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The potential of disaster digital archives in disaster education: The case of the Japan disasters digital archive (JDA) and its geo-location functions

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ABSTRACT

Using the Japan Disasters Digital Archive (JDA) as an example, the present study examines how geo-location functions in disaster digital archives may contribute to disaster risk awareness. It focuses on the sites affected by or representing lessons learned from the 2011 Great East Japan Earthquake (GEJE), such as the tsunami inundated coastal areas or museums. The study tests the thesis that geo-located data in digital archives can enhance disaster risk awareness by allowing its users to discover novel location-specific information. The Covid-19 pandemic drastically influenced the research design and the results. The research methods had to be changed from group-based field trips and in-person interviews to virtual research methods that participants could follow on their own. Although there is room for improvements in the JDA design and function, the research results suggest that options for visitors to retrieve information through digital archives on their own while visiting sites of their interest can contribute to their understanding of the history of these specific places and local risks. Promoting self-guided tours by giving access to disaster digital archives with a geolocation-function could also be used as a cost saving option for museums and visitors alike to explore disaster-affected areas, especially in times of a pandemic when visitors are discouraged from joining crowded tours. As a whole, this research aims to not only improve (disaster) digital archives but also to contribute to disaster education in general and offer a widened learning experience for visitors of disaster affected areas in particular.

1. Introduction

Although disaster digital archives have long been used in disaster education ([1] Shibayama and Boret 2019), most of the time meaningful location-based information is not regularly used for didactic purposes other than exposing the archive users to already

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prepared visualizations.[1] The Japan Disasters Digital Archive (JDA), developed and operated by Harvard University's Reischauer Institute, innovated geo-location functions that allow users to add and retrieve data on a digital map. These functions visualize data on the map based on the specific location of the user (e.g., museums or disaster-affected areas), or make apparent particular data added to the collections. To our knowledge, the JDA is the only disaster archive offering such a function. The present study by researchers of the universities of Harvard, Princeton and Tohoku examines how this geo-location function may contribute to disaster education in general and risk awareness in particular. It focuses on the sites affected by or representing lessons learned from the 2011 Great East Japan Earthquake (GEJE), such as the tsunami inundated coastal areas or museums. The study tests the thesis that geo-located data in digital archives can enhance disaster risk education by allowing its users to discover novel location-specific information. Although there is room for improvements in the JDA design and function, the research results suggest that options for visitors to retrieve information through digital archives on their own while visiting sites of their interest can contribute to their understanding of the history of these specific places and local risks.

Several limitations have to be considered regarding the findings of this study. This paper presents preliminary findings of a pilot study which will be used as a basis for more substantial in-person follow up research, once the restrictions imposed through the ongoing Covid-19 pandemic allow us to do so. Further, the disciplinary background of the authors is mostly in social sciences and humanities and research results have been analyzed using qualitative analysis methods such as coding. Due to the pandemic, the research methods had to be drastically changed from group-based field trips and in-person interviews to virtual research methods that participants could follow on their own. However, this limitation led us to new interesting observations. For instance, promoting self-guided tours by giving access to disaster digital archives with a geolocation-function could be used as a cost saving option for museums and visitors alike to explore disaster-affected areas, especially in times of a pandemic when visitors are discouraged from joining crowded tours. Further, the results of this study are also expected to contribute to a better understanding of the use of virtual research methods in social science research. This research aims to not only improve (disaster) digital archives but also to contribute to disaster education in general and offer a widened learning experience for visitors of disaster affected areas in particular. Based on these preliminary results, more detailed analysis of the quantitative data in combination with follow-up qualitative interviews and workshops are planned to be held in the near future.

1.1. Digital archives in disaster education in Japan

Japan faces a wide range of natural hazards, including earthquakes, typhoons, earthquakes, volcano eruptions and tsunamis. For the same reason, the experiences of handling disasters and recovery have been passed on in material and oral forms for centuries ([2] Imamura, 2019). However, Watanabe ([3] 2000) notes that it was only after the Great Hanshin-Awaji Earthquake in 1995 that the term "disaster archive" (*shinsai ākaibu*)[2] was used for the first time in Japan in relation to Kobe University's "disaster library" (*shinsai bunko*). Further, Shibayama et al. ([4] 2018: 283) stress the importance to differentiate "disaster archives" (*shinsai ākaibu*) and "disaster digital archives" (*shinsai dejitaru ākaibu*). Although there are several subcategories, such as whether archives keep material records in addition to digital ones, the term "disaster archives" is often used as a generic term for the collection, organization, preservation, and utilization of disaster-related materials, whereas "disaster digital archive" describes archives that turn materials into a database that can be searched from computers [or handheld devices]" ([4] Shibayama et al., 2018: 283).

The significance of preserving memories and records of disasters for educational purposes has been stressed regarding any type of disaster archive. For instance, Takakura and Boret ([5] 2020: 58) summarize some of the merits of disaster digital archives as follows:

> "Their activities and visual records impact our understanding of disasters and the whole process of recovery and collective memorialization. They assist in the monitoring of rehabilitation and provide data for safe reconstruction planning of devastated coastlines. They actively help to share the information necessary to draw lessons from the behaviour of the tsunami and the people affected by it."

Disaster archives perform a number of roles in disaster risk reduction. However, the one function that is most commonly highlighted is their ability to pass on lessons learned and to keep the memory of past disasters alive. For instance, Miura and Suzuki ([6] 2019) highlight the need to remind residents of hazards they may face in their neighbourhoods. In their research ([6] 2019: 215), they describe how many residents in disaster-affected areas tend to express their disbelief about disasters happening in areas that never had been prone to such hazards. Yet, they note that such assumptions often refer only to living history, which means about 100 years. "Disaster Archives are vital to show that in reality disasters have happened in such areas and to understand what kind of hazards exist and under which circumstances they unfolded'' ([6] Miura and Suzuki, 2019: 216). In addition, describing the "Voices from Tohoku" digital archive, which preserved oral narratives of GEJE survivors, Fulco et al. ([7] 2019) state that such oral narrative archives can give understandings in how local people feel about recovery in the different phases through which the project was carried out and can provide more personal insights about the disaster and its consequences.

