INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

Vol 14, Issue 2, (2024) E-ISSN: 2222-6990

Socio-Economic Vulnerability Assessment of The Pahang Community Due to Floods Using GIS

Nor Diana Mohd Idris, Nuriah Abd Majid, Syaidatul Azwani Zulkafli

Institute for Environment and Development (LESTARI), Universiti Kebangsaan Malaysia, 43600 UKM Bangi Selangor

Corresponding Author Email: nordiana@ukm.edu.my

To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v14-i2/20741 DOI:10.6007/IJARBSS/v14-i2/20741

Published Date: 09 February 2024

Abstract

Flood is one of the annual natural disasters that frequently take place not only in Malaysia but also worldwide. Drastic development can cause environmental changes and expose humans to catastrophic incidents. Changes in the quality of the environment can ultimately lead to the risk of flooding. The state of Pahang was one of the zones that suffered from a catastrophic flood that occurred in 2014. Several Pahang districts have indirectly become one of flood-prone areas year after year. This study was conducted to determine the effect of this particular flood event on the social economy of the community in Pekan District, Pahang based on several socio-economic parameters. A total of 290 respondents answered the questionnaire systematically randomly selected in the area around Pekan District. The findings demonstrated that the flooding in the study area had affected the population in several sub-districts of the survey. Generally, statistical analyses indicated that the majority of the community was affected 100% by the flood and indicated that the flood imposed some impact about 67.7% (202) were affected housing, 94.4% (101) were affected by school session closures and working day delayed,74.9% (217) effect to income earning, 47.6% (138) family member more than 3 people effected of a flood. This implies that the relationship between sub-districts with the socioeconomic variables is affected by the flood. Experiences with previous flood events may have also helped the residents to prepare for the flood disaster both physically and health-wise. This involved a combination of data retrieved from the survey which later presented in maps that were generated using the Geographical Information System (GIS).

Keywords: Socio-economic, Effect, Environmental Changes, Flood, GIS, Pahang.

Introduction

Flood is one of the annual natural disasters that frequently occurred worldwide which significantly impact on country's economy and social life. Major types of floods, including river flooding, coastal flooding, flash floods and urban flooding give varies range of impacts on human, for instance injuries, disruption of power supplies, and worse, death (Denchak, 2019).

According to Centre for Research on the Epidemiology of Disasters (2014), an event cannot be identified as a natural disaster if ten or more persons are reported killed, more than 100 are confirmed to be affected, and a state of emergency declaration is issued. The United Nations (UN) has also stated that floods have affected nearly 4 billion people and resulted in 43% of all weather-related disasters around the world from 1995 to 2015. It includes 606,000 life fatalities along with the high occurrences in Asian countries (Wallemacq et al., 2015). Thus, Figure 1 shows flood and other weather-related disasters are more common in Asia, including Malaysia, with more deaths and affected communities than any other continents. Ang (2015) reported that floods could contribute to a significant impact on the socio-economic ambience of Malaysia, as people may become homeless, lose a family member, suffer an increase in the cost of daily resources and spreading of infectious disease. In addition, there are 5.7 million people living in the flood risk area (Sabri, n.d).

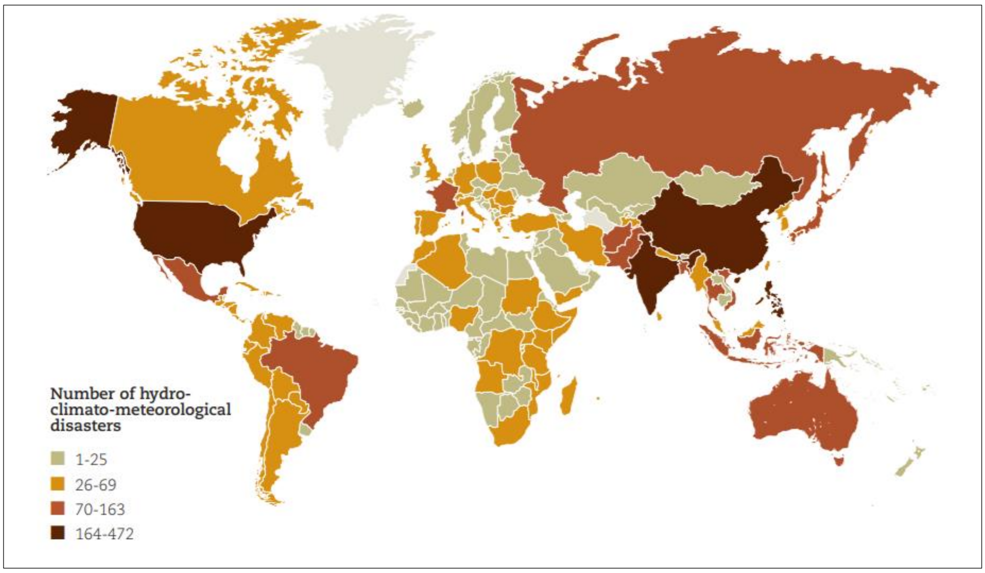

Figure 1: Number of weather-related disasters recorded per-country.
Source: Wallemacq et al (2015)

During the last few decades, global flood risk has been increasing and is expected to continue rising due to changing physical characteristics of the hydrological system caused by human activities (Chan, 1997). For instance, the changes in land-use associated with urbanisation affect flooding in many ways. According to the latest global projections, the urban population will increase from 2.8 billion in 2000 to 5 billion in 2030 (Muis et al., 2015). A drastic and largescale development of land use from forest area to the more concrete surface such as buildings and industries contributes to the decreasing of vegetation and soils. Essentially, the plant holds down the ground and contributes to its protection from overwhelming downpours. Earth Observatory of Singapore (2020) says that soils are very significant because they act as a sponge and assimilate most of the water when it rains. Removing vegetation and soil, grading the land surface and constructing drainage networks, will increase the runoff water streams from rainfall and subsequently flowing into rivers, causing a flood.

Moreover, the construction of roads and buildings often involves removing vegetation, soil, and depressions from the land surface. After impermeable material replaces the permeable soil, it will reduce infiltration of water into the ground and accelerate runoff to ditches and streams (Lewis, 2015). Thus, the peak discharge, volume, and frequency of floods in nearby streams will be rising.

Besides, floods were also contributed by the high amount of annual rainfall (monsoon) and continuous rates that have led to a sudden increase in river water discharge and eventually sparked flood disaster. Monsoon flood is a seasonal flood amid the monsoon seasons. The phenomenon of monsoon floods in Malaysia often took place from November to March due to the occurrence of the Eastern Monsoon Wind. Northeast monsoon (NEM) brings more substantial rainfall than the southwest monsoon (SWM) (Zaidi et al., 2014). Thus, whenever the capacity of the river is unable to cope with the volume of water generated by rainfall, it will overspill and cause flooding. This evidence brings the primary cause of in Malaysia over the past decades up until today.

The Department of Irrigation and Drainage (DID), Malaysia (in Malay, *Jabatan Pengairan dan Saliran Malaysia*, commonly abbreviated as JPS) stated that there were several major floods such as incidences of 1926, 1971, 1996, 2000, 2006, 2008, 2010 and 2012 (Mohd Ghazali, 2019). In the year 2000, Malaysia suffered a severe impact of which 30,000 square km or 9 per cent of Malaysia's total landscape, and about 5 million citizens were affected (Zakaria et al., 2017). Additionally, the scenario of a catastrophic event in 2014 was the worst monsoonal flood recorded in the east coast of Peninsular Malaysia, which resulted in RM2.9 billion loss (Table 1). It was also considered to be a "tsunami-like disasters" which hit six states, and 500,000 victims were displaced during a storm record of which 30% (1000mm) annual rainfall fell in 10 days (Ghazali, 2019; Boo, 2015).

Table 1
Some major historical flood event in Malaysia

Year	Events
1926	"The RED flood" destroyed low land forest affect entire peninsular
1971	Catastrophic flash flood in Kuala Lumpur causing 24 deaths. JPS led flood control
1996	Tropical storm Greg in Sabah claimed 241 lives and USD 97.8 million damage
2000	15 people killed in Kelantan, Terengganu and 100,000 people at in Peninsular Malaysia affected
2006	Flood in Johor caused 18 deaths and USD 489 million in damage
2008	Flood in Johor caused 28 deaths and USD 21 million in damage
2010	2/3 of Perlis submerged, killing four people, 50,000 people displaced and 45,000 ha rice field destroyed
2014	"The YELLOW flood" resulted in 25 deaths, 500,000 people displaced and RM2.9 billion loss.
2021	Eight states affected and 54 deaths.
2023	Four states affected, 30,000 move to evacuated centers.

Source: Ghazali (2019), Floodlist (2023).

