Information	information, warning, advisory, early-warning (sokuhou)
	9	Lessons learned	folklore (tradition), transmit, lesson learned, lesson, stone monument, monument
Measure	10	Measure and plan	measure, response, plan
	11	Training	training
	12	Evacuation and shelter	evacuation, evacuate, evacuation tower, shelter

*Abandonment**	13	Despair	despair, give up
	14	Abandonment	abandonment
Restoration & Recovery	15	Rescue	rescue
	16	Restoration	restoration, restore, repair
	17	Support	support, help, corporate, assist, volunteer, donation, fundraising
	18	Recovery	recovery
Life & human	19	Death	pass away, die, dead, death, victim, mortality
	20	Mourning	mourning, mourn, moment of silence, requiescat (chinkon)
	21	Life	life (inochi, seimei, jinmei)
	22	Survivor	survivor, bereaved family (izoku)
Housing & living	23	House	home (ie, jitaku), house, housing, residence
	24	Temporary house	temporary, temporary house
	25	Rebuild	rebuild, reconstruct
	26	Living	life (jinsei), living, livelihood, daily life
	27	Relocation	relocation, emigration, collective relocation, higher elevation
Construction & public work	28	Public works	public work
	29	Construction	construction, building, [infrastructure] development
	30	Land use	district (kukaku), rezoning, land forming (zousei), land, curtilage
Discussion	31	Opinion	opinion, intention (ikou, ishi)
	32	Agreement	agreement, consent
	33	Claim and demand	ask, demand, request, need, complain, claim
Politics	34	Politician	assemblywoman/man, councilwoman/man, Congresswoman/congressman, mayor
	35	Election	election, vote
Administration	36	Government	government, prefecture, town, village, city, municipality
	37	Public service	administration, public service (kouei, koukyou)
	38	Public facility	center, facility, park, public hall
	39	Budget	budget, subsidy, grant-in-aid, cost (expense)
Education	40	School	school, elementary/primary school, middle/junior high/secondary school, high school
	41	Education	learn, educate, education
	42	Child	student, pupil, child, children

* "Abandonment [Houki]" refers to giving up in a stronger and more formal sense and is an expression rarely used in daily conversation so that it is coded separately from "Despair." The term "evacuation abandonment [Hinan-Houki]" is also mentioned in a previous study on Kuroshio Town (Hatayama et al, 2014).

In Step 2, Research 2 and Research 3 using the coding lists were conducted to interpret the dataset used in Research 1. In Research 2, code analysis area was applied to Research 2 to investigate RQ2. The number of articles on Kuroshio, which includes each code, was counted under two different periods: before (April 1, 2002–March 31, 2012) and after the New Estimation announcement (April 1, 2012–August 31, 2020). For example, when an article has the sentence "The evacuation training was conducted at the junior high school," the morpheme includes "evacuation," "training," and "school"; hence, the article falls under two categories, "Measure" and "Education" and has three codes, "Training," "Evacuation and shelter," and "School."

In Research 3, correspondence analysis using the coding list and co-occurrence network analysis were conducted to address RQ3 in Research 3. To grasp the relation between the categories and regions,

the study employed correspondence analysis (Greenacre, 2007), which is an analysis made possible by KH Coder (Higuchi, 2016b) and can grasp the relation between items by illustrating the characteristics of the data from multiple categorical data. KH Coder displays the results of the correspondence analysis in a two-dimensional table based on the chi-square distance, but it is common to display standardized values because the overall distribution becomes extremely difficult to see (Higuchi, 2016b). Therefore, it should be noted that Research 3 uses standardized values, so the relative distance between the two is an issue. In addition, for ease of reading, codes are indicated by blue circles and regions by red squares, with the size of each representing the frequency of occurrence. The correspondence analysis was performed using 13 categories with four areas in Table 4 (coding list) from articles that only included the recovery phase (March 12, 2012–August 31, 2020) in the affected areas and the period after the New Estimation in the estimation areas. To determine the direct correlation of each subcategory between the areas, a supplemental analysis that follows the process in Research 2 was performed to investigate significant differences by the chi-square test.

In the co-occurrence network, figures were created with 60 frequent co-occurrence relations using the Jaccord index for 50 frequent words in each area. The different communities sorted via random walk were painted with different colors, the edges between them were connected using dotted lines, and nonaffiliated words were colored white.

4 Results

4.1 Research 1: To what degree did the extent of "disaster preparedness" increase after the New Estimation?

The result of Research 1 in Figure 3 depicts the number of articles on "disaster preparedness" in Kuroshio and three other municipalities in each elapsed year. The figure denotes that article count for Kuroshio, a tsunami estimation area, increased 7.0 times from 2012; the article counts for Otsuchi, a tsunami-affected area, increased 17 times; and the article count for Noda increased 7.4 times from 2011. This indicates that the Great East Japan Earthquake and the New Estimation adversely impacted these three areas. Meanwhile, in Muroto, the increase was 1.4 times after the New Estimation, which was gradual but not as large as in Kuroshio. A comparison of the number of articles demonstrated a quantitative increase after the two events. As indicated in the graph, the substantial number of articles on Kuroshio since 2012 on "disaster preparedness" indicates the significant impact of the New Estimation, which estimates the arrival of the highest tsunami in Japan. This means that Kuroshio was characteristically mentioned in 2012 under the New Estimation and that the increase after the announcement was as high as that for disaster-stricken areas.

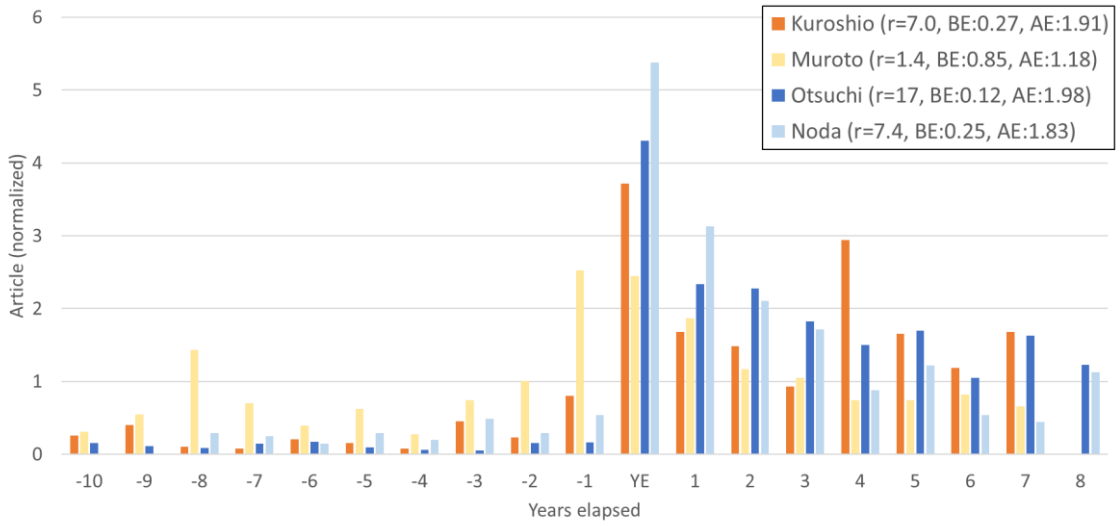

Figure 3. Number of articles and elapsed years from the events

(YE: year of the events, r: article count ratio after the events to before them, BE: average number of articles before the event, AE: average number of articles after the event)