Although the above is true for both analog and digital archives, with time passing, digital archives become even more important to preserve the memory of disasters, as the increased use of the internet also leads to an increasing amount of so-called "born-digital" content. This term describes materials that "originated in a computer environment" ([8]Society of American Archivists, 2021) as

[1] Some examples include the Aceh Tsunami Archive (https://aceh.mapping.jp/index.html) and the Iwate Nippo's "Wasurenai/We Shall Never Forget" (https://wasurenai.mapping.jp/).

[2] Before 2011, the term *shinsai* (earthquake) was more commonly used than the more general term *saigai* (disaster) as most archives focused on preserving material related to earthquakes.

opposed to digitized materials, such as digital scans of texts or photographs. One of the first examples for widespread creation of digital contents in the direct aftermath of a disaster is said to be the 7/7 bombings in London in 2005 where citizens shared photos taken with their cellphones on various blogs and other websites ([9] Peary et al., 2012: 4–5). When the GEJE hit in 2011 smartphones were widely spread in Japan and witnesses and survivors alike shared videos of the shaking ground or the incoming tsunami, or pictures of the surrounding devastation taken from their rooftops on various online platforms. Further, social media platforms like Twitter, Mixi or Facebook became a critical tool for coordinating support work, spreading information, checking the safety of family members and friends, or asking for help ([10] Shigyo, 2011). Discussions that unfolded on these public online platforms, especially regarding the nuclear disaster in Fukushima Prefecture, can be seen as examples for confusion, anxiety, the lack of information, and the spread of misinformation in the direct aftermath of the disaster ([11] Miura et al., 2016). In order to understand the happenings around a specific disaster both in real-time and retrospectively, it is therefore vital to preserve such born-digital materials. However, Shibayama ([12] 2020) emphasizes that preserving data is not enough for disaster risk reduction - the data needs to be actively used and lessons turned into practice. Here, two of the challenges that disaster digital archives bring with them are that users may have to navigate between thousands of data points and that it may be difficult for them to interpret the data they find ([12] Shibayama 2020: 460).

To tackle such access and interpretative challenges, this research aims to investigate the possibilities of linking archived data to place-based information through a geo-location function. We hope that such features could allow users who visit places of interest for disaster education, such as disaster remains, memorials or museums, to retrieve additional information about that specific place via a map function (similar to google maps). Although not many disaster digital archives use such a function (see footnote 1), there have been studies on location based disaster risk services ([13] Aloudat et al., 2014 [14]; Cheng et al., 2017). In particular Sari and Kanegae ([15] 2020) examined users' views of a map-based disaster application service in Indonesia. They emphasize that, amongst others, "such apps allow users to increase their hazard risk awareness in a spatial context, to explore and query complex hazard risk databases efficiently (…)." ([15] 2020: 18) Drawing on these studies, we hypothesize that combining the contents of disaster digital archives with such geo-location based features, as offered by the JDA, is not only useful for the users to navigate through the amount of data preserved in archives, but it can also improve learning experiences about past disasters at the places affected by them, as not all disaster memorial facilities may offer detailed descriptions.

1.2. The Japan disasters digital archive

The Japan Disasters Digital Archive (jdarchive.org) was founded in response to the 2011 Great East Japan Earthquake (GEJE). Its original mission, and still today its primary focus, was the preservation of born-digital (and some digitized) materials related to the GEJE. Faculty, students, and staff at Harvard with professional and personal connections to Japan were seeking a way to contribute to the understanding of this disaster, both at the time and long into the future. They realized that in the digital age, much valuable information and interpretation of any disaster or major world event would exist only in digital form, and would therefore require new methods of digital preservation ([16] Gordon and Morimoto, 2019). This was of course a realization that many people came to at the same time, so it was possible to build the archive in strong partnership with numerous individuals and organizations in Japan. The Michinoku Shinrokuden project at Tohoku University's International Research Institute for Disaster Science (IRIDeS) has been a particularly important institutional partner, and the authors of this paper have all at one time or another worked with the JDA. Gordon was the faculty member at Harvard who launched the archive with colleagues. Shibayama was the key early partner at the Michinoku project. Morimoto, both as a graduate student based at IRIDeS and as a postdoctoral digital fellow at Harvard has been closely connected to JDA for many years. More recently Boret and Gerster have made extensive use of the archive in their classes at Tohoku University, and joined in user outreach workshops organized by Harvard and IRIDeS. In 2016, the JDA began to collect materials on other disasters in Japan, such as the 2016 Kumamoto Earthquake, and changed the English title from *The 2011 Japan's Disaster Archive* to the plural–*Japan Disasters Digital Archive*. But the great majority of the content is still focused on the GEJE.

From the outset, a goal of the archive was to take advantage of the unique ability of digital platforms to engage with a user community as co-creators (e.g., some aspects of crowdsourcing). The JDA has made it possible for users to add their own curated content to the archive, and to build discrete collections of materials in the archive focused on a topic of their interest. The JDA project has sought to become a participatory archive by creating an archive of use to researchers, to teachers and students, and to members of the wider society, both in Japan and globally. To date, the project has been more successful in engaging scholarly and pedagogic communities than in building a wider user community among residents of the disaster regions or elsewhere in Japan.