JPS highlighted that the causes of flooding (since the first occurrence of the flood in 1926) were mainly due to the loss of flood storage and increased runoff rates due to the urbanization (Department of Irrigation and Drainage, 2017). These causes were used by the government to plan for early preparedness and mitigation measures in reducing the potential for future losses. Other options include planning for risk mitigation and adaptation, including the construction of flood control infrastructure, early warning, insurance, land use planning, and building codes. Yet, efficient reduction of risks requires a comprehensive understanding of disaster impacts on society as well as studying in detail the effectiveness of mitigation options. The government has thus formed the Natural Disaster Management and Relief Committee (NDMRC) with the joint objective of minimising disruption to floods and avoiding loss of lives (Khalid et al., 2015). The flood management is governed by the National Security Council (NSC) Directive No. 20 (Elias et al., 2013; Yahya et al., 2016). The National Security Division (NSD) in the Prime Minister Department is responsible for the coordination of all activities related to the disaster. From the study of Saifulsyahira et al (2016), there are various agencies (Table 2) involved in flood management that often overlap the goals and roles in managing disasters. To achieve more systematic control management, the National Security Council (in Malay, *Majlis Keselamatan Negara*, MKN) in Malaysia has divided catastrophe control into three major phases, i.e., before, after and after disasters.

Table 2
Agencies involved in flood governance in Malaysia.

Level	Actors	Responsibility
National	National Security Council National	Guidelines & directive
	Disaster Management and Relief Committee	Guidelines
Community	Federal Village Development and Safety Committees	Organizing residents
Public organisation	Department of Irrigation and Drainage	The drainage system, river basin, information flood
	Housing department	Shelter
	Municipal council	Flood operation room, city cleaning
	Malaysia Meteorological Department	Rainfall monitoring and warning system
	Universities	Relief, research
	Army, Police	Rescue, safety
	Ministry of Health	Emergency medical response
Public organisation	Takaful	Flood insurance
NGOs	Medical Relief Society Malaysia	Medical aid
	Voluntary bodies	Help ad-hoc, mainly cleaning, supplies

International	United Nations Response Depot	Humanitarian	Critical relief items and equipment

Source: Saifulsyahira et al (2016)

The state of Pahang is one of the states in Malaysia, which suffered many major flood events in the past. The heavy rain that struck Pahang at the end of 2014 and early 2015 caused a significant increase in water level in its primary water drainage system, i.e., Pahang River. Pahang river basin is the largest catchment area in the Pahang state and its annual flood incidents severely affected the residents as well as their economic activities, specifically those who are residing in Pekan (the state Royal capital) up to Temerloh districts. According to Abd Majid et al., 2019, Pahang River has been inundated most of the Lower Pahang Area River Basin during the flood, and Che Ros et al (2019) also stated that Pahang is the 6th of 14 states in Malaysia that have lost up to RM76.15 million to annual damage and affected the well-being of 615,128 people. Rahmah et al (2017) outlines eight possible drivers for Pahang flood which is including excessive upstream rainfall (>60 mm/h, 200–450 mm/day), water from low-lying are not connected to the river's drainage system, both the tributary network and the irrigation system are too small to handle the high runoff and water flow rates, wetland reclaim for construction increasing and congested irrigation system, the area that is not absorbent to water grew due to frequent forest clearing and logging activities, ground cutting for development purposes, slow moving of water and have heavy sedimentation from several activities, and the last is most of residential areas are found in low-lying, flood-plain areas, and poor irrigation systems, particularly in large residential areas, enhance the risk of flooding.

Thus, Bernama (2018) reported that the state government with the help of the federal government had implemented flood mitigation plans (RTB) after the monsoon flood that took place in 2014 and integrating river basin development projects (PLSB) to tackle floods in the state.

Generally, GIS has succesfully used in many studies regarding flood to visualize the flood area and at the same time analyse the flood damage estimation by creating flood maps. As GIS is a conceptualization of multiple fields in a layer, this approach is used to analyse the data to understand and evaluate the distribution of the affected community in the selected sub-districts, hence it is fundamental to use GIS in this study.

Flood maps are not only created to have a better visual on flood effects in the certain sub-districts, but also use to predict the upcoming flood events in the study area. GIS is also often used in flood studies for prediction, mitigation, flood hazard mapping, flood management and etc. For instance, GIS works on catering informative mapping, which is essential for flood studies (Abd Majid & Rainis, 2017). Also, modern GIS contains models, graphic data displays, or spatial and databases that can integrated data into various aspects related to flood disasters and mapping the areas that often involved with flooding to facilitate flood risk management (Abd Majid et al., (2017); Abd Majid et al., (2018); Abd Majid et al., 2019).

There for the onjectives of the study to

- Determined the effect of flood event on the socioeconomic victims
- To presenting the socioeconomics parameter into the visualization through the geography infomration systems (GIS) application.

Research Methodology

Quantitative research design was implemented in this study by collecting the primary and secondary data. The primary data was collected by using set of questionnaires, meanwhile, the secondary data was collecting to get the information about the study area background by district authority report and documents. This research design examines the relationships among the socioeconomic parameters with sub-districts in Pekan area those are affected by flooding in the year 2017. The data collected in the field through a survey was entered, coding, computed and analysed using Statistical Package for Social Science (SPSS) version 25 software. Briefly, the SPSS is a computer program that is specially designed to analyse data from questionnaires distributed and obtained by field researchers. In the context of analysing data using the software, all information contained in the questionnaire form was systematically processed and recorded. It also provides the calculations by using a descriptive statistical technique and the results tabulated.

Study Area

Table 3 shows the sampling by sub-districts in Pekan area. There are 13 districts involved in the study which covers 92.8% of the entire Pekan district (Figure 2). However, Bebar sub-district was not included in the study because the residents in the sub-district were not affected by the floods, and it was located far from the Pahang River Basin (Figure 3).

Table 3
Sampling by sub-districts in Pekan district, Pahang

No	Sub-districts	No of samples	Percentage (%)
1	Ganchong	30	10.3
2	Kuala Pahang	20	6.9
3	Langgar 1	19	6.6
4	Langgar 2	20	6.9
5	Lepar	30	10.3
6	Pahang Tua	20	6.9
7	Pekan 1	15	5.2
8	Pekan 2	25	8.6
9	Penyor 1	21	7.2
10	Penyor 2	20	6.9
11	Pulau Manis	26	9.0
12	Pulau Rusa	20	6.9
13	Temai	24	8.3
Total		290	100%

