A social encouragement in risk awareness using volunteered geographic information and scenario-based analysis

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Abstract

The geographic information is important for analysis, not only physical-related analysis but also socio-economic analysis. In the part-day, data access is limited to a government or a large private company. Recently, technology is leading the new era of mapping which is known as crowdsourced data; everyone can access geographic information. This new information source design for disaster risk management at an initial state is also called volunteered geographic information. The geographic information has got increasingly popular in the last five years; however, the level of data accessibility in Thailand is still limited to academic reasons or Geographic Information System (GIS) specialists. The main contribution of this study is to promote the potential of volunteered geographic information for Thais through social analysis using mapping technology and scenario-based analysis. Hazard awareness is a critical issue to ensure the community’s security. Unfortunately, most of the communities, especially in the urban and industrial area, do not recognize it. The volunteered geographic information provides alternative ways for the community to understand their risk. The related community data are collected from open-sources, both of the spatial data and the statistic data. A spatial analysis is conducted and produced the community risk map. Using the map as a communicating tool, we found that the community is able to recognize their risk from the hazard, and also community’s awareness is encouraged. Another critical finding is demographic data from an open spatial point dataset; these are able to infer the number of people and social conditions, which are the critical data for risk management and community issue. In conclusion, this study confirms that the demographic data or social data can generate from open-sources’ data, which is the wise option for the community to collect their geographical data.

Keywords: Volunteered geographic information, Risk area, Community-based, Scenario-based, GIS

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INTRODUCTION

The geographic information is important for analysis, not only physical-related analysis but also socio-economic analysis. In the part-day, a government or a large private company provided the geographic data which is limited to accessing. Recently, technology is leading the new era of mapping which is known as crowdsourced data; everyone can access geographic information. This new information source design for disaster risk management at an initial state is also called Volunteered Geographic Information (VGI) (De Albuquerque, Eckle, Herfort, & Zipf, 2016). VGI is referred to as an assertive method of collecting geospatial information as opposed to the authoritative method employed by government agencies and private industry (Goodchild, 2010). According to the increasing demand, geographic information should be collected in a wide area such as urban planning, community management, or humanitarian action (Arunplod, Nagai, Honda, & Warnitchai, 2017; Bariscil, 2017; Hotsom, 2019). The large community of volunteered geographic information commonly refers to Open Street Map (OSM) (Latif, Islam, Khan, & Ahmed, 2011). Various applications of using VGI are also seen in different national and international issues. However, it is a bit challenging to develop this sort of voluntary efforts in developing countries, like Thailand (Latif et al., 2011; Weng & Yang, 2016). Most of the geographic information is completed by government sectors that the information accessibility by communities is limited. Since the volunteered geographic conceptual information is pointed out, it increases the use of spatial information. Volunteered geographic information is defined as data that is free to be used, reused, and shared legally and technically (Latif et al., 2011; Iskandaryan, 2017; Vescoukis & Bratsas, 2014). Even though the VGI has become popular, Thai people are not families with

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that information, limited to technical users. The outstanding spatial application has proven itself in the benefit of VGI and is encouraging people to understand the importance of spatial datasets (Latif et al., 2011; Iskandaryan, 2017; Vescoukis & Bratsas, 2014; Miyazaki, Nagai, & Shibasaki, 2015). One of the well-known procedures to promote the VGI is a risk map because the risk assessment directly affects human life. The risk map is conceptual to the use of geographic information to understand the community criteria in the physical environment and their vulnerability. Within the emergency forces, awareness of such multidisciplinary geographical data infrastructures is rising. A socio-technical perspective has been adopted, which means that geographical data infrastructures are being regarded as worthwhile only if they are meeting the community needs. The user needs are the driving force for geographical data infrastructure development. The user requirements are a user’s description of the functionality and performance characteristics of the geographical data infrastructures (Iskandaryan, 2017; Vescoukis & Bratsas, 2014). The main objective of this study is to assess the quality of VGI and promote the potential of VGI for Thais. Based on the disaster risk management requirements, geographic information is collected and matched with the vulnerable assessment parameters, integrated risk assessment, socioeconomic analysis with geoinformatics technology, and scenario-based analysis. Finally, the community geographical dataset has been deployed and the risk map of air pollution has been issued as a supplementary decision support. The VGI provides alternative ways for the community to understand their conditions with the high accessibility of data.