One aspect of the archive that has potential to engage that wider community is the ability of users to search the archive through a map, briefly noted above. Roughly half of the items in the archive (about 840,000 out of 1.7 million) contain geo-location in the metadata. When zoomed out, this massive number is displayed in the form of a heatmap, allowing users to see regions with extensive archival material (Figs. 1 and 2). When zoomed in, a user sees discrete items displayed in the form of red dots, which can then be opened and viewed in full (Fig. 3). The map can quickly refresh itself upon zooming into an area of Japan (or elsewhere in the world where there is material related to disasters in Japan). Comparing the heatmap (Fig. 1) with locations that have been affected by recent large-scale disasters in Japan (Fig. 7) also reveals that these areas tend to feature more geo-located data. Examples are Iwate, Miyagi and Fukushima prefectures – the three prefectures that have been affected most by the GEJE, and areas that have been affected by torrential rainfalls, such as Hiroshima, or the Kumamoto earthquake in Kyushu. However, it is not only in the directly disaster-affected places that information can be found. The heatmap (Fig. 1) also shows large amounts of geo-located data in metropolitan areas such as

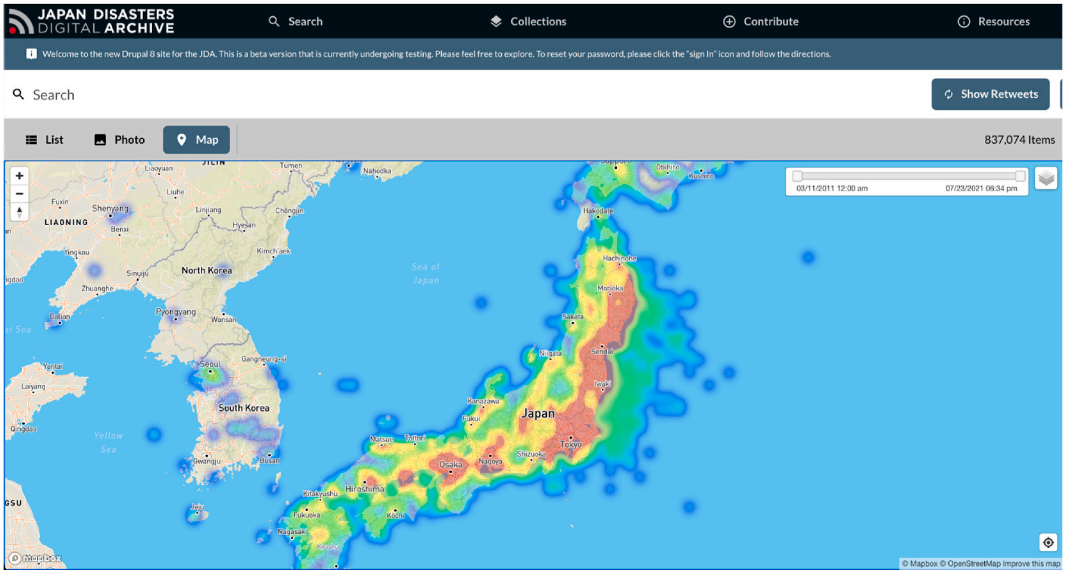

Fig. 1. An example of the JDA heatmap, displaying geo-located items in the archive. The darker the color, the more items can be found in the specific areas.

Tokyo, Osaka, or Nagoya. This amount reflects for instance volunteering activities from afar or outside of the disaster area or social media activities about the disasters, such as in tweets and retweets, which account for a lot of data in the JDA. Further, it can be seen that people outside of Japan contributed data to the archive as well. So the map clearly shows how a disaster also affects areas outside of the disaster zone. Zooming into the map allows the users to check exactly what kind of data is featured in which location.

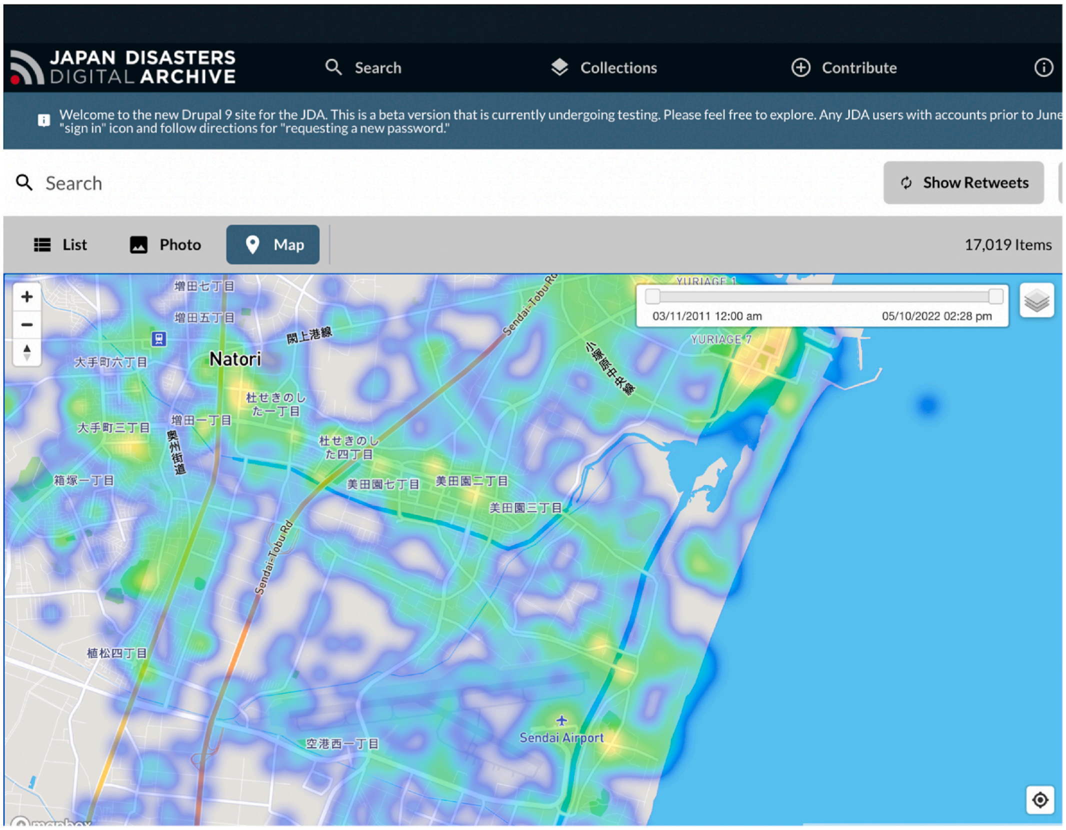

Fig. 2. When zoomed in, the map gradually changes color to show how many items can be found around a specific location. This example shows parts of the coastal area of Natori City and Sendai City.