Sources: Author's analysis, 2023

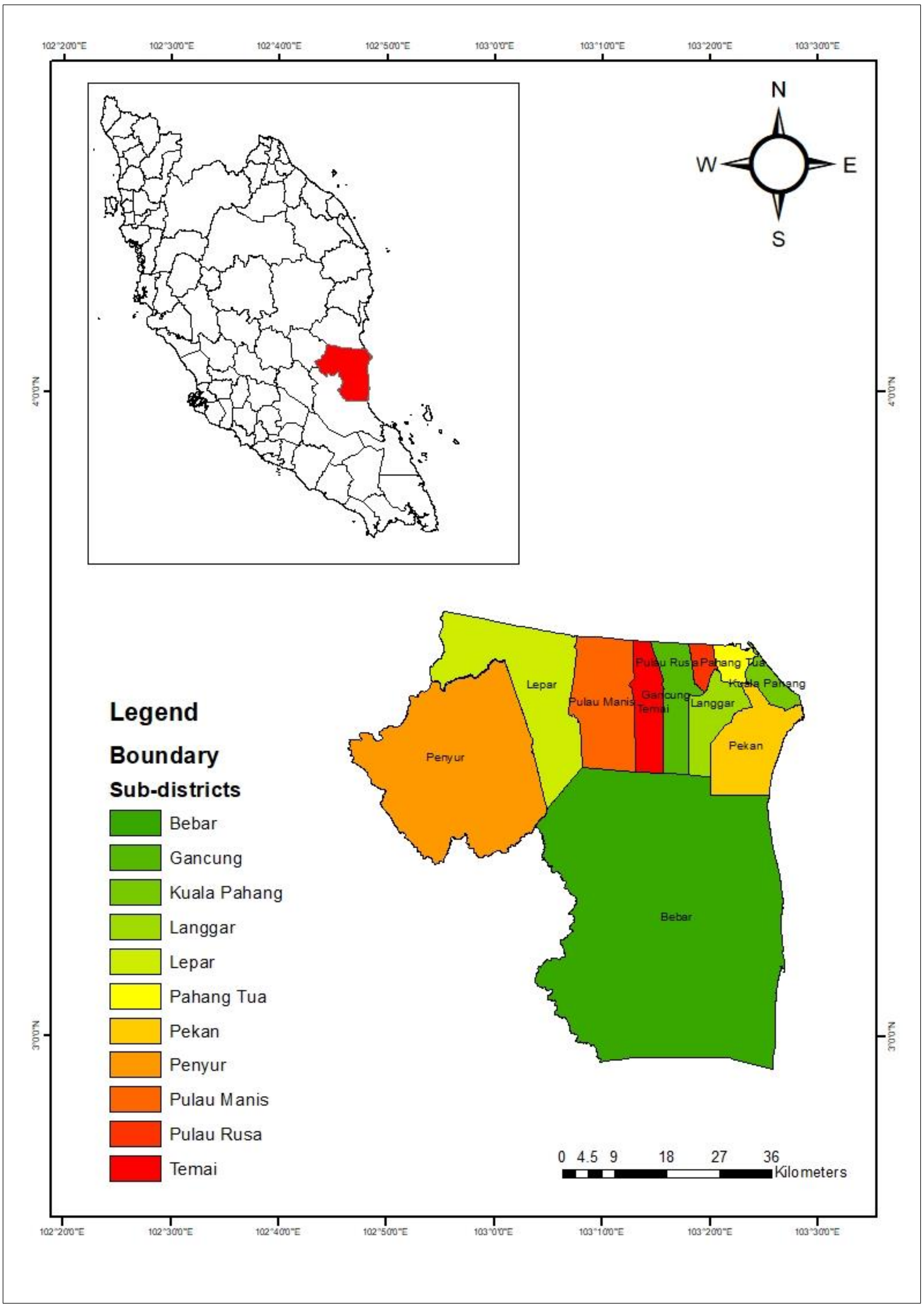

Figure 2: Map of Pekan District, Pahang

According to The Department of Statistics Malaysia (2017), Pekan town (Pekan town is the main town in the Pekan district) is located in the downstream of Pahang River Basin and quite frequently hit by the flood. The population of Pekan is 105, 822. Additionally, Pahang River Basin is the largest catchment area in the state of Pahang, leading to flooding every year (Figure 3) as it is one of the areas that received the highest total rainfall during the northeast monsoon period, i.e., about 40% of the total rain annually (Kamarudin et al., 2019). In 2014, a total of 116 villages were hit by the flood covering a population of about 80,000 in the districts of Pekan, Kuantan, and Temerloh (Abd Majid et al., 2017). The tragedy also brought much destruction to infrastructures, properties, crops, livelihoods, routine services and healthcare.

Chan (2015) also said that this flood event is the most significant and severe flood in Pahang's history. The District of Pekan, lying in a low land topographic area where the Pahang River drains out into the South China Sea suffered almost yearly flooding resulting from the water that spills from the Pahang River every time during heavy rain. The daily high tide of the sea also aggravated the situation as water from the river was held back, subsequently widespread flooding in the area.

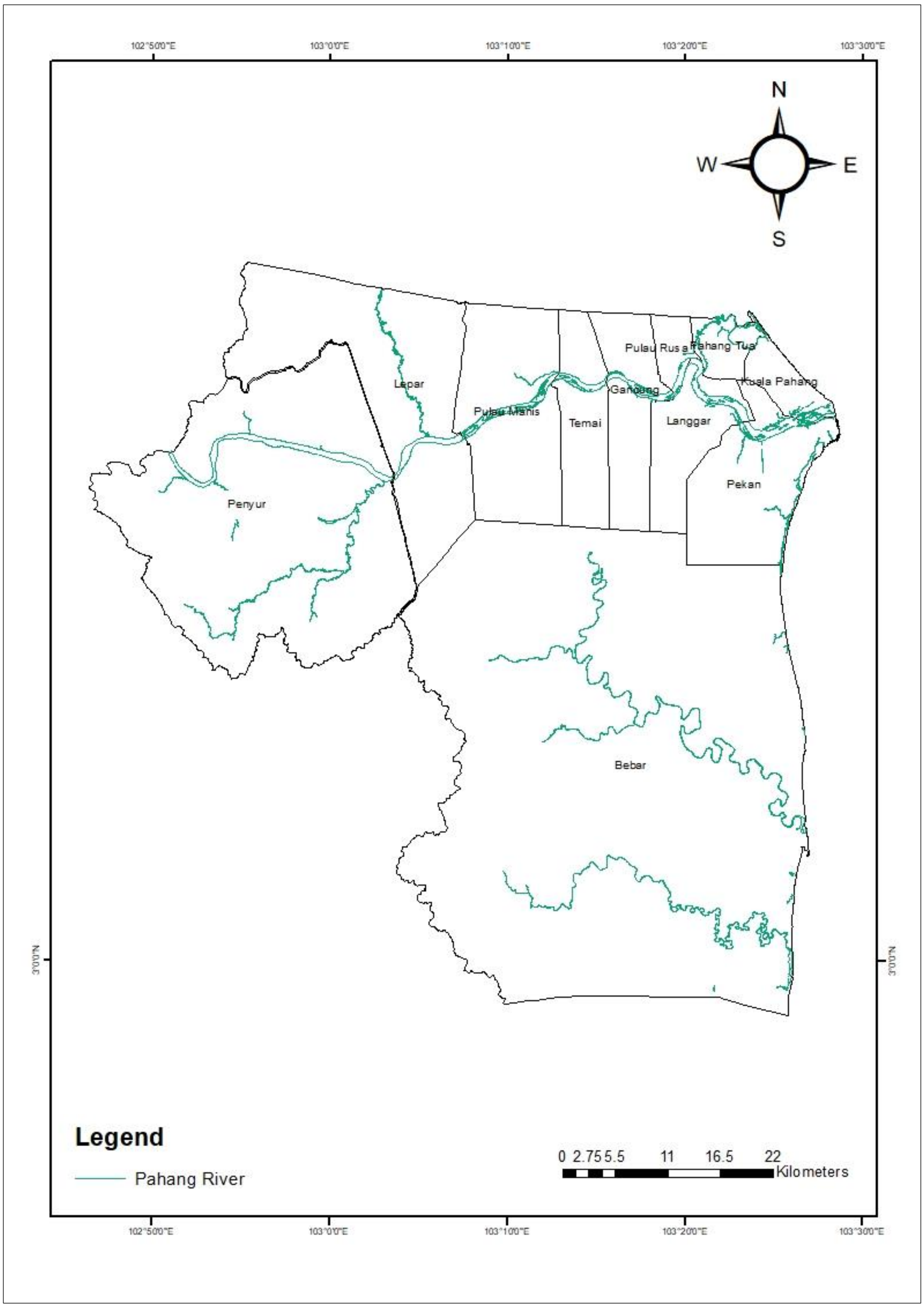

Figure 3: Map of Pahang River

Data Collection

Field data were collected from April to July 2018 by using a set of questionnaires, with the assistance of qualified enumerators comprising local people to obtain the primary data. The survey consists of 15 parts containing 128 questions in total. A questionnaire is a tool used in this exercise, and items were provided to get all the information required for the study. Besides that, each respondent was subjected to a face-to-face interview for about 45 minutes. Furthermore, the questionnaire was use to obtain the information from large number of people and to encourage people to answer the question, researcher decide to administered the questionnaire in person which has the advantage of including those are having difficulties reading and writing. From this action, respondent have the belonging of his answering and taking part in an interview rather than completing the questionnaires and researcher jot note the responses on behalf. They were systematically randomly selected, and the target group of this study was the people who resided in places prone to the flooding and shared a particular social network. The flood affected 9,961 people in Pahang. This study was using the systematic random sampling technique. Therefore, 300 samples were needed in this study from the long list population. Thus, the calculating of sampling interval is k= 33 (k = N/n). A total of 300 sets were distributed, but only 290 replied, and the questionnaires were returned with complete input and thus ready for analyses.

Data Analysis

Descriptive Statistic

Descriptive statistics represent the analysis of data that facilitates describing, show or summaries data in a meaningful way. It such that patterns might emerge from the data and therefore enables the data to be presented in a more meaningful way, which allows more accessible interpretation of the data (Lund and Lund, 2018). For instance, Martin (2006) found that these statistics also summarise various aspects of the data, giving details about the samples and providing information about the population from which the sample was drawn. Moreover, frequency statistics are the main descriptive statistics used with discrete variables. These include absolute frequencies (raw counts) for every category of the discrete variable, relative frequencies (proportions or percentages of the entire number of observations), and cumulative frequencies for successive types of ordinal variables. For this particular study, the components that were measured include the effects of the flood on the community's general socio-economy such as houses, school session, earnings, the number of households and health.

Crosstab Analysis

Initially, a crosstabs analysis used in this study is also known as contingency tables, which summaries the relationship between different variables of categorical data and presenting the proportion of cases in subgroups (Stephanie, 2013). By using this analysis, the relationship between Pekan sub-districts and the five components of socio-economic parameters mentioned earlier will be presented. Data results will also be reflected in a simple schedule and included with critical descriptions.

Chi-Square Analysis

The Chi-Square study was used to evaluate the overall functional consequences of the floods in different communities. The test statistic for the Chi-Square Test of Independence as shown in Equation 1 is denoted X^2, and is computed as follows

$$X^2 = \sum_{i=1}^{R} \sum_{j=1}^{C} \frac{(o_{ij}-e_{ij})2}{e_{ij}} \qquad [1]$$

Where;
o_{ij} is the observed cell count in the i^{th}row and j^{th} a column of the table.
e_{ij} is the expected cell count in the i^{th}row and j^{th} a column of the table.
The calculation X^2 value is then compared to the critical value from the X^2 distribution table. If the calculated X^2 value > critical X^2 value, then study will reject the null hypothesis, and there is a strong correlation between the variables involved.

Map Generation

This study also uses ArcGIS software to analyse and present data collected through maps to easily visualise the distribution of the impacted community. The software is generally used to support storage, procurement, processing, analysing, and data presentation in spatial form. The Spatial Analyst in the ArcGIS software was used as a catalyst in assisting for obtaining the results on the flood impacts of the community's socio-economy based on the mapped area (Mohamad et al., 2012). With this software, SPSS can be used to further analyse the socio-economic parameters of the respondent. It can then be added into the variety of layers of maps. Hence, the maps of distribution on the study parameters can be generated. Therefore, the relationship between flooding and the socio-economic of community in the affected areas can be studied in detail.