RQ1 is informed by the article count increasing 7.0 times on average after the New Estimation, and this level is close to that of the areas actually affected by the Tohoku Earthquake. In addition, article on disaster prevention sharply increased after the announcement of the New Estimation in 2012, not in 2011 immediately after the Tohoku Earthquake.

4.2 Research 2: What topics emerged more frequently after the New Estimation?

Research 2 concerned the qualitative change in articles on Kuroshio, while Research 1 revealed a quantitative increase in "disaster preparedness" articles on Kuroshio after the New Estimation. Table 5 presents the code analysis results before and after the New Estimation.

Compared with the code ratio before the New Estimation, the ratio of disaster (2. damage), hazard (3. hazard; 4. scale), information (6. prediction; 7. communication; 8. information; 9. lesson learned), measure (11. training; 12. evacuation and shelter), and abandonment categories (13. despair) significantly increased overall. Information on earthquake and tsunami hazards as well as preparedness, especially those focusing on evacuation programs in response to the New Estimation, increased despite the lack of significant differences in 1. disaster, 5. earthquake information, and 10. measure and plan.

Table 5. Code comparison among articles on Kuroshio before and after the New Estimation

Category	No.	Codes	before *N* (%)	after *N* (%)	sum *N* (%)	χ^2 *p*	higher period
Disaster	1	Disaster	49 (44.55%)	327 (53.08%)	376 (51.79%)	1.314(n.s.)	
	2	Damage	38 (34.55%)	405 (65.75%)	443 (61.02%)	14.891***	after
Hazard	3	Hazard	76 (69.09%)	575 (93.34%)	651 (89.67%)	6.123*	after
	4	Scale (size)	46 (41.82%)	468 (75.97%)	514 (70.80%)	15.379***	after
	5	Earthquake info.	20 (18.18%)	161 (26.14%)	181 (24.93%)	2.369(n.s.)	
Information	6	Prediction	40 (36.36%)	426 (69.16%)	466 (64.19%)	15.636***	after
	7	Communication	18 (16.36%)	235 (38.15%)	253 (34.85%)	12.711***	after
	8	Information	26 (23.64%)	222 (36.04%)	248 (34.16%)	4.203*	after
	9	Lesson learned	14 (12.73%)	185 (30.03%)	199 (27.41%)	10.197**	after
Measure	10	Measure & plan	70 (63.64%)	426 (69.16%)	496 (68.32%)	0.416(n.s.)	
	11	Training	17 (15.45%)	234 (37.99%)	251 (34.57%)	13.706***	after
	12	Evacuation & shelter	42 (38.18%)	433 (70.29%)	475 (65.43%)	14.709***	after
Abandonment	13	Despair	0 (0.00%)	68 (11.04%)	68 (9.37%)	12.143***	after
	14	Abandonment	0 (0.00%)	19 (3.08%)	19 (2.62%)	3.393(n.s.)	
Restoration & Recovery	15	Rescue	6 (5.45%)	33 (5.36%)	39 (5.37%)	0.002(n.s.)	
	16	Restoration	11 (10.00%)	31 (5.03%)	42 (5.79%)	3.981*	before
	17	Support	34 (30.91%)	236 (38.31%)	270 (37.19%)	1.375(n.s.)	
	18	Recovery	7 (6.36%)	72 (11.69%)	79 (10.88%)	2.432(n.s.)	
Life & human	19	Death	12 (10.91%)	164 (26.62%)	176 (24.24%)	9.507**	after
	20	Mourning	3 (2.73%)	4 (0.65%)	7 (0.96%)	4.180*	before
	21	Life	14 (12.73%)	157 (25.49%)	171 (23.55%)	6.452*	after
	22	Surivor	0 (0.00%)	3 (0.49%)	3 (0.41%)	0.536(n.s.)	
Housing & living	23	House	26 (23.64%)	168 (27.27%)	194 (26.72%)	0.462(n.s.)	
	24	Temporary house	0 (0.00%)	2 (0.32%)	2 (0.28%)	0.357(n.s.)	
	25	Rebuild	21 (19.09%)	23 (3.73%)	44 (6.06%)	36.320***	before
	26	Living	21 (19.09%)	102 (16.56%)	123 (16.94%)	0.353(n.s.)	
	27	Relocation	13 (11.82%)	81 (13.15%)	94 (12.95%)	0.128(n.s.)	
Construction & public work	28	Public works	18 (16.36%)	120 (19.48%)	138 (19.01%)	0.477(n.s.)	
	29	Construction	47 (42.73%)	241 (39.12%)	288 (39.67%)	0.306(n.s.)	
	30	Land use	5 (4.55%)	49 (7.95%)	54 (7.44%)	1.458(n.s.)	
Discussion	31	Opinion	18 (16.36%)	119 (19.32%)	137 (18.87%)	0.432(n.s.)	
	32	Agreement	3 (2.73%)	46 (7.47%)	49 (6.75%)	3.107(n.s.)	
	33	Claim & demand	72 (65.45%)	343 (55.68%)	415 (57.16%)	1.559(n.s.)	
Politics	34	Politician	30 (27.27%)	137 (22.24%)	167 (23.00%)	1.028(n.s.)	
	35	Election	26 (23.64%)	32 (5.19%)	58 (7.99%)	39.732***	before
Administration	36	Government	95 (86.36%)	520 (84.42%)	615 (84.71%)	0.042(n.s.)	
	37	Public service	27 (24.55%)	126 (20.45%)	153 (21.07%)	0.741(n.s.)	
	38	Public facility	39 (35.45%)	252 (40.91%)	291 (40.08%)	0.693(n.s.)	
	39	Budget	23 (20.91%)	116 (18.83%)	139 (19.15%)	0.210(n.s.)	
Education	40	School	32 (29.09%)	205 (33.28%)	237 (32.64%)	0.502(n.s.)	
	41	Education	22 (20.00%)	182 (29.55%)	204 (28.10%)	3.026(n.s.)	
	42	Child	27 (24.55%)	237 (38.47%)	264 (36.36%)	4.979*	after
		Total	110 (15.15%)	616 (84.85%)	726 (100.0%)		

*** $p < .001$, ** $p < .01$, * $p < .05$, n.s.: no significance

The codes that indicated a decline were found in 16. restoration, 20. mourning, 25 rebuilding, and 35. election, but no consistency was detected in terms of code level. Instead, contradictive results in life and human categories were observed; codes for 19. death and 21. life increased, while codes for 20. mourning decreased.