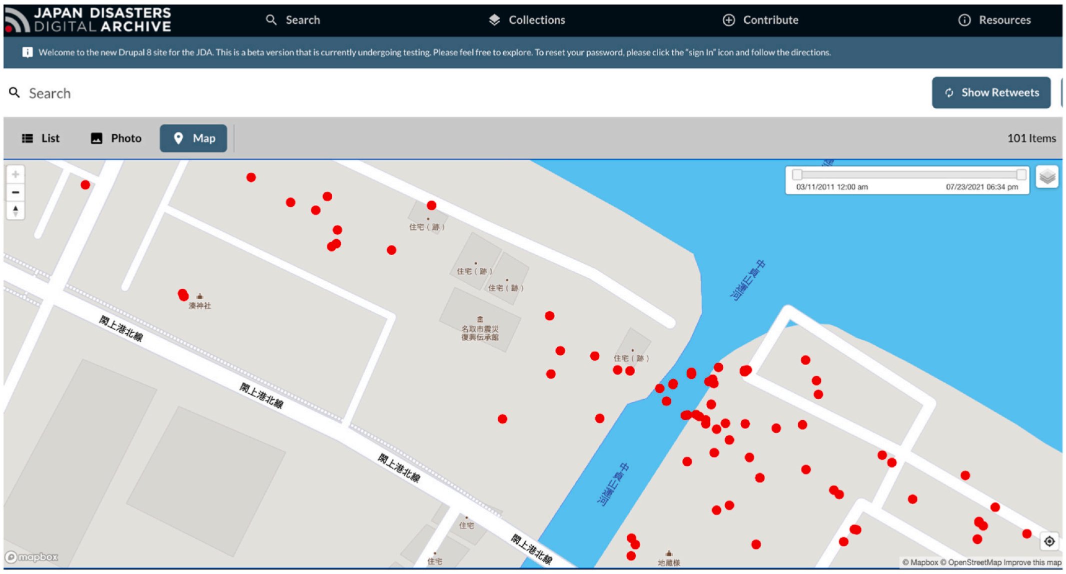

Fig. 3. Zoomed in even closer on a specific area, in this case Natori City, the colors of the heat map vanish and instead red dots appear. In the screenshot above, the red dots indicate the geo-located items around Natori City Disaster Reconstruction Denshōkan, Japan.

More recently, it has become possible to use the map on mobile devices (or on WIFI connected laptops) that show the user's current geo-location as well as the nearby contents of the archive (Fig. 4). These map-related functions lead us to hope that archive users, both in the disaster region and in more distant places in Japan (or possibly elsewhere) can locate information relevant to their own home or to a place they are visiting, such as a disaster memorial or museum. The research project we are introducing here explores the possibilities for broadening our user community through use of the archive map.

2. Methods

According to the original research plan, several hundred people representing different age and gender groups and regions within Japan were supposed to take part in an in-person workshop to learn about how to use and search data within the JDA, and curate additional contents for it. They were subsequently expected to take part in one or two day tours to areas affected by the GEJE and museums in the Tohoku region to test the JDA's geo-location functions. This plan could not fully be implemented due to travel restrictions, university regulations, and other measures to prevent the spread of coronavirus in Japan. Instead, the authors developed a two-step google form-based questionnaire. 50 participants were recruited for pilot research to test the feasibility of the new protocol. The participants were recruited using the research support company "TRANSMIT" to ensure that the participants remain anonymous to the research team. TRANSMIT used their mailing list and an open call for applicants. Further, this research project was advertised at several online symposiums held at Tohoku University. For the modified research that allowed research participants to take part while adhering to measures to prevent the spread of coronavirus, the participants were asked to either visit a disaster-related site or take part from home, find information on nearby areas, the GEJE, or other disasters in the JDA. Since the research participants were reimbursed for their travel expenses to disaster memorial museums or disaster-affected sites, TRANSMIT knew their personal information (if disclosed). However, before filling in the survey, the participants received an ID so that the authors would not have access to non-disclosed personal information, such as their names. They filled in the questionnaires on their phones or computers before and after the use of the archive. The participants were provided with brief instruction both in text and video on how to use the map-related functions. The research scope of this pilot study was limited to 50 participants because this allowed us to do in depth analysis with qualitative research methods, such as coding. Coding is essentially "naming segments of data with a label that simultaneously categorizes, summarizes, and accounts for each piece of data" ([17] Charmaz 2006: 43). In general, coding can be done with any device that allows attaching notes to data, ranging from pen and paper to programs such as Excel. For this study Excel and the qualitative data analysis program MAXQDA were used.

All participants of the survey were Japanese, representing the following age groups: 20% of the participants were in their 20s, 12% in their 30s, 32% in their 40s, 22% in their fifties, 10% in their 60s, and 4% in their 70s (Fig. 5). In addition, 57% of the respondents are male, whereas 40.8% are female. One person preferred not to disclose their gender. The vast majority of participants (66%) live in one of the three prefectures hit most severely by the GEJE, with 32 participants from Miyagi Prefecture (Fig. 6). This high collaboration from Miyagi Prefecture can probably be attributed to the recruitment method; the advertisement about the project was shared at events related to Tohoku University's Michinoku Shinrokuden Disaster Digital Archive.

The first part of the questionnaire included 31 questions aimed to find out about the participants' personal backgrounds: age, gender, residence, and experience and knowledge of disasters in Japan, etc. It included questions on technological literacy and digital device use habits. The second part, to be completed after the archive use at specific disaster-related sites, workplaces, or at home,

Fig. 4. A screenshot taken with a smartphone on the Aobayama Campus of Tohoku University. The blue dot shows the location of the user in addition to red dots marking the geo-located contents.

