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

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Abstract

Aim: This research's main contribution is a social analysis of volunteered geographic information for Thais that uses mapping technology and scenario-based analysis. The community's safety depends on its members having a thorough understanding of potential threats. It has yet to be widely acknowledged, especially in urban and industrial areas.
Method: Both the geographic data and the statistical data associated with the local community are gathered from publicly available sources. The community risk map was created through spatial analysis. In this context, the map serves as a means of communication.
Findings: The study results show that locals are aware of the dangers they face and are motivated to take action to reduce their risk. Population counts and social conditions can be inferred using demographic data from an open spatial point dataset, making this information essential for risk management and community issues.
Implications/Novel Contribution: This research fills a gap in the literature by providing empirical evidence that social and demographic data can be derived from publicly available sources.

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

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INTRODUCTION

All sorts of physical and socioeconomic analyses rely on location data. In the past, limited-access geographic data was provided by the government or a large private company. Crowdsourced data, which has been at the forefront of recent technological developments, has enabled anyone to access previously inaccessible geographic information. Volunteered Geographic Information (VGI) is another name for this emerging data architecture for disaster risk management in its formative stages (De Albuquerque, Eckle, Herfort, & Zipf, 2016). VGI is seen as a more assertive means of gathering geospatial information than the authoritative method used by government agencies and private industry (Goodchild, 2010). Geographic data collection is becoming increasingly important in many fields, including urban planning, community management, and humanitarian action (Arunplod, Nagai, Honda, & Warnitchai, 2017; Bariscil, 2017; Hotsom, 2019). Open Street Map (OSM) is used frequently by the large community of volunteers who contribute geographic data (Latif, Islam, Khan, & Ahmed, 2011). VGI is used in a wide variety of ways at the domestic and international levels. However, developing countries like Thailand need help to cultivate such volunteer efforts (Latif et al., 2011; Weng & Yang, 2016).

In many cases, citizens only have limited access to relevant geographic data because it has been collected and compiled by government agencies. Volunteered geo-conceptual information is highlighted, leading to greater application of spatial data. "(Latif et al., 2011; Iskandaryan, 2017; Vescoukis & Bratsas, 2014) defines "volunteer" geographic information as data that is free to be used, reused, and shared legally and technically. Despite the VGI's success, only a small subset of Thais (mostly techies) have access to its data. (Latif et al., 2011; Iskandaryan, 2017; Vescoukis & Bratsas, 2014) reviews to see how this remarkable spatial application has aided VGI and is helping more people appreciate the value of spatial datasets (Latif et al., 2011; Iskandaryan, 2017; Vescoukis & Bratsas, 2014; Miyazaki, Nagai, & Shibasaki, 2015). Because risk assessment has such direct implications for human life,

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creating a risk map is one of the most well-known methods for promoting the VGI. To comprehend the criteria in the physical environment and the community's vulnerability, the risk map is conceptual to use geographic information. Emergency services are beginning to realize the value of such multidisciplinary geographical data infrastructures. Geographical data infrastructures are now considered successful if and only if they serve local needs due to a shift toward a socio-technical stance. Geographical data infrastructure is driven by user requirements. Specifically, (Iskandaryan, 2017; Vescoukis & Bratsas, 2014) user requirements are a user's description of the functionality and performance characteristics of geographical data infrastructures. The primary goals of this research are to (1) evaluate VGI's quality and (2) increase Thais' awareness of VGI's potential. Geographic data is gathered for vulnerabilities, assessed for risks, analyzed economically using geoinformatics tools, and analyzed in light of potential outcomes based on what is needed for disaster risk management. The air pollution risk map has been released as a supplementary decision support tool, and the community geographical dataset has been successfully deployed. The VGI's high level of data accessibility means that it can be used in various ways to improve people's understanding of local conditions.

LITERATURE REVIEW

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.