With regard to RQ2, the articles on Kuroshio since the New Estimation have increased mainly on the causes and information about disasters; meanwhile, issues such as restoration, mourning (not death or life), and rebuilding have decreased. Articles related to "disaster preparedness" in Kuroshio after the New Estimation revealed that some specific topics (e.g., disaster, hazard, information, and measure) were frequently mentioned while others (e.g., restoration, mourning, and rebuild) were avoided.[3] In addition, abandonment issues are increasing, and there is an ambivalent process in which topics actively discussed about disaster prevention coexist with topics passive about disaster prevention (e.g., giving up on evacuation)[4].

4.3 Research 3: What topics were more and less discussed after the New Estimation compared with those on affected areas after the actual tsunami?

Research 3 mainly investigated the qualitative differences of frequent issues among four areas to characterize the Noah's Ark effect in Kuroshio.

Figure 4 depicts the correspondence analysis results involving the coding list categories for the four areas. The row with the blue bubble plot represents the article categories, and the column with the red squares indicates the four areas. The size of the bubble plot explains the frequency of the row, with disaster (2,307) and administration (2,259) being the most frequent categories and abandonment (145) and mourning (266) being the least frequent ones. The results revealed that the first component constitutes 86.01% of the inertia, and the second component constitutes 10.36% of the inertia. These two components constitute 96.37% of the cumulative inertia, which explains 96.37% of the total variance. Component 1 in the vertical axis best explains mourning (4.84), abandonment (-3.44), and restoration and recovery (1.24), while component 2 in the horizontal axis best explains abandonment (5.33), politics (1.84), and life and human (1.69). Component 1 clearly contrasts the disaster-related issue of preparedness abandonment. Component 2 has a more complex classification, but it would be understood with the requirement of individual or collective change considering individual responses as abandonment and politics and collective responses as construction and public work and measure (top–down).

In the plot, the columns of the four areas are located in four different directions from the origin: Noda on the upper left, Muroto on the lower left, Otsuchi on the upper right, and Kuroshio on the lower right. The differences between the estimation and affected areas were consistent with what component 1 indicates: Otsuchi and Noda are close to mourning and restoration and recovery, while Muroto and Kuroshio are close to abandonment in component 1. Kuroshio is closely located on measure (bottom–up), hazard, and abandonments with the same location; meanwhile, Muroto is on measure (top–down), discussion, and administration; Otsuchi is on life and human, politics, and mourning; and Noda is on housing and living. In addition, some categories were characterized in two areas: education is in between Kuroshio and Otsuchi, information is in between Kuroshio and Muroto, construction and public work is in between Muroto and Noda, and restoration and recovery is in between Otsuchi and Noda. Disaster is a neutral category close to Otsuchi but closest to the origin.

Correspondence analysis results revealed that the issues in the articles varied in each area, but it is unclear what types of words would appear and what types of articles co-appear with other words. Figure 5 displays the results of the co-occurrence network of 60 frequent edges in each area and

[3] The change of issues in the articles on Kuroshio was characterized by a "shift," that is, a more gradual change, compared with that in Muroto; however, such change was not drastic compared with that in affected areas, which was characterized by a "turn" (see Appendix Figure 1).

[4] Looking at the content of the articles, many articles were first written about residents "giving up" on evacuation due to the New Estimation, and then gradually more articles were written about "not giving up" or "not giving up" (written in the negative form). The same tendency is observed in both Abandonment and Despair, and the expressions are often used from the perspective of lay people rather than the national or local governments.

indicates the number of words and average edge number. The number of words and the average of edges in each area are 28 and 4.29 in Noda, 25 and 4.80 in Otsuchi, 23 and 5.71 in Muroto, and 20 and 6.00 in Kuroshio, respectively. In the figure, Kuroshio has two communities, but one of them comprises 12 words (60%), which is the largest community; meanwhile, Noda has four communities and a lower average number of edges (4.29) than Kuroshio (6.00). Compared with Muroto (3 communities, 23 words, 5.71 edges) and Otsuchi (3 communities, 25 words, 4.80 edges), Kuroshio's co-occurrence network is concentrated on more similar issues, representing the largest community words: estimation, mega, tsunami, earthquake, and evacuation. These words are also consistent with the measure (bottom–up) and hazards categories. This indicates that articles on Kuroshio are more likely to be written focusing on a single or a relatively fewer number of issues.

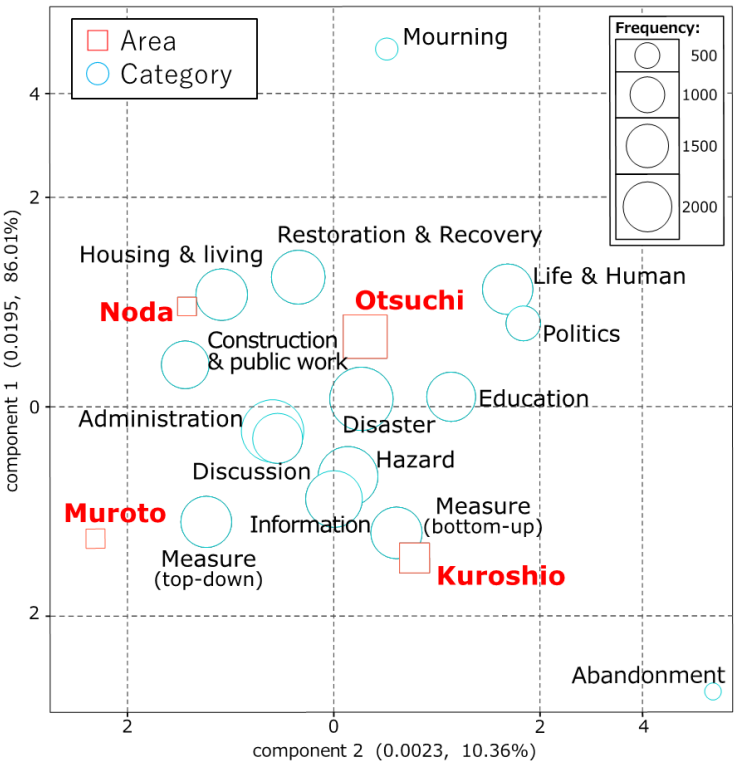

Figure 4. Correspondence analysis plot of the coding list categories against the four areas