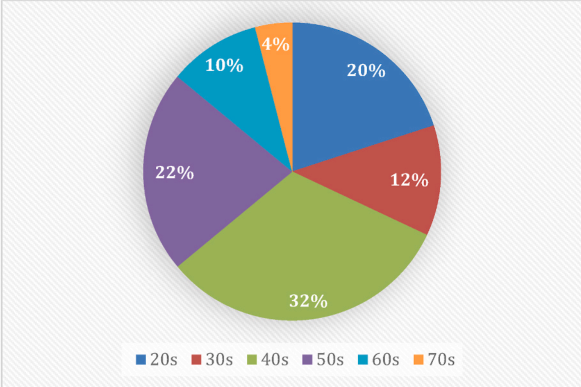

Fig. 5. Age distribution among the participants.

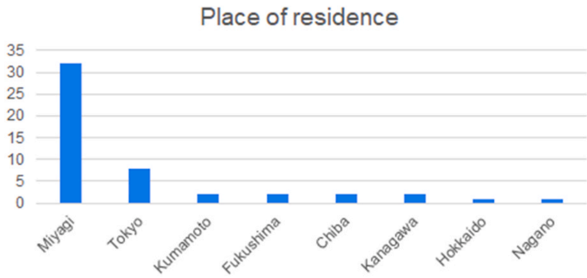

Fig. 6. Place of residence by prefectures.

contained 26 questions concerning the user experience. Some questions were: the location they explored, the kind of data they retrieved, the usefulness of the information, the degree to which the geo-location function added to their experience and learning while virtually or physically visiting disaster-affected areas. The questions featured in the survey were all nonmandatory which means that the respondents were free to skip questions if they preferred to not answer. Although this may lead to less data acquisition in some cases, this is an important feature as especially disaster survivors may risk suffering from PTSD if confronted with certain questions about a disaster. Fig. 7 lists large-scale natural hazard induced disasters that affected Japan in the past 50 years and the mainly affected prefectures. Comparing Fig. 6 – which shows the places of residence of the respondents– with Fig. 7, allows us to understand that the majority of respondents live in prefectures that have been affected by disasters in recent years. As will be discussed further in the results section, having experienced disasters or living in places that may feature a strong collective memory of disasters may affect the responses to the survey, especially regarding levels of risk awareness. Since Japan is prone to a variety of natural hazards this increases the likelihood of people who experienced a disaster before to participate in studies like this. For this reason, this research and the survey were supervised by Tohoku University's ethics committee.

Although research completely carried out in the virtual realm made collecting and visualizing the retrieved data easier than in-person field research, several challenges remained. For instance, in-person workshops have allowed us to supervise the participants when using the JDA. This led to a better understanding about problems users faced, such as technical issues or misunderstandings. In contrast, we could only resolve some of the difficulties mentioned by respondents through online follow up interviews as the short replies in the survey were at times not enough to describe issues in detail. After the participants completed their use of the JDA and filled out the survey, we followed up with interviews of four subjects: three women in the age groups 20s, 30s and 40s and one man in his 70s. We selected the interviewees among those who shared their contact information, were willing to be interviewed, and raised issues in their responses that the authors wanted to clarify. Those who agreed to be interviewed were invited to share their screen to replicate the problems that they encountered. For instance, a male respondent had replied in the survey that he had problems with retrieving data through the map function of the JDA. When sharing his screen during the interview, it turned out that his security settings did not allow the geo-location function to operate which would make manual zooming into the map necessary in order to retrieve the data. This interview in particular revealed some of the limitations of our research design: During in-person workshops the instructors are informed about problems, technical issues and misunderstandings almost immediately and are able to clarify those most of the time. In this anonymous study such support was not possible and follow-up interviews could only be conducted with four individuals. These interviews may not give us the same insights we would have gained from using and working with the archive at the same place together, yet it did allow us to clear some misunderstandings and reflect on the survey responses.

Year	Name	Mainly affected Prefectures	Dead and missing
1972	Heavy rain, flood	All of Japan, in particular Kochi and Aichi	442
1977	Heavy rain, flood	Northern Kyushu to Kanto regions	375
1978	Miyagi-ken Oki Earthquake and Tsunami	Miyagi	28 (1325 injured)
1982	Heavy rain, Nagasaki Great Flood	West of Kanto region, Nagasaki in particular	539
1991	Mt. Unzen Eruption	Nagasaki	43 (11,000 evacuees)
1993	Hokkaido Nansei Oki Earthquake (Okushiri Earthquake and Tsunami)	Hokkaido	230
1995	Great Hanshin Awaji Earthquake	Hyogo	6437
2000	Tokai Heavy Rain	Aichi, Saga, Mie	10
2004	Typhoon No. 23 (Tokage)	Kinki and Shikoku region, in particular Hyogo, Kyoto, Kagawa, Kochi	99
2004	Chuetsu Earthquake	Niigata	68
2005	Heavy snow (Dec-Feb)	Kitariku region	152
2008	Iwate-Miyagi Nairiku Earthquake	Iwate, Miyagi	23
2009	Chugoku and Kyushu Heavy rain	Yamaguchi, Fukuoka	35
2009	Typhoon No. 9 (Etau)	Shikoku and Kinki region, Hyogo	27
2010	Heat wave	All of Japan	217
2010	Heavy Snow	Hokkaido, Tohoku, and Kitariku regions	128
2011	Great East Japan Earthquake, Tsunami and Nuclear Disaster	Iwate, Miyagi, Fukushima	19868
2011	Typhoon No. 12 (Talas)	Mie (Ise Peninsula)	92
2013	Typhoon No. 26 (Wipha)	All of Japan	40
2014	Heavy rain, flood	Hiroshima	74
2014	Mt. Ontake Eruption	Nagano	63
2016	Kumamoto Earthquake	Kumamoto	55 (more than 1800 injured)
2018	Heavy rain, flood	Shikoku, Hiroshima, Wakayama, Okayama	263
2018	Hokkaido Iburi Earthquake	Hokkaido	44
2019	Typhoon No. 19 (Hagibis)	Miyagi	94
2020	Kumamoto Heavy Rain	Kumamoto	67

(caption on next page)

Fig. 7. Large-scale natural hazard induced disasters in Japan that occurred in the past 50 years and the most affected prefectures based on [18] Takara et al., 2011 and [19] Japan National Police Agency 2022.
The numbers of dead and missing until 2011 are based on Takara et al., 2011; the ones after on Japan Police Agency 2022. Events of more than 20 casualties that caused larger societal disruptions were included in the table.