Results and Discussion

Primarily, the demographic profiling presented the overall of the scenario of community background in Pekan, Pahang. Table 3 shows most of the respondent is male (78.6%) and is the head of the household rather than female making them as a majority group. Though the survey is for the leader of the house (who is generally a male), nevertheless, if they were not available at their home at the time of the survey, their wife was required to answer the survey questions on behalf of their husband. Next, more than 80 % of the respondent is a productive worker (someone who earns money by working or having a job), which is in the age range 31 to 70 years old. This age category consists of 41.5 % and 46.2 % within 31 to 50 and 51 to 70 years old, respectively. Most of the respondent (96.6 %) have attained an education of at least at primary school level (basic schooling for 7 to 12 years of age). Furthermore, the middle (13-15 years old), secondary (16-17 years old), and tertiary (18-19 years old) school leavers are 20 %, 40.7 %, and 6.9 %, respectively. Respondents with higher education (university degree) only account for 1.7 % of the respondents, and 3.4 %t of respondents did not receive any formal education. Overall, it shows that the victim of the flood has a mixed background in terms of education, and almost all completed their primary studies. Majority of respondents are married (74.8%), followed by widow or widower (17.9 %) as a single mother and single father in the study area. Meanwhile, respondents who are still single gave the lowest percentage (4.1%).

The residential area of the respondents is along the Pahang River and almost located in the rural area. Thus, it also affects their economic activity. Most of them are involved in the agriculture sector as a self-worker and doing the non-skill job. In term of occupation, the majority of respondents in Pekan were self-employed (40.3%). These include working as farmers, rubber tappers and business owners. The unemployed (18.6%) were female-headed household. Those are involved in the private sector (15.5%) were production operators in automotive and electronics manufacturing factories such as Hicom Automotive Manufacturers and Vacuumschmelza (M) Sdn. Bhd. Meanwhile, those who work in the government sector (9.3%) were teachers, support staff and clerks. The rest of the respondents either retirees (9.3 %) or housewife (6.9 %).

There are four levels of income of the respondents and most respondents were within the RM1001 - RM3000 (44.5%) bracket, followed by the income group of <RM1000 (43.8%). The remaining 18 respondents (6.2%), 11 respondents (3.8%) and 5 (1.7%) were within the income range of RM3001 - RM5000, RM5001 - RM8000 and >RM8000, respectively. The analysis showed that overall, respondents in Pekan received a minimum income of RM100 and a maximum income of RM10000 per month. Statistically, the average monthly income for respondents involved in the flood in Pekan, Pahang is RM 1701.70 (Standard.Deviation (SD): RM164.79). The level of income demonstrates that the average respondents in the study were in the B40 group. B40 group is the 40% lower household group with an average monthly income of less than RM4360.00. The poor households whose monthly income is less than the poverty line income (PLI) with the current value of PLI national are RM950.00 per month also included in this B40 group (Economic Planning Unit, 2020). Therefore, the respondent in Pekan, Pahang mostly are trapped and vulnerable to poverty.

In all 13 sub-districts, 202 houses were affected (Table 4) representing majority of the correspondents interviewed. The most affected sub-districts are Pahang Tua (95 %) and Pulau Manis (92 %) but in terms of real number of houses, most occurred in Lepar with 25 followed by Ganchong and Pulau Manis sub-districts both with 23 houses which were affected during the flood. Overall, almost 70 % of the houses were affected in the areas of the survey.

Table 4
Sample crosstabs analysis of sub-districts and socioeconomic parameters (N = 290)

Sub-districts	Socioeconomic parameters affected by flood				
	No of houses	Missing schools and workdays	Income	No of family members	Health
Ganchong	23 (11.39%)	17 (17.35%)	6 (8.57%)	15 (10.87%)	3 (6.25%)
Kuala Pahang	15 (7.43%)	-	-	17 (12.32%)	5 (10.42%)
Langgar 1	8 (3.96%)	1 (1.02%)	1 (1.43%)	7 (5.07%)	2 (4.17%)
Langgar 2	12 (5.94%)	9 (9.18%)	7 (10.0%)	4 (2.90%)	9 (18.75%)
Lepar	25 (12.38%)	12 (12.24%)	1 (1.43%)	15 (10.87%)	-
Pahang Tua	19 (9.41%)	6 (6.12%)	5 (7.14%)	1 (0.72%)	3 (6.25%)
Pekan 1	10 (4.95%)	3 (3.06%)	1 (1.43%)	8 (5.80%)	1 (2.08%)
Pekan 2	17 (8.42%)	3 (3.06%)	2 (2.86%)	13 (9.42%)	1 (2.08%)
Penyor 1	18 (8.91%)	8 (8.16%)	8 (11.43%)	12 (8.70%)	8 (16.67%)
Penyor 2	11 (5.45%)	7 (7.14%)	7 (10.0%)	8 (5.80%)	1 (2.08%)
Pulau Manis	23 (11.39%)	18 (18.37%)	12 (17.14%)	11 (7.97%)	9 (18.75%)
Pulau Rusa	12 (5.94%)	5 (5.10%)	6 (8.57%)	10 (7.25%)	2(4.17%)
Temai	9 (4.46%)	9 (9.18%)	14 (20.0%)	17 (12.32%)	4 (8.33%)
Total	202 (100%)	98 (100%)	70 (110%)	138 (100%)	48 (100%)

Source: Author's analysis, 2023

The Chi-Square Tests were also conducted on some variable and tabulated in Table 5 as shown. In the first case (Test No 1 in Table 5), analyses found that the floods did have impact on the number of houses or dwelling. There is a significant relationship between the two variables, i.e. sub-districts and number of houses. The sub-districts differ in terms of the percentage of total houses affected by the flood. Visually, the flood has imposed significant loss to the community in the sub-districts selected as most of the residents agreed that their houses were affected as indicated by the red dots in Figure 4 when superimposed on GIS map.

Table 5
Relationships between sub-districts and other variables in Chi-Square Tests

Test #	Variables	X^2	X^2_{cri}	*p* value
1	No of houses	86.9	26.217	<0.001
2	Missing schools and workdays	39.2		<0.001
3	Income	27.18		0.007
4	No of family members	90.51		<.0001
5	Health	3.171		0.203

Source: Author’s analysis, 2023.