(For the visualization of the figure, the values on both the x and y axes from -2 to 2 are enlarged by two using the articles in the recovery phase (March 12, 2012–) in the affected areas and the phase after the New Estimation (April 1, 2012–) in the estimation areas. The "mourning" subcategory is separately and independently included in the original category. "Measure (top–down)" includes the subcategories of "measure and plan" and "measure (bottom–up)" as well as "training" and "evacuation and shelter." The size of the circles and squares indicates the frequency of occurrence.)

From these results, the following answers were obtained for RQ3; after the announcement of the New Estimation, articles on disaster prevention were characterized by contents related to hazards, resident-oriented measures (e.g., evacuation drills), and abandonment and were compared with the disaster-affected areas. The articles on disaster prevention tend to be less related to the contents on mourning, restoration and recovery, housing and living, construction and public work (Figure 4). In addition, the content of articles was not only characterized by hazards, resident-oriented measures, and abandonment but also revealed that they tended to consist of fewer topics and limited vocabulary (Figure 5).

5 Discussion

5.1 The effect of the New Estimation on disaster preparedness discourse

The three studies investigated the social meaning of the Noah's Ark effect using articles on disaster preparedness after the announcement of the New Estimation by the Cabinet Office on March 31, 2012. This study confirmed both the qualitative and quantitative transformations of articles on Kuroshio after the announcement of the New Estimation.

First, from the temporal difference between before and after the event in Research 1, the number of articles on disaster preparedness is seven times larger than that before the New Estimation, with the same level of increase as in affected areas, especially Noda (research 1). These results suggest that the New Estimation affected Kuroshio and Muroto differently. Compared with articles on Muroto, the number of articles on Kuroshio in 2012 (around YE in Figure 3) indicate a much higher increase than

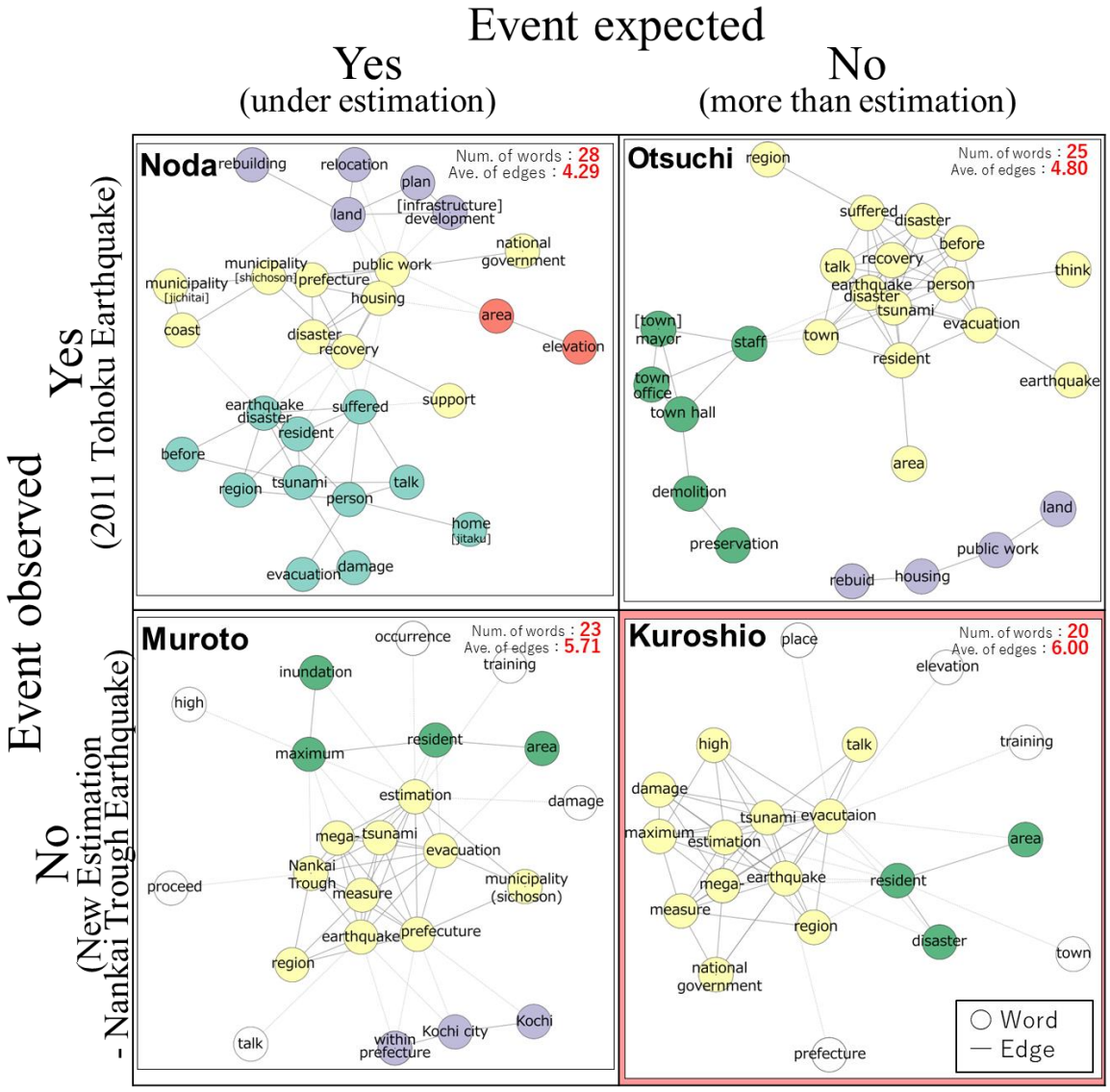

Figure 5. Co-occurrence network created with 60 frequent edges

(The edges (lines) in the figures show 60 frequent co-occurrence relations using the Jaccord index for 50 frequent words. The different communities sorted via random walk have different colors, and the edges between communities are connected by dotted lines. Words colored white are not affiliated with any community. Num. of words: the number of words in the figure; Ave. of edges: the average number of edges in each word (node).

the number in 2011, while those on Muroto show a similar level of increase in 2011 and 2012. This indicates that the New Estimation, rather than the 2011 Tohoku earthquake, clearly brought controversial disaster preparedness issues in Kuroshio[5].