3. Results

3.1. Age and technological literacy

The technological literacy of our participants appeared extremely high. The results of the first survey showed that all participants had prior experience using virtual map functions (e.g., google maps). Out of fifty participants, none reported difficulties using digital technology, except one participant, who had trouble using the archive on his smartphone. Moreover, a man in his fifties commented, "I'm not used to using a PC or tablet, so it took me over an hour to get used to it" (ID 20). The high level of technological literacy among the research participants is especially significant since our study covers all age ranges evenly from the 20s–70s. That being said, it seems that people in their 60s or 70s reported more difficulties than any other age group. For example, a man in his 70s responded that although there was no issue using the archive, "I cannot say it is easy to use" (ID 03). Participants aged between 20 and 50 did not report any problem with the website or map itself.

Most of the comments on the technology concerned JDA's usability, limitations, or technical issues (compatibility with Chrome) rather than their lacking skills. Participants reported occasional slowness of the system, incompatibility with specific browsers or types of devices (e.g., notebook versus smartphone), and inaccuracy of geo-locations or dead links to certain archived contents. For instance, a woman in her 60s reported, "I used it on my Macbook Pro High Sierra and found that I could see more things in Google Chrome than in Safari. I tried to set up location information, but it didn't work" (ID 23). Likewise, a man in his 60s commented that "Android devices (smartphones) take a long time to access and display, and an auxiliary battery is essential. I mainly used my PC (mac)" (ID 13). Such comments indicated a high literacy since they could problem solve by comparing different internet browsers, or guessing various compatibility problems depending on the device they used.

While these initial findings are encouraging, they also suggest that the JDA demands a high level of technological literacy for its users to navigate its distinct user interface comfortably. Further, some users experienced difficulties navigating through the large volume of data the JDA provides without adequate prior knowledge of the disasters. These comments suggest that some level of disaster literacy, in addition to technological literacy, is critical to maximizing the user experience. The question concerning technological literacy requires further research. The present study only focused on participants' age but did not ask about other potential confounding variables, such as their education and profession, which could have impacted their familiarity with digital technology.

3.2. Survey participants' responses to data types in the JDA

As mentioned, we asked the study participants to access the contents of the JDA using its geo-location map functions and respond to the survey afterwards. Some of the questions explored the participants' engagements with various data types (i.e., tweet, image, news article, video, etc) in the archive and their reaction to them. Here, as mentioned above, one of the merits of digital archives emerged as the fact that in addition to digitized contents, the JDA also archives "born-digital" data.

The survey participants named born-digital data, such as social media materials, among other contents of the JDA as especially meaningful. Tweets, Facebook posts, YouTube videos, and blog posts were the most frequently mentioned materials. Several users stressed that reading tweets from the time immediately following the earthquake made them relive or remember what had happened more vividly. A woman in her 20s commented that "it's good that you can see the tweets of people who were in the area at the time of the earthquake because you can get more realistic information" (ID 28). Similar responses were given to videos taken by survivors or from surveillance cameras and archived materials of news reports from 2011. A woman in her 40s from Kumamoto Prefecture listed a video that captured the arrival of the tsunami in Kesennuma City as the content that moved her the most. She wrote: "The repeated broadcasts calling for evacuation, the changes in the sound of the tsunami, and the fishing boats pushed away by the tsunami taught me a lot about what had happened back then" (ID 49). Another woman in her 20s who experienced the GEJE in Miyagi Prefecture, found various photographs especially impactful because "you can understand the information just by looking at them [the images]. I don't even have to mention images of the tsunami, but there were also photos of damaged homes. [Looking at them] makes it easy to understand how much damage there was. With them, I imagined the anxiety of the people who were there." She further mentioned a picture of flowers placed in front of a morgue. She explained that "up until now, I felt like the Great East Japan Earthquake didn't really concern me because I didn't suffer much damage, but [seeing this] I strongly felt the existence of those who had died and understood how terrifying the Great East Japan Earthquake was" (ID 34).

These responses suggest that materials that were produced during the still unfolding disaster or in the direct aftermath are found valuable by the users. Further, more than scientific analyses or summaries, raw materials, often produced by individuals on the ground, such as the above-mentioned tweets or videos, were seen as reminders of the confusing situation in the direct aftermath of the disaster, when it was not clear how to react or how recovery would proceed. A young woman from Chiba in her 20s (ID 46) summarized the merits of the different data types as follows:

> "I felt that each media had its own merits. If you want to understand the damage of a disaster intuitively, I think the images are a good source. For instance, where and how houses collapsed, and where flood damage and road damage occurred. If you want to read summarized information, reports and reviews on websites and newspaper articles are a good source. I think that tweets are not only interesting regarding the individual contents themselves, but they are also meaningful for observing human behavior

that is often seen in the event of a disaster and for finding out about troubles that are likely to occur in anxious situations. For example, learning about the actual cases of disaster-related hoaxes that are likely to occur even in non-disaster areas, I think that the number of people who are deceived by them in a future disaster might be able to be reduced" (ID 46).

Yet the same person also reminded us of the potential negative impact raw materials may have on survivors of disasters. Regarding tweets in relation to torrential rainfalls in Kumamoto, she shared that,

> "When I read a lot about the Great East Japan Earthquake, I feel sick, so I searched for "Kumamoto" instead (referring to the 2016 Kumamoto earthquake or torrential rainfalls) and got some results. The hardships of the local residents and the people who volunteered there were well covered. It made me think about what it means to volunteer for disasters and what else I can do even if I can't go to the disaster-stricken area" (ID46).

