

GIS Communicate Emergency Preparedness Mapping: The Usability for Rural Area

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Abstract: The importance of geographic information system (GIS) in daily life is well known as it is really helpful and eases the user. GIS is basically a database system with software that can analyse and display data using digitized maps and tables for planning and decision-making. Unfortunately, there are people in rural area that far from unreachable to apply this GIS tool in life. Thus, this reviewed study aimed to provide further understanding of the application of GIS in emergency preparedness for rural areas. It also will be able to recognize a management information system for rural planning. This systematic literature review concentrates on previous research starting from 2015 to 2020 to evaluate the application of GIS in mapping, transportation planning and network service. From 16 papers that have been analysed under eligibility test, 37.5% of them reviewed on the application of GIS, another 37.5% on emergency preparedness and 25% for rural area. The result shows there is a common type of knowledge and the way it can respond to emergency preparedness. Nevertheless, there are fewer cases related to rural areas and it shows the need for more case studies and experimental research to support this promising field. In conclusion, to meet present day and future information needs for emergency preparedness, more attention needs to be given to evaluate the effectiveness of GIS in rural areas.

Keywords: GIS, Emergency Preparedness, Rural Area

1. Introduction

A GIS can assemble, store, manipulate and display geographically referenced data, typing this data to points, lines, and areas on a map or in a table. GIS can be used to support decisions that require knowledge about the geographic distribution. A part of GIS can be wherever location with known latitude, longitude or other geographic grid system [1]. GIS has strong modelling capabilities, that allows its users to make a prediction, planning and estimation. GIS maps are being widely used by community in health and environmental issues.

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GIS can integrate many types of data and that is one of the many reasons why GIS is used in health and security sector. It analyses spatial location and organize layers of information into visualization using maps and 3D scenes. It allows authorities to figure out the best way to reach rural area by transportation or communication in emergencies state. The fact that GIS can be applied in both aspects is really fortunate for society in preparing for emergency especially for rural area.

Unfortunately, there is a major underlined statement should be taken care of which is time. In rural areas, some of the places have longer time to arrive. This is not a case to deal with when emergency is taken place. Secondly, rural areas may have a bad coverage of internet as some of the places have not been develop fully yet with internet sources. Thus, to overcome the problems, the aim of this research is established by understanding the efficiency of decision making and planning. In the same time, it is also to recognize a management information system for rural planning in decision making.

This systematic literature review concentrates on previous research starting from 2015 to 2020 to evaluate the application of GIS in mapping, transportation planning and network service. Furthermore, it will be focusing on improving the application of GIS in rural areas. The methodology used is eligibility test which is to strengthen the review of this research.

2. Literature Review

A GIS is also known as the system of computer hardware, software, organizations and business process designed to support the capture, management, interpretation, analysis, modelling and display of partially referenced data for solving complicated planning and problems from management. A GIS can be used to locate all the things mentioned to solve the problems that are related to planning and management of resources. Hence, GIS is a computer-based.

By using GIS, the sets of data will be combined and help any government or authorities to use the provided information. The fact that all the data could be used multiple times, it gives benefit to the agencies to use other agencies data collection by using this method [2]. Moreover, GIS application also will reduce cost, time and give out effective output. The maps and information produced are clearly understood and will always give benefits to the users. Other than automatic decision, GIS is a tool that had been programmed to receive questions, analyse and produce maps to make a decision. The accuracy of the map is absolutely correct and only takes a few minutes compared to conventional method. The scales and suitability can be sets as the demand and needs.

Emergency preparedness refers to any cautions taken to prepare for and reduce the effect of emergency. Which being said, it is to predict the emergency and where possible, to prevent it from occur, mitigate the impact on minor populations and effectively cope with consequences [3]. Public Health Emergency and Disaster Coordinating (PHEDC) Committee was established in order to make this plan successful. Thus, PHEDC sync all emergency and disaster preparedness, response and recovery into one service. It also established an information center and database on health emergency issues that can be accessed to district and state health managers also to other relevant organizations.

3. Materials and Methods

A Systematic Literature Review (SLR) is used in this study by means of evaluating and interpreting all the studies available in the literature about research questions, area or phenomenon of interest [4]. Literature review is defined as a systematic in methodological approach, explicit in explaining the procedures, comprehensive in its scope and reproducible by others for the same approach [5]. Nevertheless, systematic review is an efficient scientific technique.