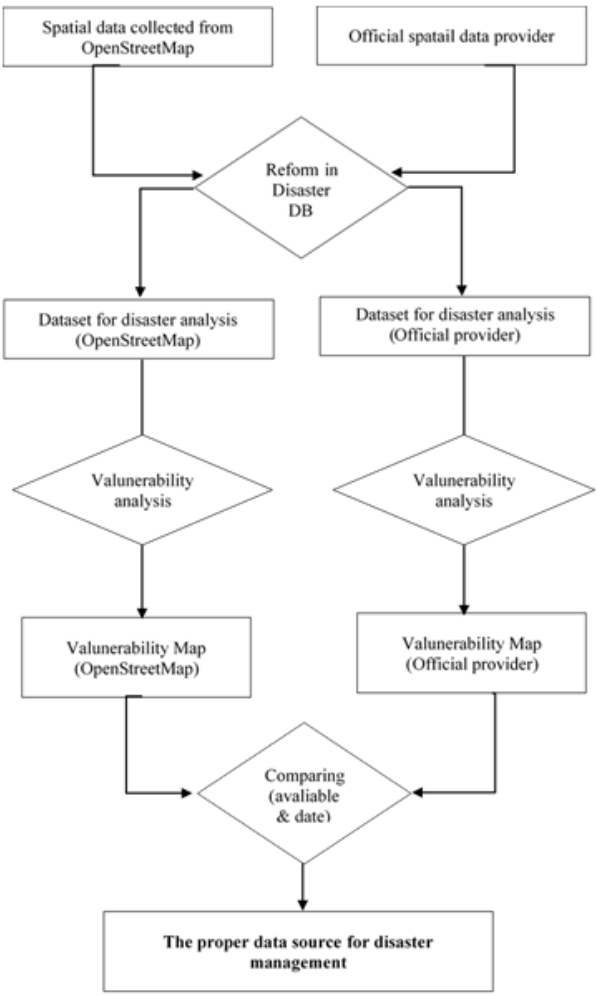

Figure 1. Overall methodology

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

geographical datasets. The standards of disaster databases were investigating and rebuilding both government and volunteer geographic information for quality assessment.

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.

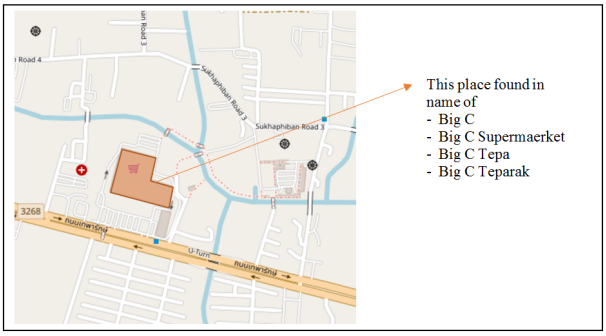

Figure 2. The building data from VGI. It was found in the same location but with a different name

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 VGIs 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.

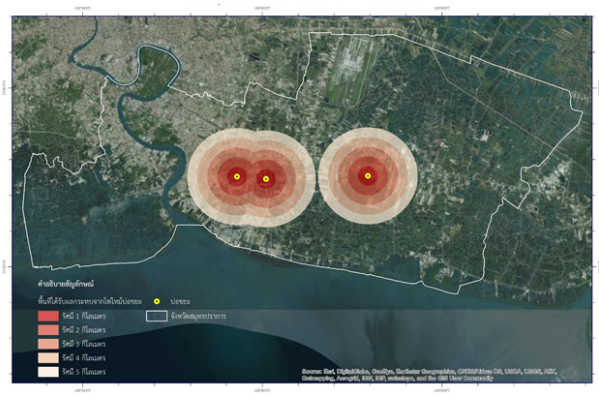

Figure 3. Risk map of air pollution (carbon monoxide and sulfur dioxide) caused by the landfilled explosion

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.

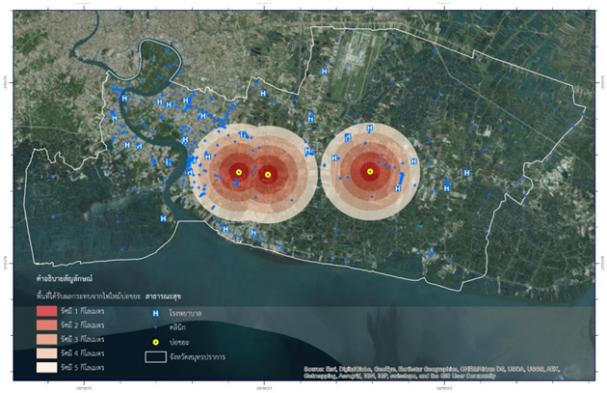

Figure 4. The hospitals based on open data and the affected hospitals

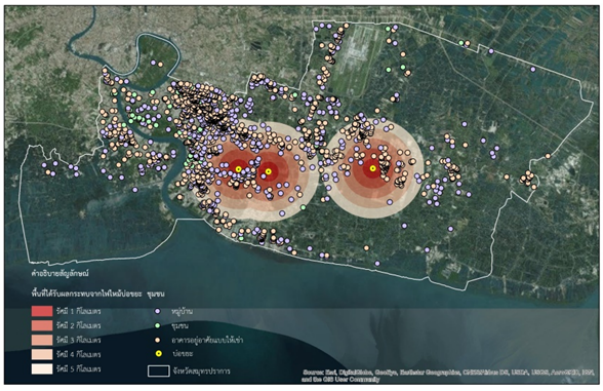

Figure 5. The community from open data and the affected communities

CONCLUSION, RECOMMENDATIONS AND IMPLICATIONS

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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