Although the young woman did not reveal herself as a disaster survivor, her replies to a few questions implied that she was very likely directly affected by the GEJE. For example, she answered that during the time of the disaster, she was in Miyagi Prefecture, one of the most severely affected areas. Also, she answered that she has a "strong connection to the disaster" (*taihen kakawari ga aru*). Although one essential aspect of digital archives is to preserve materials as they are, this participant's discomfort suggested that digital archives should take appropriate measures to allow users to know about contents prior to engaging with them in depth. However, the need for such measures does not negate the fact that the strength of digital archives comes from the preservation of materials as they were. With such materials, researchers and other users can reassemble and reconstruct certain events, including aspects of societal responses to them, political decisions or news coverage about them. Also, raw materials such as survivor videos of incoming tsunamis can have strong impacts on people who experienced such disasters themselves and/or suffer from post-traumatic stress disorder (PTSD). Importantly, since the JDA allows users to continue adding tags or descriptions to existing contents, the community of archive users can be encouraged to collaborate to update the contents in order to avoid exposing its users to potentially sensitive data. To this end, future research involving in-person workshops will be critical.

Overall, however, the post-JDA use survey regarding data types indicated that participants found born-digital contents–raw materials from social networks, videos, and images–as most meaningful. Since many born-digital materials come with geo-location as their default metadata, the JDA's geo-location functions are beneficial. Now we will turn to the preliminary findings on the relationship between disaster risk education and geo-location functions.

3.3. Disaster risk education and JDA's geo-location functions

One of the goals of disaster digital archives is to contribute to risk education and raise disaster risk awareness by preserving and passing on the experiences made in previous disasters. In this project, we explored whether a map and geo-location functions can further contribute to its users' risk awareness. Close to half of the participants agreed that the use of the JDA increased their disaster risk awareness (Fig. 8). In addition, six people (12.6%) replied that they already had a high level of risk awareness. 38% reported that their awareness level did not change. The high level of self-reported risk awareness might be attributable to the fact that many participants were from the disaster-stricken regions.

We asked questions to evaluate the participants' self-report on disaster risk awareness. Although replies on the participants' interest and knowledge on disaster memorial facilities and expertise on the disasters were rather diverse, 84% of the respondents already knew about disaster memorial facilities related to the GEJE, and 30 people had first-hand experience of another disaster. Regardless of their past direct experience with any disasters, 82% responded that they wanted to learn more about the GEJE. Most surprising, however, was that almost all participants replied that they learned something new through their engagement with the JDA about the disasters and/or the place where they accessed the archive. Among the 47 people who replied to the question, 42 said they found new information, four did not and one person (in the chart noted as "Other") mentioned they did not invest enough time to know whether there was such information (Fig. 9).

The map and geo-location functions seemed to be helpful for finding information and learning something about disasters. Participants reported the JDA helped them discover new information and perspective about the disasters which was even the case for

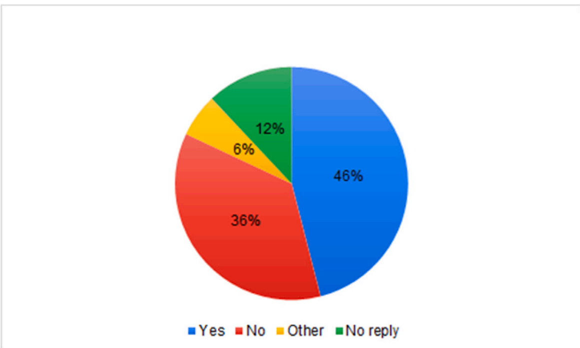

Fig. 8. Responses to the question: Do you feel that using the JDA raised your risk awareness?

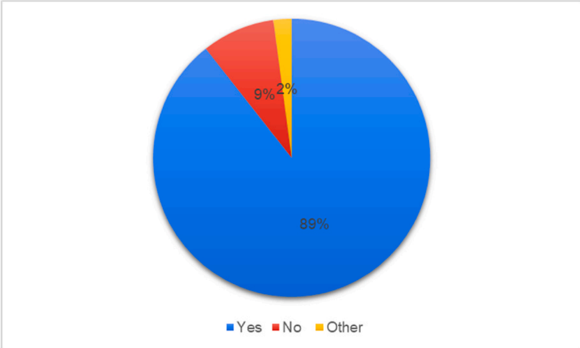

Fig. 9. Responses to the question: Did you find new information about the GEJE by using the JDA? The open replies were coded as “Yes”, “No”, and “Other.”

people who came from disaster-affected areas. One category of users were those who were able to find location-specific materials relating to specific affected areas where they now live or used to inhabit. At the same time, the contents they accessed help broaden their reflections and think about lessons to be learned, such as a comment from a woman from the disaster-stricken area who did not suffer any direct damage (ID 34). Some reportedly helpful items included photos, tweets, news, websites, or even the locations of shelters. In addition, participants reported that existing digital information revived their fading memories. Equally important, some who did not experience the disaster directly mentioned they felt that engaging with the JDA allowed them to feel closer to those who survived the tsunami. While some people increased their awareness of larger group activities led by non-profit organizations, private corporations and local government agencies, a couple of participants realized the importance of individual resilience through this virtual proximity.

The importance of searching contents through a map and using the geo-location functions are also highlighted in a comment by a woman in her 60s. She shared: “I think the archive will help me to be more aware of disaster prevention because I found maps of areas where earthquakes are predicted, areas under evacuation orders and landslides” (ID 23). A woman in her 30s from Tokyo noticed that the number of tweets on March 11, 2011 intensified at locations frequently used by people, such as train stations. Seeing these on a map reflected the large number of individuals who were unable to return to their homes in the Tokyo metropolis (*kitaku kon'nansha*) due to suspended train services (ID 05). A man from Tokyo made another important comment on the links between knowledge acquisition and data visualization through the maps. He wrote that “seeing the map with the data linked to it made it easy to follow the developments and to gain an understanding even for areas that I am not familiar with” (ID 47). In addition, users mentioned that combining the map function with other features of the JDA led them to new discoveries about the disaster. A woman in her 60s (ID 23) mentioned that she used the map feature to add a layer of the radioactive contamination caused by the 2011 nuclear disaster and “found it interesting how it overlapped with the data on the map.” Another woman pointed to an important limitation of (re)search based on keywords. She stated (ID 36): “Until now, I had searched by the word I wanted to examine, so I only got that information, but by using the map, I could see that there was information in various places, and if I looked at different places (…), I was able to see a lot of information that I did not know.” Although using keywords is a common method in all kinds of research, the results are limited to the categories and keywords that the user already has in mind. This comment can be seen as one example of how retrieving data through the map allows users to discover not only new research categories but also data that they would not have searched for otherwise.