A SLR consists of three steps: planning, conducting and results. In the planning phase, the research questions are created to achieve the objectives. Next, in the conducting phase, the planning is being extracted through the online databases and a selection has been made with eligibility test for the reviewed papers. Figure 1 is the summary shown on the methodology of studies made.

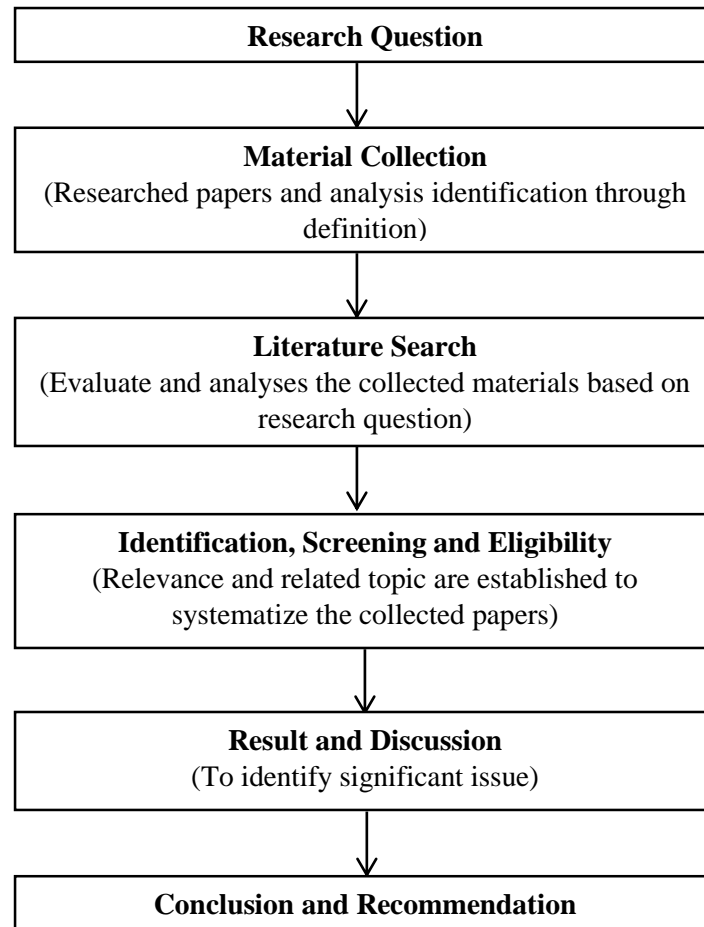


Figure 1: Review methodology of flow chart

As mentioned in Figure 1, the research questions are important and it will be used as guidelines to define the activities and processes in the SLR [6]. This is to ensure the main objective of this review which is to understand the efficiency of GIS mapping for public user, authorities and specifically for rural areas during emergency, thus research questions have been selected. For research question 1: In which phases of emergency situation has GIS been used? Next for research question 2: In what types of emergency is GIS used? Lastly, the question on what types of methodologies is employed in research that use GIS for emergency preparedness? has been chose for research question 3.

3.1 Material collection

The collection of materials was carried out using the Google Scholar and Science Direct as the main platform. There are also several platform that has been used as supporting platform such as Open Resources, Malaysian Citation Index (MyCite), Pusat Siswazah and Malaysian Theses Online (Myto). Table 1 shows the online database used and the website.

Table 1: Online database used and the website

No.	Online Database	Website
Main Platform		
1	Google Scholar	https://scholar.google.com/
2	Science Direct	https://www.sciencedirect.com/
Supporting Platform		
3	Open Resources	https://ptta.uthm.edu.my/v3/openresources
4	Malaysian Citation Index (MyCite)	http://www.mycite.my/
5	Pusat Siswazah	https://cgs.uthm.edu.my/
6	Malaysian Theses Online (Myto)	http://myto.upm.edu.my/find/

3.2 Identification

To search the articles more efficiently, the keywords are used rather than the whole title. Hence, more keywords allow more related articles to be searched. Suitable keywords can be identified from the synonym, related terms and the variation from the main keywords. Table 2 shows the main keywords and the related terms that are enriched from the main keywords. Other than these, keywords provided by the previous studies or the keywords suggested by the databases can be taken into consideration.