Second, in Research 2, the articles on Kuroshio after the New Estimation were characterized by not only a quantitative increase but also a qualitative change, which can be explained by preparedness from the perspective of disasters as events and not as processes (Perry, 2013). Perry (2013) described two main approaches to defining disasters: the Hazards-Disaster tradition, in which a hazard becomes

[5] It should be mentioned that the difference between Kuroshio and Muroto, despite being in the same prefecture, can be also explained by other factors; for example, Kuroshio has more houses in the lower areas near the city center than Muroto and has the advantage of longer time (8–10 minutes vs. 2–3 minutes in Muroto) to evacuate by the tsunami reach.

a disaster when it intersects with society, and the Social Phenomena approach, in which a disaster is a socially constructed phenomenon. The latter approach differs from the former in that it rejects the former's position that disasters are "events" limited in terms of geography and time, instead holding that disasters are "processes" of social change. In this sense, the articles after the New Estimation are likely to focus on preventing the disaster itself or the aspect of disaster as events, as shown by the increase in articles on information and measure codes. However, at the same time, they are not likely to focus on preparing for a disaster's effect only after it strikes; in other words, they do not seem to discuss the issues extended to the phases of response and recovery from the aspect of disaster as process rather than the prevention and response phases with spatially and temporally limited lengths.

Third, in addition to Research 2, the qualitative change in Kuroshio is also understood by its lower magnitude and gradual ones, which can be called a "shift," especially comparing the affected areas. The quality of change in the affected areas was achieved via three separate steps, before the event, during the event, and after the event (see Appendix Figure 1), while Kuroshio experienced two slightly different steps, which are more seamless and gradual change. If the transformation of articles on Otsuchi and Noda is called a "turn" as a sudden change with a gap, for Kuroshio this could be explained by a "shift" as a gradual and seamless change.[6]

Fourth, in Research 3, from a spatial difference between the affected areas and expected areas, the qualitative changes are explained by the residents' voluntary process. The two components in Figure 4 can be interpreted as observations of whether a disaster occurred (still expected) and the requirement of whether a disaster is large enough to require individual effort or small enough to require only a collective response. Comparing the differences in the horizontal axis, articles on Kuroshio positively show more voluntary individual effort or change, such as bottom–up evacuation training and running shelters or education programs, while the opposite shows more dependent behaviors on experts or governments characterized by administration, construction, public service, and top–down measures. This is in contrast with the suggestion that the more residents trust the government (Wachinger et al., 2013) and the more that the government implements measures (Katada et al., 2011), the less likely they are to act (become dependent); the Noah's Ark effect has the potential to make residents more proactive in their prevention actions.

Fifth, the qualitative change is also characterized by simplifying processes (event prevention-based measure), which similarly adopt a single action bias (Weber, 1997) in that once an individual takes one action, they do not follow through. Focusing on frequent words in each area, the articles on Kuroshio are more likely to be simplified in terms of the more limited words and fewer topics, according to Figure 5. The articles on Kuroshio in the lower right area mean that housing and living, mourning, restoration and recovery, and construction and public work are not likely to be discussed compared with those on other areas even though they will be important after a disaster occurs.

5.2 Noah's Ark effect

Considering the results, Figure 6 depicts a conceptualized summary of the results and discussion with the Noah's Ark effect, especially referring to the arrangement in Figure 4.[7] The red-dotted square indicates areas that may experience the Noah's Ark effect, which is newly proposed in the research, and the blue-dotted square indicates areas more likely to be influenced by the cry wolf effect. The difference in color between the upper and lower fields indicates the magnitude of the change in qualitative meaning (blue: turn, yellow: shift).

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[6] The period of articles on affected areas can be separated into three: before the earthquake, in 2011, and after 2012. According to Appendix Figure 1, words that correspond with 2011 are mostly associated with fact-based information, consistent with the study by Uchida et al. (2015). However, the words of articles after 2012 significantly changed and are now highly associated with the survivor's life.

[7] To make the relations between the four regions and the categories in Figure 4 easier to interpret, the plot is standardized by chi-square distance, which is a default function of the KH Coder (Higuchi, 2016b). This eliminates the meaningfulness of the absolute location (distance) between a category and a region, and the plot is usually read according to whether elements share a common direction from the origin (Greenacre, 2007). This is the reason why Kuroshio and Abandonment are shown as similar groups in Figure 6, although they are far apart in Figure 4.