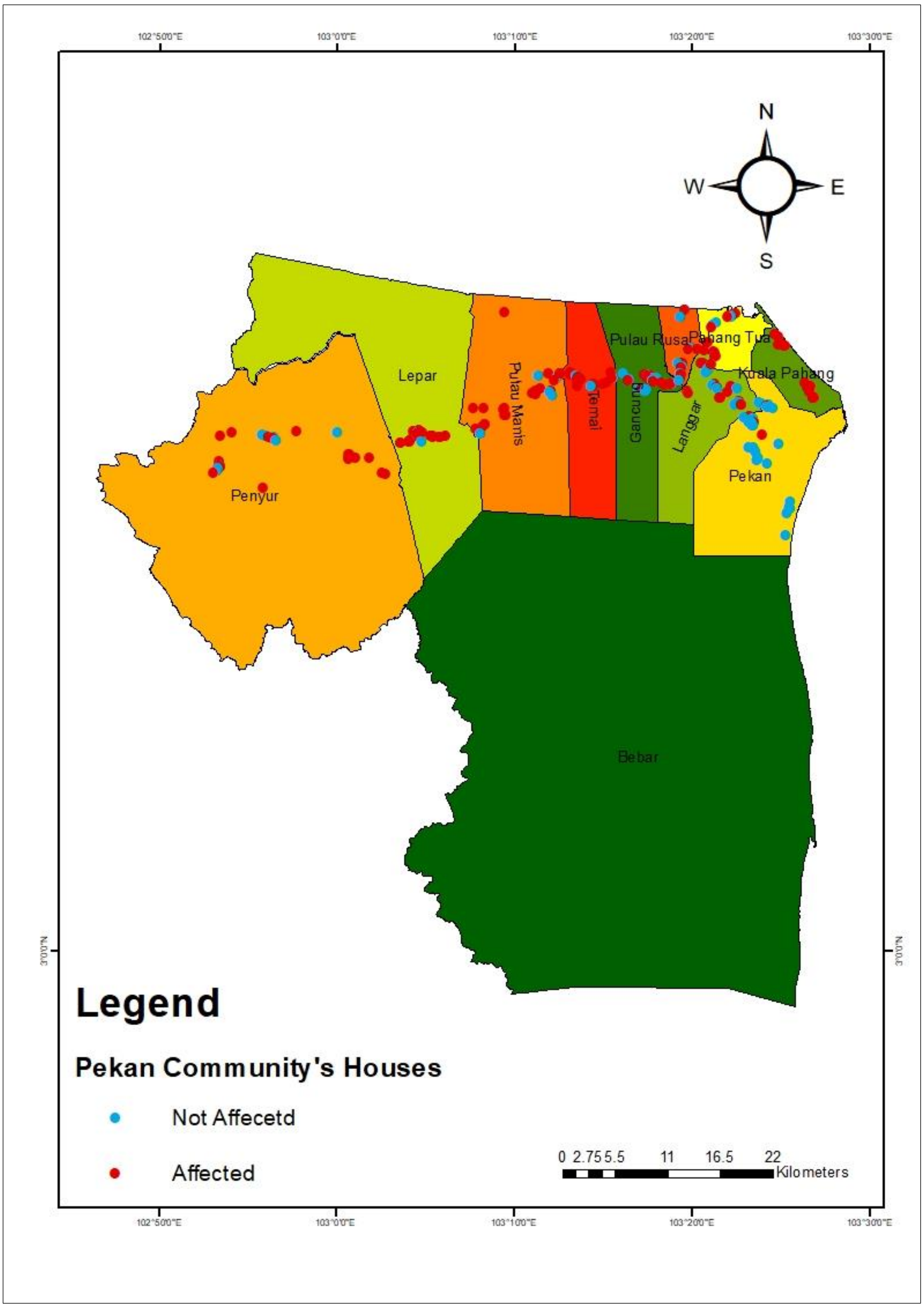

Figure 4: Distribution map of flood impacts on Pekan community's houses

In Test No. 2 (Table 5), there is a close interaction between the two variables shows by the statistical analysis and it is concluded that the floods event has hindered the movement of the community to carry on with daily activities such as school and work. Two (2) out of thirteen (13) sub-districts were affected seriously (those with more than 50 %) with missing schools and experienced work delays due to the flood (Figure 5). This was particularly due to the school's properties which suffered some damage by the flooding and therefore forced to close. In addition, the transportation network was weakened such as road disconnected and disrupted, for example, by falling trees, flooded and damaged highways and bridge closures. This causes general work and life disruptions for a time, in some cases, were well beyond the length of the flood (Associated Programme on Flood Management, 2013). Figure 6 shows that the graphically of sub-districts was affected by this factor.

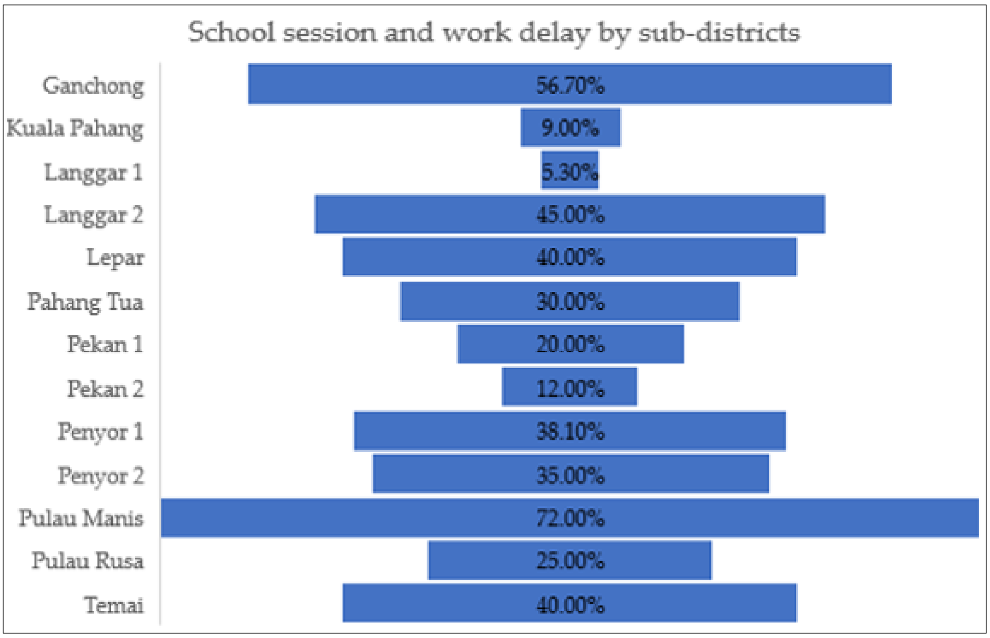

Figure 5: Missing school and work for two weeks by sub-districts in Pekan, Pahang

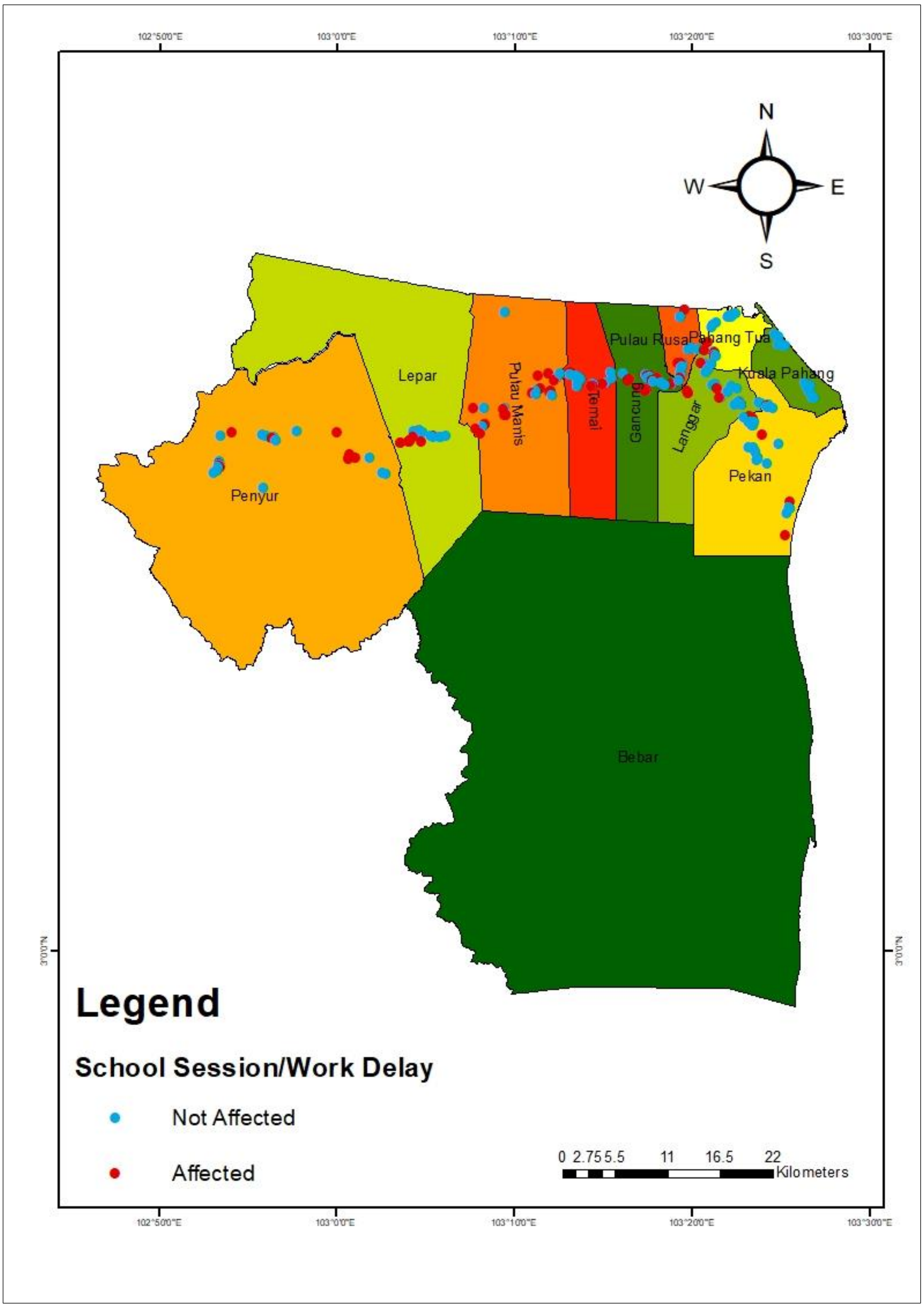

Figure 6: Distribution map of flood impacts on school session and work delay

The flood also affects the income earning of community in Pekan, Pahang (Test No 3, Table 5). The detailed results of the survey also show that 74.9% of the respondents in these districts indicated that the flood negatively affects their earnings. These areas were mainly rural and the economic activity were mainly related to agriculture sector. The income earnings are around RM1000 – RM3000 per month with 40.3% (117 total no. of correspondents) were self-employed. These include working as farmers, rubber tappers and businesses and the majority are involved as a non-skilled worker and living nearby the Pahang River Basin. In general, about 88.6% of the overall respondent of all sub-districts had income in the range RM100 to RM3000 per month. Analyses also indicate that the sub-districts of Penyor 2, Kuala

Pahang, Langgar 1, Pekan 1, Pekan 2 and Pahang Tua were the most effected in terms of income earnings due to the flooding season (Figure 7).