**VGI AND RISK ANALYSIS**

VGI refers to the free information, allowing people to contribute to a data product, providing a mechanism for participants to collect and review the data (Latif et al., 2011). However, a huge dataset needs a common readable format to understand; in this case, the open data license is clarified. There are many types of licenses like Creative Commons License, Open Data Commons, Open Government License and so on (De Albuquerque et al., 2016; Hotsom, 2019; Miyazaki et al., 2015). Technically, open means that data must be machine-readable and in bulk form (Chang, Wu, Hsu, & Yang, 2017; Horita, Degrossi, Assis, Zipf, & Albuquerque, 2013; Snoeren, Zlatanova, Crompvoets, & Scholten, 2007). Late in 2013, the Sendai Framework for Disaster Risk Reduction 2015-2030 was released, The increasing geographic information mapping invoked all disaster community levels (Miyazaki et al., 2015; United Nations International Strategy for Disaster Reduction, 2005). The outstanding contribution of VGI over disaster sciences is real-time access to reliable data, the use of space and in situ information, including GIS, and the use of information and communication technology innovations to enhance measurement tools and the collection, analysis, and dissemination of data.

Modern disaster management is pointing out the ability of the community on adaptation and resilience that means the community has to know its physical conditions, capabilities and technology. During the crisis, events have been increasing in the last few years; it seems the geographic information is needed to make communities more resilient to them. In addition to providing conventional authoritative data, ordinary citizens and residents in the affected areas are also voluntarily supplying information about the affected areas (Horita et al., 2013). The one critical point of using VGI is the quality of VGI. In the literature, the quality of VGI is often measured by making reference to the “quality elements” that are traditionally used to assess the quality of geographic information (International Organization for Standardization, 2013). These quality elements include completeness, positional accuracy, and thematic accuracy, among others. Although these elements can be applied to measure the quality of VGI, this type of information has particular features that make assessing its quality different from traditional geographic data (Mohammadi & Malek, 2015).

In a related study, we found that VGI is more important as a data supplier like UNESCO produced a lot of related HIV/AIDS maps using VGI under the GIS-Linked Social Sentinel Surveillance Project (United Nations Educational, Scientific and Cultural Organization, 2019). Scholz, Knight, Eckle, Marx, and Zipf (2018) overviewed the missing maps project using remotely sensed information and VGI combined with ground-level information, not only one-dimensional, as the methodology can be used across a multitude of sectors within the humanitarian space Scholz et al. (2018). In addition, we found the various VGI applications on disaster management like in Bangladesh (Horita et al., 2013; Latif et al., 2011; Miyazaki et al., 2015).
METHODOLOGY

The quality of VGI largely depends on different factors, such as the characteristics of the volunteer, the type of information, and the way in which the information is produced (Scholz et al., 2018). VGI is provided by a wide range of sources (i.e., volunteers) who have different levels of expertise and come from different backgrounds. This research aims to assess the quality of VGI in Thailand by comparing two sources of the geographical dataset. One source is an official provider, i.e., the government sector; another came from the volunteered source. Aforementioned, the quality elements include 1) completeness, 2) positional accuracy, and 3) thematic accuracy, among others. Therefore, the two datasets are assessing those conditions, as demonstrated in figure 1 for the overall method.

The first geographical dataset came from the information and publication sector, Samut Prakan Provincial Office, in this study called as the official provider. Primary geographic information formatting in shapefile (.shp) and other data are represented in tabular data (excel and hard-copy).

Another geographical dataset came from the well-known volunteered data source, OpenStreetMap via www.openstreetmap.org, in short called OSM. The OSM data represented in soft-copy-based format and CSV format is mainly recognized.

The quality assessment starts with an investigation of two datasets in the completeness and positional accuracy. For thematic accuracy, the vulnerability of the air pollution crisis was selected. Next, the risk map of air pollution caused by the landfilled explosion (Arunplod, 2017) was selected as the scenario analysis for both

Figure 1. Overall methodology

Spatial data collected from OpenStreetMap

Reform in Disaster DB

Dataset for disaster analysis (OpenStreetMap)

Vulnerability analysis

Vulnerability Map (OpenStreetMap)

Comparing (available & data)

The proper data source for disaster management

Official spatial data provider

Dataset for disaster analysis (Official provider)

Vulnerability analysis

Vulnerability Map (Official provider)
RESULTS AND DISCUSSION

It was found that the amount of VGI in the study area compared with an official provider, Samut Prakan Provincial Office, is similar, but the date of data from the VGI is less modern. Actually, the data from the official provider has stated that it is checked and updated every 5-6 years, while VGI is updated as reported by data users or data developers, which slows down the update due the last few years. The details of the different sources of geographic information are hereby.