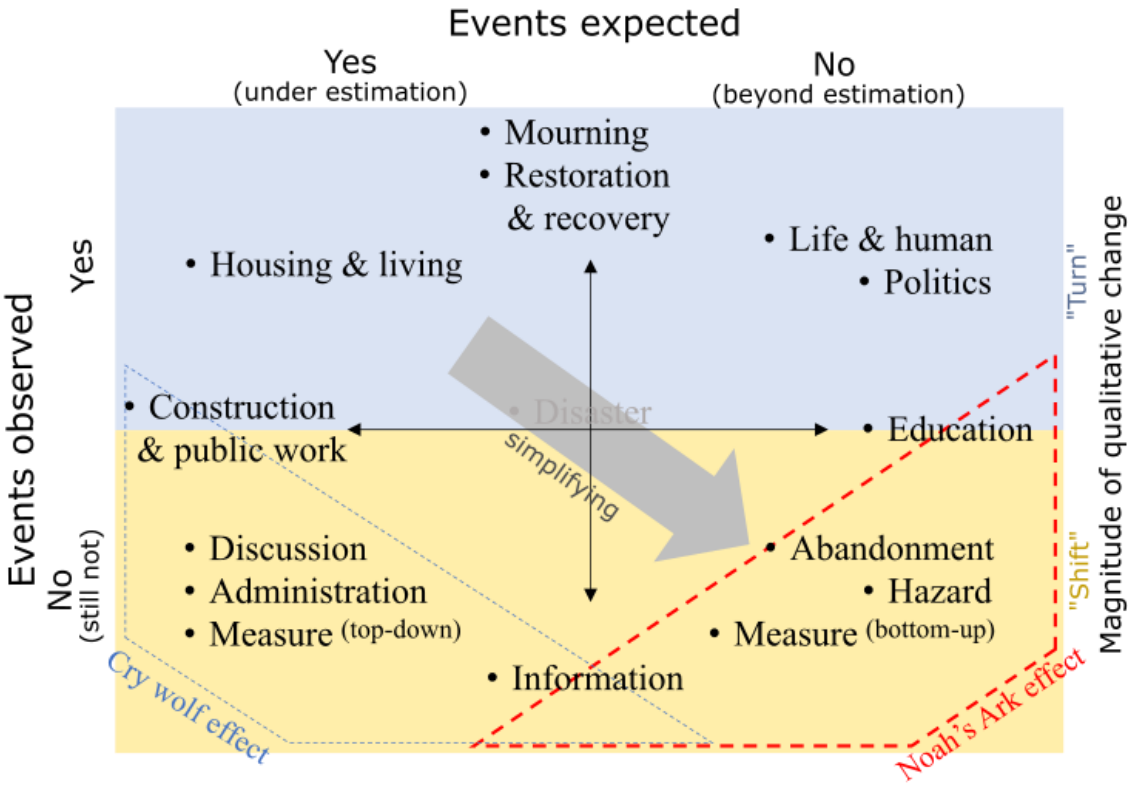

Figure 6. Structure of a characteristic article on disaster preparedness

Compared with previous studies on the cry wolf effect, the areas under the Noah's Ark effect are much more active, not passive, toward disaster preparedness. The effect of estimation is ambivalent but not to the same extent as in the cry wolf effect. First, the emphasis on the magnitude of hazards and potential damage, as well as other estimations, has led to a widespread despair among local residents. In response, residents and the local (town) government seem to have actively believed in, rather than ignored, the impact of the disaster and began to implement disaster prevention. However, the content of the disaster prevention that has spread there tended to be more uniform and to focus more on specific topics (e.g., evacuation) than those discussed in the affected areas. In this regard, the Noah's Ark effect should be viewed from both sides: the positive impact on disaster prevention in the sense that it promoted disaster prevention, and the negative impact in the sense that it turned away from certain topics. Although this study cannot directly identify what is a "good" disaster prevention and what is not, it is important to consider this aspect for risk communication of what emphasizing the magnitude of an assumption can do to a community.

5.3 Limitations

This research provides a new perspective on risk communication; however, several limitations exist. First, the issues are related to the methodology. The analysis targeted newspaper articles and their transition; however, the study did not directly focus on the event and the person's behavior. To understand behaviors in the field, other methods such as a content analysis of newspaper articles and a social survey comparing each region should be considered. This dataset has interesting possibilities for deepening the study of this area research; for instance, the research investigated only tsunami hazards, and only four Japanese cases with a limited time span (around 10 years before and after the event) were considered. To establish the Noah's Ark effect on the community, other hazards, areas, and time spans should be considered. This also includes the need to investigate other countries and their communities with different political, economic, social, infrastructural, cultural, and spiritual context. In addition, although KH coder (Higuchi, 2021) is now available for basic analysis such as correspondence analysis, other possible and sophisticated analyses should be considered: machine learning to extract and classify coding rules (rather than relying on the analyst to create the coding

rules alone), cluster analysis for classification at the document or article level, and hierarchical cluster analysis for word-by-word associations. To compensate for this deficiency, the direction of the study is to increase the validity of the interpretation by examining the results from multiple analysis methods, such as verbal analysis for words, coding analysis, co-occurrence network analysis, and correspondence analysis from multiple perspectives.

Second, a gap is assumed to exist when data are applied to individual behaviors and interaction between individuals and governments. The research focuses on the sociopsychological aspect of the communities using newspaper articles. In the real world, behavior depends on each individual, and the Noah's Ark effect is also affected by personal traits or characteristics, which the present research has not fully investigated. The study did not sufficiently consider interactions between the national government and local residents and their structures. Although it emphasized the unidirectional relation of the impact of the national government's announcement of New Estimation on the local residents, there is a decent possibility that interactive effects and feedback loops exist.

Finally, the Noah's Ark effect needs to be discussed from the political, policy, and ethical perspectives. For example, Klein (2002) used the concept of "disaster capitalism" to explain the fact that the occurrence of catastrophe can be used to urge neoliberal policies that would otherwise have been unacceptable in disaster-affected areas. This is not the same as in our case because Kuroshio Town was not actually hit by the tsunami, and it is not clear from the present study whether the new policies are neoliberal or supportive of specific corporations. However, due to the release of the New Estimation, the policy has progressed under the concept of disaster prevention measures, emphasizing not only governmental measures but also resident-based measures such as tsunami evacuation drills. In fact, in Kuroshio Town, the town hall and fire station have already been moved to higher ground, and plans are underway to carve out new higher ground to construct a residential area. In a quiet fishing village, a 10-story tsunami evacuation tower was built in the Saga district at a total cost of 590 million yen, and a Kuroshio resident actually moved in front of the tsunami evacuation tower from the tsunami high-risk areas. The Noah's Ark effect may have a tendency to leverage the "possibility" of catastrophe to resonate with certain political ideologies.

It would be prudent to address these limitations; nevertheless, the concept of the Noah's Ark effect would be a good basis to discuss positive and negative effects brought about by an emphasis on or exaggeration in risk communication. In other words, this study provides useful descriptive, rather than explanatory, results. It raised important questions about possible changes in attitudes within communities exposed to the threat of extreme disasters. An important potential value of the study is the ability it may bring to support communities and not to abandon attempts to develop disaster preparedness and enhance community resilience through further research.

6 Conclusion

This research examined ways in which the Noah's Ark effect changed the disaster preparedness discourse in Kuroshio, which was expected to be struck by Japan's largest tsunami as indicated by the New Estimation. The research analyzed Japanese newspaper articles before and after the events and conducted a comparison of tsunami disaster caused by the Tohuku earthquake and the expected tsunami devastation in other areas. The three studies demonstrated that the Noah's Ark effect has five features: (1) increasing, not decreasing: increasing the number of articles to the same level as that of tsunami-affected areas; (2) events, not process: focusing on preventing a disaster or a hazard itself (disaster as an event) rather than preparing for issues brought about by a disaster (disaster as a process), compared with events before and after the issuance of the New estimation; (3) shift, not turn: understanding changes as gradual "shifts" rather than sudden changes observed in the affected areas; (4) voluntary, not dependent: being typically characterized by the resident voluntary action (e.g., evacuation training) rather than their dependence on government measure; and (5) simplified, not complex: promoting specific issues and simplifying less relevant issues. The study proposed the Noah's Ark effect, in which estimations of a massive disaster urge people to radically accelerate (e.g., evacuation training) and/or decrease (e.g., recovery, mourning) the degree of specific disaster prevention programs prior to disaster occurrence.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Authorship contribution

Hiroaki Daimon, Genta Nakano, Kohei Takahara, and Ryohei Miyamae conceived the concept and designed the research. Hiroaki Daimon contributed to data collection and text mining analysis. Hiroaki Daimon and Genta Nakano led the writing of the manuscript, and all authors provided critical feedback on the manuscript and worked to revise it.