Table 2: Main keywords and the related terms

No.	Main Keywords	Enriched Keywords
1	GIS Mapping	GIS mapping technique, GIS mapping flood risk, GIS mapping and analysis, system and risk, GIS mapping software.
2	Rural areas	Rural area of developing countries, prevalence, Rural areas and basic needs.
3	Emergency Preparedness	Response and plan, Emergency preparedness training, Emergency preparedness and response, transportation and emergency.

3.3 Screening

This section will screen all the articles that are selected in the Identification section. There are 2 stages in screening section which are removing the duplication and screening based on research limit. From the total of 100 papers found during material collection, only 24 of them were selected based on its relevance for eligibility test. The majority of the papers analysed is by using the method of conducting the case studies (15 papers). For the other 9 papers conducted a literature review in the area of study.

3.4 Eligibility test

Based on the screening stage, the 24 papers have been manually selected in this stage and listed accordingly. The papers were selected based on research questions. In full articles assessment, all the contents in the articles are advisable to be reviewed in order to ensure that the remaining articles are fulfilling all the inclusion criteria. However, this research is focusing on the empirical part, hence the

title, abstract and followed by the result or discussion reviewed. This test is verified by the supervisor and co-supervisor. Figure 2, 3 and 4 show the result on eligibility test.

Titles	Relevant	Not Relevant	Verified
A Detailed 3D GIS Architecture for Disaster Management	1		1
Application of Geographic Information System in Monitoring and Detecting the COVID-19 Outbreak	1		1
COVID-19: Challenges to GIS with Big Data	1		1
GIS and local knowledge in disaster management: a case study of flood risk mapping in Vietnam	1		1
Geographic Information Systems for Disaster Response: A Review	1		1
How usable are current GIS maps? Communicating emergency preparedness to vulnerable populations	1		1
GIS: Scope and Benefits	1		1
GIS based land-use suitability analysis: a critical overview	1		1
Hazard, Vulnerability and Capacity Mapping for Landslides Risk Analysis using Geographic Information System (GIS)	1		1
Mapping of Student Sustainable Development Education Knowledge in Malaysia using Geographic Information System (GIS)	1		1

Figure 2: Eligibility test result for GIS

Titles	Relevant	Not Relevant	Verified
Development of inter agency information system for flood catastrophic preparedness in Malaysia	1		1
Disaster and Emergency planning for Preparedness, Response and Recovery	1		1
Disaster Preparedness for Academic Libraries in Malaysia: An Exploratory Study	1		1
Emergency Preparedness and Disaster Response: There's an App for that	1		1
Emergency Response during Disastrous Situation in Densely Populated Urban Areas: A GIS Based Approach	1		1
Geographic Situational Awareness: Mixing Toggles for Disaster Preparedness, Emergency Response, Impact and Recovery	1		1
Implementation of disaster management policy in Malaysia and its compliance towards international disaster management framework	1		1
Improving emergency response logistics through advanced GIS	1		1
Increasing Emergency Preparedness	1		1
Use of Information Technology in Emergency and Disaster Management	1		1

Figure 3: Eligibility test result for emergency preparedness

Titles	Relevant	Not Relevant	Verified
Conceptual Framework and Usage Between Social Capital and Disaster Preparedness: A Case of Orang Asli Families in Malaysia	1		1
Disaster experiences and preparedness of the Orang Asli Tribes in Bukit Chini of Malaysia: A conceptual framework towards building disaster resilient community	1		1
Factors contributing to flood resilience among rural community: Case Study of the East Coast of Malaysia	1		1
The possibility of using public transport in rural area	1		1

Figure 4: Eligibility test result for rural area

4. Results and Discussion

For the purpose of analysis, data are obtained from a number of papers. In this study, topic related is collected depending on the accuracy measure used in each study, GIS, emergency preparedness and rural area are considered as most used keywords in most of the studies. The topic discussed will be gathered for further data analysis.