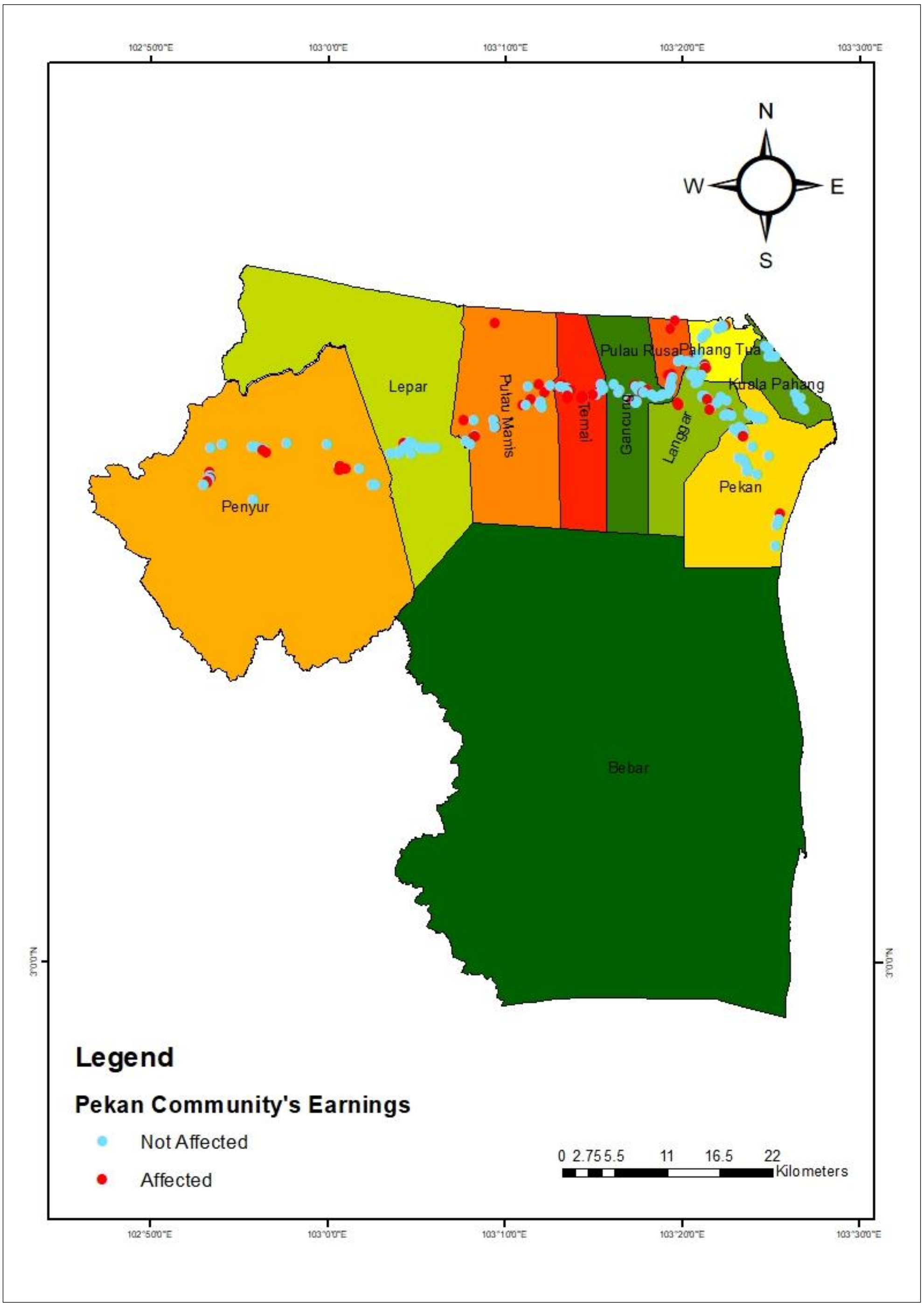

Figure 7: Distribution map of flood impacts on Pekan's community earnings

The number of households in the community can be classified into several groups, 0, 1 – 2, 3 – 4, and 5 – 7 members. The mean number of family members is ± 3.2 people per head of household. Generally, the majority of the respondents only have between 3 to 5 number of members, which represent 138 (47.6%) families in Pekan District (Figure 8). Chi-Square Test results (Test No 4, Table 5) indicate that the association of sub-district and the number of family members were quite significant showing that the more the number of households, the greater the effect they had during the flood. For instance, the Pulau Manis, Temai, Kuala Pahang, Langgar, Lepar, Pahang Tua, Pekan 2 and Penyor 1 sub-districts were those that had dependents more than 3 member per house and suffered more in that flooding event. As for a family who has a big count of households, it will also become strenuous for the family to make early preparation measures as good as the 0 – 2 family groups.

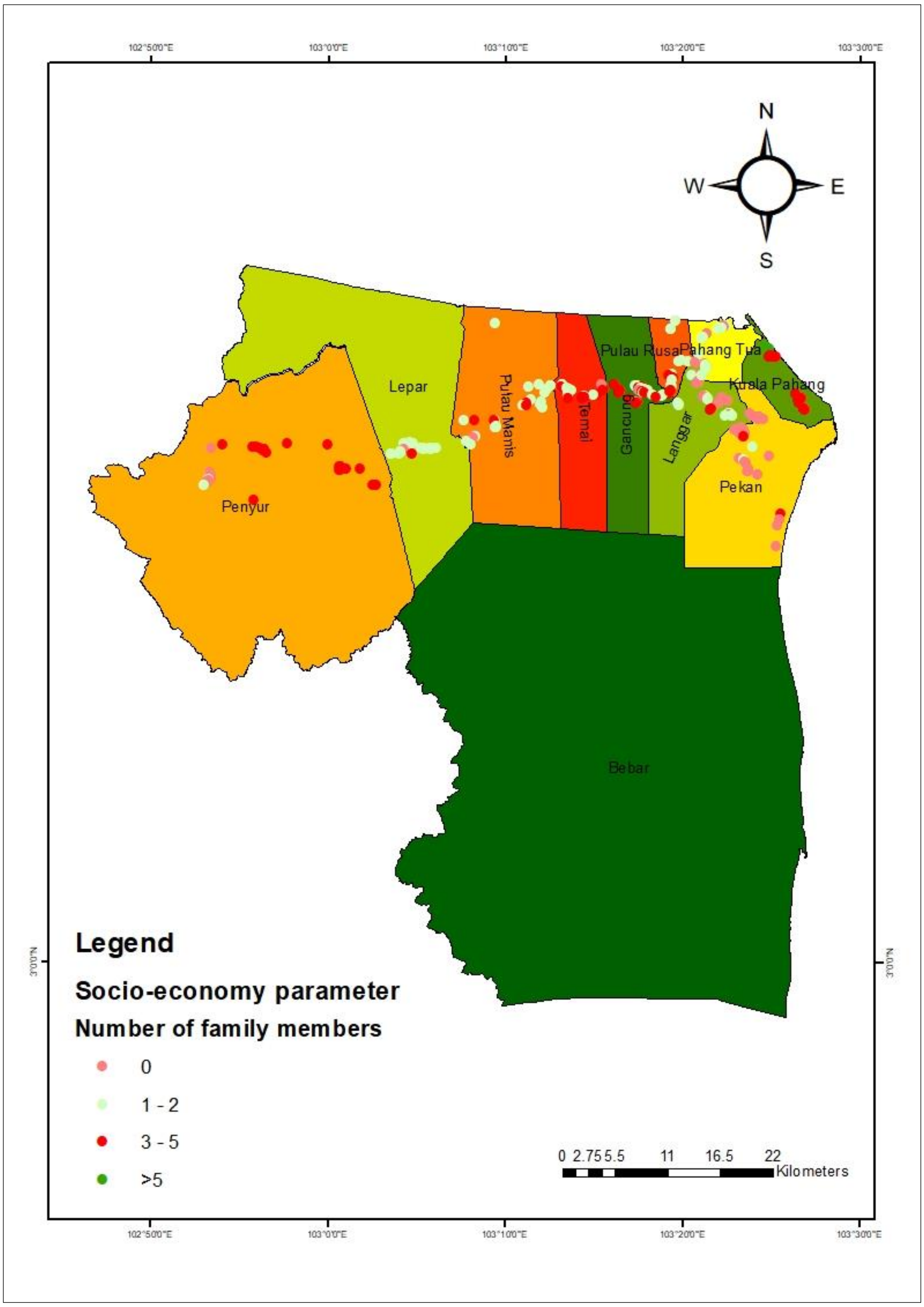

Figure 8: Distribution map of flood impacts on Pekan community's number of households

With regard to health (Test No 5, Table 5), statistical analysis shows that here is no association between sub-districts (low C^2 with high p value) with the health status of the correspondents in all sub-districts all suffer similar health problems in terms of types of health problems and the level of sickness. One particular health problem, i.e., the respondents' mental health was a concern because the experience of handling the flood was traumatic as they lost most of their property and had nowhere to go after the house got flooded. The respondents also had taken some adaptation steps to cope with health risks, both physically and mentally. The red dots shown in Figure 9 specify that there were fewer affected communities in all sub-districts regarding their health. In general, is about 16.6% (48 respondent) show that the residents health was not affected the residents' health was not affected by the flood with a large gap to the ones who are said to be affected by illness as the blue dots that represent the not affected community occupied the maps. This outcome could be a result of early preventions took by the communities due to previous experience with flooding and educating family members that floods not only will cause damage to the properties but also to human's health state.