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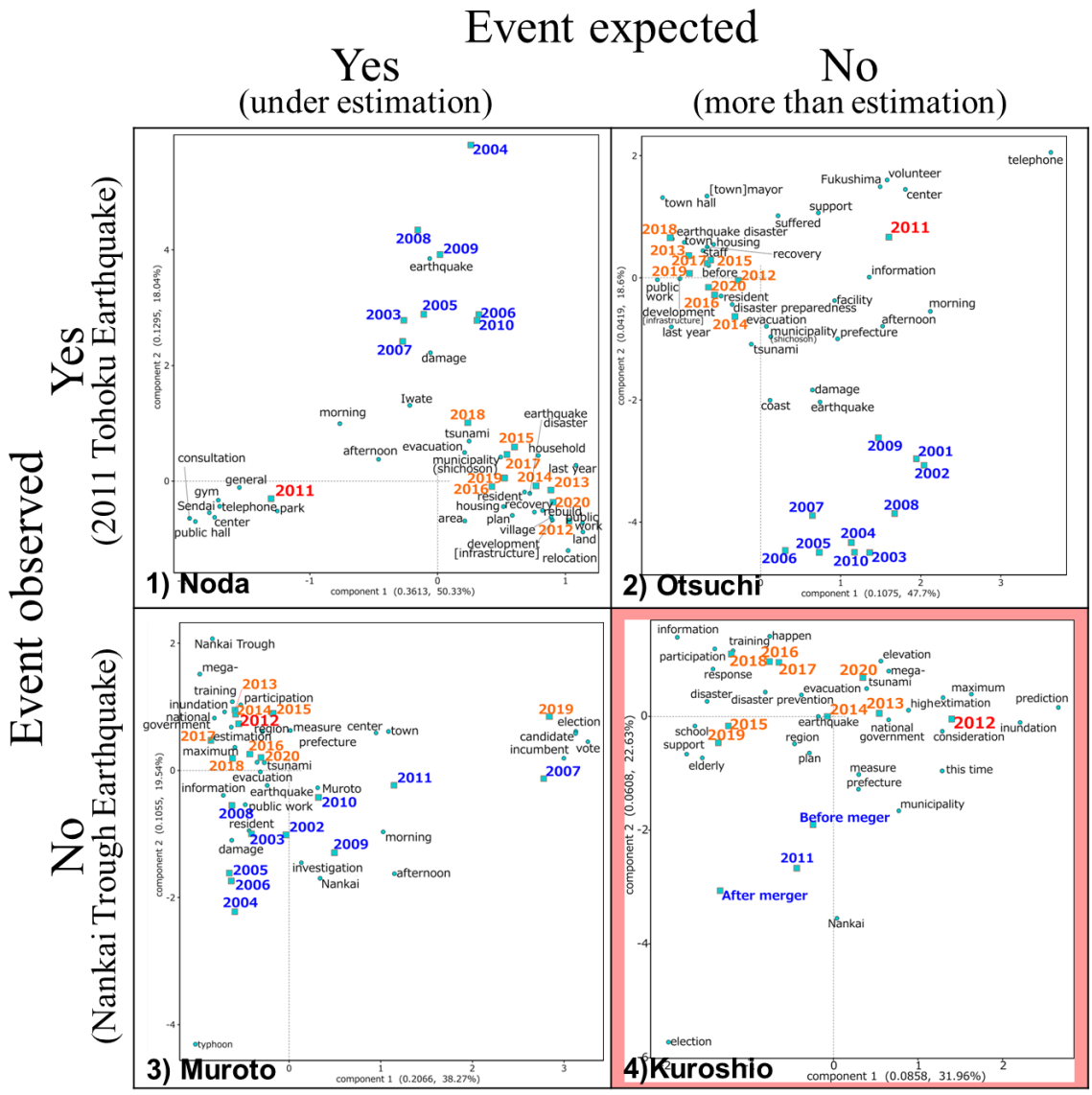
Appendices

Appendix table 1. the 50 most frequently occurring words.

No.	Words (Japanese)		Frequency (times)
1	tsunami	津波	11127
2	preparedness	防災	8322
3	evacuation	避難	8266
4	earthquake	地震	6553
5	recovery	復興	5832
6	earthquake disaster	震災	5701
7	prefecture	県	5429
8	suffered	被災	4819
9	resident	住民	4524
10	town	町	4497
11	disaster	災害	4491
12	person	人	4208
13	region	地域	3801
14	support	支援	3651
15	measure	対策	3605
16	area	地区	3569
17	damage	被害	3349
18	talk	話す	3199
19	center	センター	3185
20	staff	職員	3118
21	before	前	3048
22	housing	住宅	2945
23	estimation	想定	2916
24	public work	事業	2879
25	afternoon	午後	2760
26	municipality	市町村	2745
27	plan	計画	2682
28	municipality	自治体	2625
29	city	市	2441
30	need	必要	2407
31	training	訓練	2247
32	national government	国	2215
33	[infrastructure] development	整備	2158
34	Information	情報	2050
35	coast	沿岸	2038
36	high	高い	2016
37	activity	活動	1999
38	[town] mayor	町長	1950
39	occurrence	発生	1949
40	facility	施設	1941
41	town/city hall	庁舎	1930
42	participation	参加	1925
43	within-prefecture	県内	1921
44	morning	午前	1896
45	conduct	行う	1867
46	receive	受ける	1867
47	leave/occur/come out	出る	1823
48	place	場所	1822
49	inundation	浸水	1815
50	elevation	高台	1799



Appendix figure 1. Correspondence analysis of 30 frequent words against each year

(Using the 60 frequent words in each four area, the correspondence analyses were conducted by each year. The figure shows only 30 words which are selected by the degree of difference. The whole tendency of the location of words and years in the figure is not affected by the number of frequent words. Due to the unbalanced number of articles, the articles before 2010 in Kuroshio were combined with two period, before and after the merger with the towns. There was no article of Noda in 2001 and 2002, and the two years didn't show in the figure. Year of blue: the year before the events; red: the year of the events; orange: the years after the event.)

Appendix table 2.