4.1 Studies on GIS

Figure 5 shows the chart of emergency types addressed in reviewed papers. Unfortunately, disaster results a huge damage of property, break the growth of the social environment, loss of precious soul and had a worse impact on the development of nation [7].

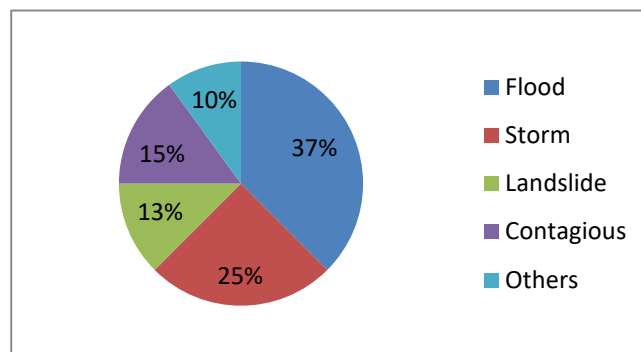


Figure 5: Type of emergency addressed in the reviewed papers

4.2 Studies on emergency preparedness

The chart below is presenting the phase of emergency discussed in published paper during emergency preparedness. The phases consist of 4 types which are mitigation, preparedness, response and recovery. Figure 6 shows the phase of emergency that has been sorted out from published paper. Emergency plan needs to be coordinated well and cooperative process of preparing to match urgent need with available resources [8]. Other than that [9] states in the article that the sites have emergency fire service and medical response greater than 30 minutes away and evacuation points greater than 500 meters away is the most vulnerable and safest sites.

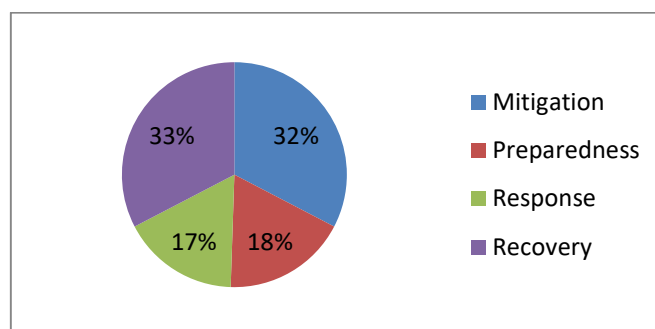


Figure 6: Phases of emergency from published paper

4.3 Studies on rural area

Based on research question 3, the methodology of published paper used for eligibility test has been recorded in Table 3. The relationship between social capital and disaster in disaster management has an increasing concern. As a hideous community, people in rural area have an advantage and disadvantage in communication ability [10]. Last but not least, [11] highlights that the accessibility of public transports for rural area need to be improved and provide a basic necessity such as good coverage for communication.

Table 3: Methodology of published papers

Methodology	Papers	%
Case Study	15	62.5
Literature Review	9	37.5
Total	24	100

4.4 Discussion

From the research question 1, the type of emergency has been recognized where the most natural disaster occurred is flood (37%) followed by storm, contagious, landslide and other diseases respectively with 25%, 15%, 13% and 10%. This shows that every disaster occurred are easily detected by authorities and the damage can be minimized.

Next, the phases of emergency discussed for research question 2 are recovery (33%), mitigation (32%), preparedness (18%) and response (17%). All the phases are the most crucial terms in emergency preparedness. The emergency plan produced by the country or states defines the effectiveness for people. Furthermore, the standard operating procedure (SOP) is the only thing that keeps people in order. Thus, by following the plan prepared during emergency or even pandemic can save many precious lives.

Finally, the last research question explained on the methodology of published paper where 62.5% of them are case study while the rest is literature review with 37.5%. The reviewed papers on rural area are found the least as there are not many specific research on that.

5. Conclusion

In conclusion, GIS is a reliable tool that has been used over a decade to help people in need and authorities to analyse data. As it is a common thing uses nowadays, it will be great if the accessibility can be used nationwide including rural area. It is also best recommended that we need to develop a better and accessible road in order to meet a basic need for people in rural area especially during emergency. Other than that, by enhancing the wide use of GIS in daily life will lead to a bright future development. Finally, to achieve the aim of this study, a good network service needs to be provided for a good two-way communication of people in rural area and local authorities.

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