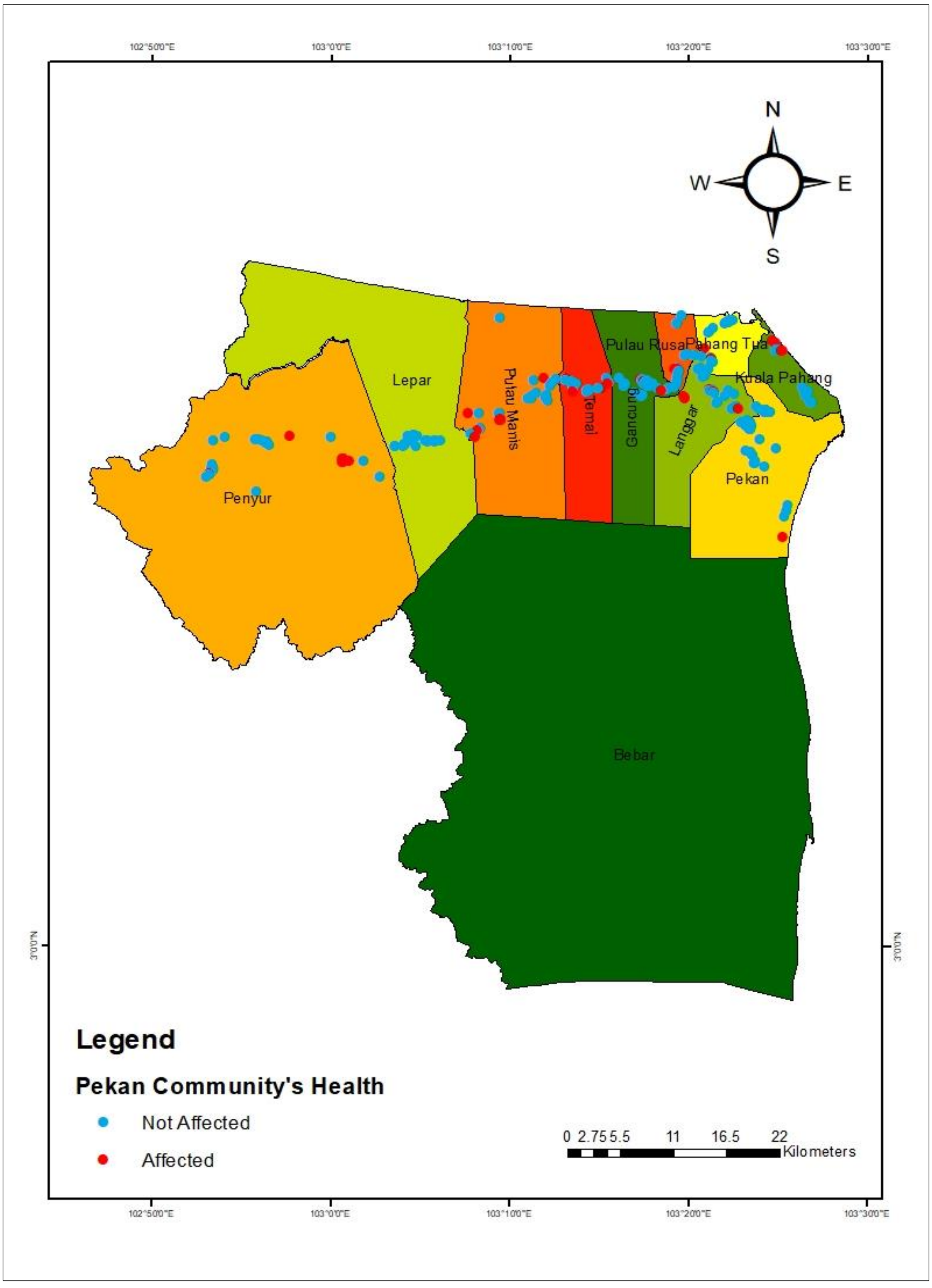

Figure 9: Distribution map of flood impacts on Pekan community’s health

In general, flood victims in Pahang often experienced the loss of property, damage of plantation, destruction of livestock etc. However, after fronting such events over the past years, the socio-economy of the community in Pekan District today does not seem to be too severely affected by the floods. From this micro study, however, residents were still affected by the 2014 flood event in term of monetary and non-monetary form. The loss was mainly due to damage and/or losing their houses during the flood. The houses around survey come in many forms but 2 main forms we observed, i.e., wooden, brick wall and concrete houses. House structures practically play a significant role in this outcome. A weakly structured house has less resistance to natural disasters, including floods. Houses built from woods are more likely to be in a high vulnerability. Constructing the houses in a higher ground was indeed one of the early preventions to reduce flood damages. This prevention was taken by the residents who once had significant loss to flood years ago. However, the flood of 2014 seems to have a severe impact on the houses among the resident's Pekan. Even though most of the houses are built with concrete structures and brick walls, the flood still impairs their houses. The occurrence of cracks in the walls, removal of the color of the paint on the walls, and the stains of muddy water on the walls is difficult to remove. The Pekan District is actually the last or final area to receive and carry the flood waters of the Pahang River before it flows out into the sea. In this particular event, the floods water did not flow for two weeks haunted the locals. These incidents have become commonplace of late, particularly due to urbanisation, and several adaptive steps have been taken, such as an early warning to residents and improving drainage infrastructures.

By using varies flood maps designated by GIS, the preparedness for preventions can be taken. For instance, in all areas of flood disaster management, this technology has made a significant contribution, including preparedness, prevention and relief of many disasters. According to Demir and Kisi (2016), the output accumulated from flood hazard map by a GIS program is utilised to manage flood warning system including road closures and voidances. This is also supported by Che Ros et al (2014) in their study which stated that warning systems can help responsible authorities to minimize potential flood effects by planning an effective flood emergency response. On the other hand, Klemešová et al (2014) has also stated that flood hazard and risk maps are aimed to determine the areas with potentially significant flood risk and intended to become part of the flood risk management plans for the future.

In Pekan Pahang, however, most respondents of the survey conducted in this study were already prepared with early prevention measures that were put in place from past flood experiences. Most of the sub-district communities in Pekan have elevated their houses (house floor higher from the ground), and some have moved to higher ground as previously mentioned. House that built higher up above the ground (built on stilts/columns made wood or concrete) and on a higher ground can reduce the damage since it protects the house from contact with the floodwaters, thus increasing its resistance during the flood. Houses built from woods are also more likely to be highly vulnerable to flooding compared to bricks and cement/concrete. Those who are wealthy will more definitely take these preventive actions as high capital is required to build them. In this case, the income of the household, therefore, also plays an important part in resisting or minimising the flood impact.

During a flooding period, some of the residents in the sub-districts were most likely compared to others to miss school or works for two weeks. This could have indirectly affected their livability, source of income and eventually, may affect their health as well. Damaged roads cause disruption of communication. According to Associated Programme on Flood Management (2013), the economy was directly dependent on the movement of goods, knowledge, and individuals and transport networks is known to sustain the health and well-being of communities. When roads are affected, it is impossible for people to maintain their daily activities, especially when the flood took days to subside and the roads up to weeks to be fully restored. Thus, the impact after a flood on the socio-economic in Pekan District was significant to the residents, especially in Ganchong and Pulau Manis sub-districts.

The impact of floods on income also has a significant relationship between the sub-districts of Pekan. The most to be affected though slightly, is Temai sub-district. Commonly, during a flooding period, for a family who solely relies on one source of income, it will be hard for them to survive during the flood. Most of them are self-workers by working as farmers, rubber tappers and running small businesses. However, generally in the Pekan District, most of the residents were doing various jobs to support the family. Thus, their income was not severely affected by the floods. Having diverse incomes will be most likely to avoid households from poverty after disasters. Hence, this is one method to indirectly end poverty and hunger as targeted by Sustainable Development Goals (SDG) in 2030 (Department of Economic and Social Affairs Disability, 2015).

According to the Department of Economic and Social Affairs Disability (2015) too, the number of family members is one of the parameters that were tested have significantly affected the household by sub-districts. It was supported by a study where larger families suffer more from the flood. During the flood, the head of the household had to consider the safety and health of the family members. In addition, provision of shelter, food, clothing and medicine are other priorities of life that need to be provided for. For families with young children and the elderly, this is even more burdensome for the head of the household. If the head of the household is a female, she had to do all the work from raising children, packing necessities, cooking and washing clothes.

The immediate impacts of flooding include health deficiency related to waterborne diseases (Sani et al., 2018). Floods potentially increase infectious disease transmissions, typhoid flu, cholera, hepatitis A and leptospirosis (World Health Organization, 2020; Ismail et al., 2017; Isahak et al., 2018). The health issues resulting from floods in developing countries tend to be more extensive and maybe more severe (with a more significant number of people suffering from outbreaks of illness) (Fewtrell et al., 2008). From this study, it was found that most of the residents in Pekan District were aware of flood dangers following various incidents over the last few years and thus became more conscious of flood threats. Preparedness, living with flood and mental readiness were possibly some of the reasons in avoiding greater loss for the people of the Pekan district in this major flood event. Besides, the hospitals and localised health centers in this district are also well-prepared from experiences of many-many years of flooding.