Category	No. Code	(P) Predicted areas				(A) Affected areas				χ^2	p[1)]	χ^2 test reslts[2)] (only shown high area's name)		Significant only in Kuroshio
		(4) Kuroshio		(3) Muroto		(2) Otsuchi		(1) Noda				(P) vs. (A)	(4) vs. (3)	
		N	(%)	*N*	(%)	*N*	(%)	*N*	(%)					
Disaster	1Disaster	547	(88.80%)	183	(74.39%)	1291	(94.44%)	218	(94.37%)	9.85*		Affected	Kuroshio	
	2Damage	405	(65.75%)	124	(50.41%)	971	(71.03%)	187	(80.95%)	18.92***		Affected	Kuroshio	
Hazard	3Hazard	575	(93.34%)	194	(78.86%)	996	(72.86%)	138	(59.74%)	33.27***		Predicted	Kuroshio	high
	4Scale (size)	468	(75.97%)	156	(63.41%)	594	(43.45%)	119	(51.52%)	86.93***		Predicted		
	5Earthquake info.	161	(26.14%)	47	(19.11%)	70	(5.12%)	17	(7.36%)	171.11***		Predicted		
Information	6Prediction	426	(69.16%)	138	(56.10%)	360	(26.34%)	86	(37.23%)	205.00***		Predicted	Kuroshio	high
	7Communication	237	(38.47%)	100	(40.65%)	368	(26.92%)	67	(29.00%)	25.69***		Predicted		
	8Information	222	(36.04%)	71	(28.86%)	340	(24.87%)	52	(22.51%)	21.64***		Predicted		
	9Lesson learned	185	(30.03%)	47	(19.11%)	590	(43.16%)	78	(33.77%)	44.43***		Affected	Kuroshio	
Measure	10Meausre & plan	426	(69.16%)	185	(75.20%)	750	(54.86%)	125	(54.11%)	25.19***		Predicted		
	11Training	234	(37.99%)	72	(29.27%)	250	(18.29%)	41	(17.75%)	74.50***		Predicted		
	12Evacuation & shelter	456	(74.03%)	129	(52.44%)	743	(54.35%)	106	(45.89%)	37.34***		Predicted	Kuroshio	high
Abandonment	13Despair	68	(11.04%)	8	(3.25%)	48	(3.51%)	11	(4.76%)	46.78***		Predicted	Kuroshio	high
	14Abandonment	19	(3.08%)	1	(0.41%)	5	(0.37%)	0	(0.00%)	34.87***		Predicted	Kuroshio	high
Restoration & Recovery	15Rescue	33	(5.36%)	25	(10.16%)	73	(5.34%)	11	(4.76%)	9.25*			Muroto	
	16Restoration	31	(5.03%)	16	(6.50%)	215	(15.73%)	66	(28.57%)	86.55***		Affected		
	17Support	237	(38.47%)	103	(41.87%)	669	(48.94%)	127	(54.98%)	15.04**		Affected		
	18Recovery	72	(11.69%)	16	(6.50%)	808	(59.11%)	144	(62.34%)	324.38***		Affected	Kuroshio	
Life & human	19Death	201	(32.63%)	49	(19.92%)	740	(54.13%)	91	(39.39%)	83.64***		Affected	Kuroshio	
	20Mourning	4	(0.65%)	1	(0.41%)	218	(15.95%)	43	(18.61%)	129.82***		Affected		
	21Life	157	(25.49%)	36	(14.63%)	315	(23.04%)	46	(19.91%)	10.06*			Kuroshio	
	22Survivor	36	(5.84%)	14	(5.69%)	553	(40.45%)	104	(45.02%)	244.40***		Affected		
Housing & living	23House	168	(27.27%)	58	(23.58%)	670	(49.01%)	166	(71.86%)	112.79***		Affected		
	24Temporary house	12	(1.95%)	7	(2.85%)	424	(31.02%)	75	(32.47%)	224.25***		Affected		
	25Rebuild	23	(3.73%)	12	(4.88%)	313	(22.90%)	68	(29.44%)	134.71***		Affected		
	26Living	102	(16.56%)	39	(15.85%)	377	(27.58%)	96	(41.56%)	54.85***		Affected		
	27Relocation	119	(19.32%)	46	(18.70%)	341	(24.95%)	107	(46.32%)	54.03***		Affected		
Construction & public work	28Public works	120	(19.48%)	46	(18.70%)	421	(30.80%)	122	(52.81%)	75.38***		Affected		
	29Construction	242	(39.29%)	97	(39.43%)	597	(43.67%)	131	(56.71%)	12.76**		Affected		
	30Land use	49	(7.95%)	35	(14.23%)	332	(24.29%)	103	(44.59%)	122.95***		Affected	Muroto	low
Discussion	31Opinion	119	(19.32%)	20	(8.13%)	286	(20.92%)	45	(19.48%)	17.90***		Affected	Kuroshio	
	32Agreement	46	(7.47%)	10	(4.07%)	105	(7.68%)	48	(20.78%)	48.54***		Affected		
	33Claim & demand	343	(55.68%)	134	(54.47%)	691	(50.55%)	127	(54.98%)	2.62(n.s.)				
Politics	34Politician	138	(22.40%)	29	(11.79%)	412	(30.14%)	55	(23.81%)	31.84***		Affected	Kuroshio	
	35Election	32	(5.19%)	28	(11.38%)	34	(2.49%)	6	(2.60%)	43.93***		Predicted	Muroto	
Administration	36Government	522	(84.74%)	220	(89.43%)	1153	(84.35%)	194	(83.98%)	0.67(n.s.)				
	37Public service	128	(20.78%)	42	(17.07%)	405	(29.63%)	92	(39.83%)	35.22***		Affected		
	38Public facility	253	(41.07%)	128	(52.03%)	650	(47.55%)	110	(47.62%)	5.92(n.s.)			Muroto	
	39Budget	116	(18.83%)	55	(22.36%)	293	(21.43%)	60	(25.97%)	4.27(n.s.)				
Education	40School	206	(33.44%)	66	(26.83%)	472	(34.53%)	85	(36.80%)	4.39(n.s.)				
	41Education	183	(29.71%)	49	(19.92%)	421	(30.80%)	66	(28.57%)	8.53*			Kuroshio	
	42Child	237	(38.47%)	56	(22.76%)	522	(38.19%)	83	(35.93%)	14.46**			Kuroshio	
	Total	616		246		1367		231						

1) *** $p < .001$, ** $p < .01$, * $p < .05$, n.s.: no significance. 2) The names were shown in case of lower p-value than .05 by χ^2 tests.