Users most interestingly referred to the ability of the JDA map to expand their knowledge and stretch their interest to regions affected by the GEJE beyond their own region. For instance, one participant explained she had been focused only on the destruction in Tohoku and had remained unaware of the earthquake's impact in the Tokyo area. This woman, in her 20s from Chiba Prefecture wrote: “At the time, I knew that the Kanto area had felt a powerful tremor, but the news coverage was limited to three prefectures in Tohoku and surrounding areas … I had never paid any attention to the damage in the Tokyo metropolitan area because of the extent of the damage I had experienced. However, when I found out that there was road damage even in Ichikawa City, which is supposed to be far from the epicenter of the earthquake, I was reminded of how strong and far-reaching the tremors were at the time. We were also reminded of what would happen if a tsunami of the same magnitude hit the Tokyo metropolitan area, which has a larger population and more buildings than the Tohoku area but is lower in elevation. This made me think more about the horror of the disaster.” (ID 46) Further, a comment from a woman residing in Kumamoto Prefecture showed how people might be well informed about a certain disaster, but less about other disaster-stricken areas. She wrote: “I could not find anything new about the Kumamoto Earthquake, but regarding the Great East Japan Earthquake, I was able to feel a part of the activities of the local people.” (ID 49).

Although it is incomplete, our study reveals how the JDA map and its geo-location functions fill essential gaps in people's existing disaster knowledge, awareness, and imagination by offering an opportunity by zooming in to localize individual and collective experiences while zooming out to delocalize and broaden the boundaries of the disasters themselves.

4. Discussion

Disaster risk education tends to take place in classrooms with several dozens of students, or through lectures and guided tours through disaster-affected areas. Although not to the same extent as in some other countries, many restrictions were introduced to reduce social contact when the Covid-19 pandemic hit in Japan, posing difficulties also to disaster risk education. In our study as well, research participants could not be asked anymore to join guided tours or to join in-person workshops on the usage of the JDA. Instead, the majority of research was conducted online: the participants received explanations via e-mails (while staying anonymous) and through video messages. Yet, it was also those restrictions that underlined a merit of the JDA and its geo-location functions in disaster education: as described above, even participants who did not travel to disaster-affected areas reported that they learned new information of disasters in Japan and felt the JDA contributed to their increased risk awareness.

The spatial visualization of archived materials on the map helped them imagine how certain areas were affected by different aspects of disasters, for instance, the spread of radionuclides or inundation of the tsunami 2011, or how specific places were affected by various earthquakes. The option of using the time bar on the map, which shows when certain items were created or contributed to the archive, further helped users gain a more intuitive understanding of how attention on certain places and reports shifted over time. Such information can be especially valuable when people are deprived of the opportunity to receive information about a certain place away from where they are situated. During the ongoing Covid-19 pandemic, travel restrictions discouraged people in Japan from traveling outside of their own prefecture, which made it almost impossible for them to visit disaster memorial facilities. However, our results indicate that the JDA map allowed users to imagine various disasters' impact on certain places even without visiting them. These findings suggest that such visualized information might also be helpful in other situations where information about certain localities might be challenging to retrieve. Examples for such places are disaster-affected areas like the coastal areas of Tohoku, recovery parks, or disaster heritage sites that, in some cases, have few written explanations accessible.

However, some challenges remain regarding individual usage of the geo-location functions in a meaningful way at disaster affected areas. On the one hand, without extensive prior knowledge about a specific place or disaster, the sheer amount of data available in the JDA was hard for some research participants to process, as they had difficulties understanding the information in context of the place that they visited and the time in which the data was produced. On the other hand, in the vicinity of newly opened disaster memorial facilities, such as the Fukushima Nuclear Disaster Memorial Museum in Futaba town, little or no information could be retrieved via the map. To address these problems, we plan to expand this research to have users create publicly accessible "collections," in which they can curate data retrieved via the JDA which they find useful for specific disaster-related places, such as museums, heritage sites, or monuments. They can further add explanations or reflections to their individual collections by offering additional meaningful information for other users. Finally, we plan to test the usefulness of another function of the JDA, which allows its users to contribute missing content to the archive, and how active user participation may impact the sense of disaster risk awareness.

5. Conclusion

The findings of this preliminary research suggest that the JDA's geo-location functions hold great potential to contribute to disaster risk education and offer information accessible from home on particular disaster-related aspects in specific locations. Moreover, the change in the research protocol due to the pandemic afforded the opportunity to illustrate that the JDA has potential as a remote disaster education tool. The research also shows no direct correlation between the age and the difficulties of using digital tools among the research participants using the JDA and its geo-location functions. On the contrary, the results suggest that the inclusion of digital (research) tools could make participation in both research and education more inclusive. The results also highlight some of the main merits of JDA: the relevance and significance of (born-digital) data from the direct aftermath of a disaster might only increase with time passing. Most respondents pointed out that it was this kind of data that they found most impactful and contributed to their heightened sense of risk awareness. The geo-location functions further contributed to the educational effect by enabling the respondents to be more aware of the hazards of that specific location. Finally, the smooth running of our research method (i.e., online surveys, remote explanatory videos, and the digital archive) suggests how digital technology makes international research projects possible without any direct interaction between the participants and the researchers. This paper concludes that challenges such as technological literacy, access to technological devices, and potential exposure of participants to sensitive data need to be further considered for future digital qualitative research.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:The authors have all been involved in either the development of the JDA or working with the JDA. This research has been funded by IRIDeS, Tohoku University.

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