Completeness

According to the data structure for disaster management, either an official provider or volunteered geographic information provides that data matching with database 75%. The main contribution over the physical parameters was building information like location and name, and lifeline facilities like transportation networks. Utility lifeline, electric city line and water line are limited to authority. Therefore, it is found in an official dataset only and it requires permission to access the utility lifeline data. Another concern found in the study is data redundancy. The dataset from an official provider has low redundancy; less than 10% was found redundant which may have resulted from the quality checking process before publicizing the dataset. Opposite with VGI, the redundancy was tentative at 30%, most of the redundancy being found in case of the same location but a different name. The redundant VGI was analyzed and found as the cause of emotional-insert data; it means the user report data with the same geographic location but different names based on what the user called that place. This complication is demonstrated in Figure 2. However, this redundancy can be removed by applying the location filter analysis or redundancy checking.

Positional Accuracy

The positional accuracy means the geographical location of data compared to the GPS position at the same position. The position of data depends on their shape and scale, for example, building as point or polygon, road as line, and river as line, etc. Aforementioned various literature, the concept of generalization considers the shape of data representation. For example, the data of road networks is generally used as the centerline of the road to represent their data format. As same as the building information, the position at the center of the building represents the position of building in the dataset. Hence, the positional accuracy of both the datasets, official provider and VGI, has a similarity level because the VGI’s lifeline facilities data are retrieved from official providers.

Thematic Accuracy

Finally, the geographic information from both sources was compared in their utility on disaster application. The crisis event in the study area was selected and analyzed using the geographic information from the official provider and volunteered sources, comparing the results from both geographic datasets. The landfilled crisis was selected; this crisis is a huge effect on communities and the surrounding areas. The risk map of air pollution caused
by a landfilled explosion (Figure 3) shows the cause of carbon monoxide and sulfur dioxide spreading deployed as a hazard map for vulnerability analysis.

Figure 3. Risk map of air pollution (carbon monoxide and sulfur dioxide) caused by the landfilled explosion

The vulnerability analysis of landfilled explosion is considered in both physical and socio-economic parameters with volunteered geographic information or VGI, an example shown in Figures 4 & 5. The results confirmed that geographic information from volunteered sources could contribute to disaster management as well as the geographic information from an official provider.

Figure 4. The hospitals based on open data and the affected hospitals

Figure 5. The community from open data and the affected communities
CONCLUSION

The VGI is a breakthrough data source in this era. The geographic data provided that accessibility is a significant contribution for all users, especially in the crisis events in which it requires quick access to geographic information for assessing situations. However, promoting the use of VGI is also important presently. The VGI status in Thailand is limited to the advanced user or GIS specialists; only a few communities get to know and access it. The result of this study confirmed the VGI can encourage disaster management as well as geographic information from the authorized dataset. Even the authorized geographic information provides a high position accuracy and is trusted but the accessibility is still limited to a small group of users. VGI is easy to access under the common license agreement; everyone can access and help GI communities to provide the geographic data. It still has a question on completeness and accuracy. One more issue to be considered is the cost of data production, as a lot of resources have to payoff to produce the high accuracy of geographical data. This is the main concern for the local community or the limited resource countries having low-level technology.

An analysis of the methods presented in the taxonomy reveals opportunities for the development of new parameters and other methods to assess the quality of VGI. Furthermore, it allows researchers working with a high potential data source of VGI (e.g., social media, news) to learn about methods developed and employed in different types of VGI and application domains that could be transferred to their research focus.

The integrated benefits from both VGI and authorized geographic information can empower the national databases, which is useful not only for disaster management but other applications as well, such as urban planning, environmental management, etc. In the era of big data, the integrated data sources or crowded sources will increase the capability of spatial analysis to respond to various phenomena with a better decision to help our society.

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