Conclusion

This study presents the flood impacts on Pekan, Pahang, Malaysia community socio-economy, which focused on the community houses, school session/work delay, income earnings, the number of households and health. A total of 290 surveys were successfully collected from 12 sub-districts correspondents. A big majority (almost 80 %) of the correspondents were male who was also the head of the households. The mean average of the correspondents was 53.5 years old, and more than 80 % had jobs to sustain their family lives. The occupation varies, but most (40.3 %) were self-employed. The mean income of the household was just above RM 1700 and classified under the B40 income group, which means that they are poor but not below the poverty line. The results of the study indicated that 202 houses out of 290 were affected during the flood, which represents about 70 % of the households in the study. The sub-districts differ in terms of the percentage of total houses affected by the flood. House structures practically play an important role in evading damage due to flooding. A weakly structured house has less resistance to floods and houses built from woods are more likely to be in danger. The respondents in 2 out of 13 sub-districts, i.e., Ganchong and Pulau Manis were affected seriously with missing schools and experienced work delays due to the flood. This was due to the closure of schools and disrupted transportation networks. Analyses of results also show that the earnings of the respondents were reduced during the flood as most of them were working in the agricultural sector in which the flood directly affected their produce. The flood also re-establishes the fact that as the number of people in the households increases, the more difficult the head of the household is to cater for the family especially in the presence of young children and the elderly. Generally, health-wise, the majority of the respondents did not suffer much due to their readiness from past flooding experiences.

Acknowledgment
This work was supported by Universiti Kebangsaan Malaysia (grant number DPP-2018-008).

References

Abd Majid, N., & Rainis, R. (2017). Application of Geographical Information Systems (GIS) and Discriminant Analysis in Modelling Slope Failure Incidence in Pulau Pinang, Malaysia. *Sains Malaysian, 48*, 1367-1381. DOI 10.17576/jsm-2019-4807-06

Abd Majid, N., Rainis, R., & Ibrahim, W. M. M. W. (2017). Pemodelan ruangan pelbagai jenis kegagalan cerun di Pulau Pinang menggunakan kaedah nisbah kekerapan. *GEOGRAFI, 5*(2)*,* 13-26. Retrieved from http://ejournal.upsi.edu.my/index.php/GEOG/article/view/2044

Abd Majid, N., Rainis, R., & Ibrahim, W. M. M. W. (2018). Spatial modelling various types of slope failure using Artificial Neural Network (ANN) in Pulau Pinang, Malaysia. *J. Teknologi, 80*, 135-146. DOI: 10.11113/jt.v80.10483

Abd Majid, N., Nazi, M. N., Idris, M. N. D., & Taha, M. R. (2019). GIS-Based Livelihood Vulnerability Index Mapping of the Socioeconomy of the Pekan Community. *Sustainability, 11,* 6935. DOI: 10.3390/su11246935

Ang, K. H. (2015). Monsoon Flood Disaster in Kota Bharu, Kelantan Case Study: A Comprehensive Review*. International Journal of Scientific Engineering and Research, 3*(9), 79-81. DOI: 10.6084/m9.figshare.1558024.v1

Associated Programme on Flood Management. (2013). *Risk Management for Flood*. Retrieved from https://www.floodmanagement.info/what-are-the-negative-social-impacts-of-flooding/

Bernama. (2018). Five projects to mitigate floods implemented in Pahang. *New Straits Times.* Retrieved February 20, 2020, from https://www.nst.com.my/news/nation/2018/11/432727/five-projects-mitigate-floods-implemented-pahang

Boo, S. L. (2015). Kelantan floods like Japan's 2011 Tsunami. Malay Mail. Retrieved February 18, 2020, from https://www.malaymail.com/news/malaysia/2015/01/15/kelantan-floods-like-japans-2011-tsunami-says-nsc/819597

Centre for Research on the Epidemiology of Disasters. (2009). *EM-DAT: The International Disaster Database*. Retrieved March 13, 2020, from https://www.emdat.be/

Chan, N. W. (1997). Increasing flood risk in Malaysia: causes and solutions. *Disaster Prevention and Management, 6*(2), 71-86. DOI: 10.1108/09653569710164035

Chan, N. W. (2015). Flood Loss Suffered by Pahang Folks during the December 2014 Major Floods. In M. Hashim, Z.A. Rahaman (Eds.), *Proceedings of Persidangan Geografi & Alam Sekitar Kali ke-5. Universiti Pendidikan Sultan Idris,* Tanjung Malim, Perak, Malaysia. Retrieved March 25, 2020, from https://www.researchgate.net/publication/282664471_FLOOD_LOSS_SUFFERED_BY_PAHANG_FOLKS_DURING_THE_DECEMBER_2014_MAJOR_FLOODS

Che Ros, F., Shahrim, M. F., & Liew D. Y. (2019). *Estimation of Infrastructure Demand for Flood Control in Malaysia.* Center for Disaster Preparedness & Prevention. Retrieved from https://www.jica.go.jp/jica-ri/research/growth/l75nbg00000bac29-att/Report_Malaysia_Final_JICAv2.pdf

Demir, V., & Kisi, O. (2016). Flood Hazard Mapping by Using Geographic Information System and Hydraulic Model: Mert River, Samsun, Turkey. *Advances in Meteorology, 2016*, 1-9

Denchak, M. (2019). Flooding and Climate Change: Everything You Need to Know. Retrieved December 15, 2020, from https://www.nrdc.org/stories/flooding-and-climate-change-everything-you-need-know

Department of Economic and Social Affairs Disability. (2015). *The 17 sustainable development goals (SDGs) to transform our world.* Retrieved April 28, 2020, from https://www.un.org/development/desa/disabilities/envision2030.html

Department of Statistics Malaysia. (2017). *Preliminary Count Report—Population and Housing Census Malaysia 2010*. Retrieved May 2, 2020, from https://www.dosm.gov.my/v1/index.php

Department of Irrigation and Drainage. (2017). *Flood Management - Programme and Activities*. Retrieved March 22, 2020, from https://www.water.gov.my/index.php/pages/view/419?mid=244

Earth Observatory of Singapore. (2020). *Why do urbanisation and deforestation make flooding more likely?* Retrieved March 3, 2020, from https://earthobservatory.sg/faq-on-earth-sciences/why-do-urbanisation-and-deforestation-make-flooding-more-likely

Economic Planning Unit. (2020). *Household Income and Poverty.* Retrieved April 20, 2020, from https://www.epu.gov.my/ms/sosio-ekonomi/pendapatan-kemiskinan-isi-rumah

Elias, Z., Hamin, Z., & Othman, M. B. (2013). Sustainable management of flood risks in Malaysia: Some lessons from the legislation in England and Wales. *Procedia-Social and Behavioral Sciences, 105*(1), 491-497. DOI: 10.1016/j.sbspro.2013.11.052

Fewtrell, L., Kay, D., & Ashley, R. (2008). *Flooding and health – an evaluation of the health impacts of urban pluvial flooding in the UK. Health Impact Assessment for Sustainable Water Management*. Retrieved May 8, 2020, from https://www.researchgate.net/publication/257343520_Flooding_and_Health_an_evaluation_of_the_health_impacts_of_urban_pluvial_flooding_in_the_UK

Floodlist. Malaysia-30,00 Displaces by Floods in Johor, Pahang, Malacca and Negeri Sembilan. https://floodlist.com/asia/malaysia-floods-johor-pahang-malacca-negerisembilan-march-2023 [retrieved on November, 28 2023]

Isahak, A., Reza, M. I. H., Siwar, C. M., Ismalil, S., Sulaiman, N., Hanafi, Z., Zainuddin, M. S., & Taha, M. R. (2018). Delineating risk zones and evaluation of shelter centres for flood disaster management along the Pahang River Basin, Malaysia. *Journal of Disaster Risk Studies, 10*(1), 1-7. DOI: 10.4102/jamba.v10i1.501

Ismail, K., Ibrahim, M. H., Isa, M. N. K., & Marzuki, M. (2017). Flood Relief Management for Residents in Temerloh, Pahang, Malaysia. *International Journal of Academic Research in Business and Social Sciences, 7*(12), 1281-1288

Kamarudin, M. K. A., Sulaiman, N. H., Abd Wahab, N., Toriman, M. E., Hanafiah, M., Umar, R., Hassan, A. R., Rosli, M. H., Abu Samah, M. A., & Harith, H. (2019). Impact of Malaysia major flood to river geomorphology changes and total suspended solid using GIS technique. *Desalination and Water Treatment,* 242-257. DOI: 10.5004/dwt.2019.23837

Kawasaki, A., Kawamura, G., & Zin, W. W. (2019). A local level relationship between flood and poverty: A case in Myanmar. *International Journal of Disaster Risk Reduction, 42,* 1-7. DOI: 10.1016/j.ijdrr.2019.101348

Khalid, M. S., & Shafiai, S. (2015). Flood Disaster Management in Malaysia: An Evaluation of the Effectiveness Flood Delivery System. *International Journal of Social Science and Humanity, 5*(4), 398-402. DOI: 10.7763/IJSSH.2015.V5.488

Klemesova, K., Kolar, M., & Andrasko, I. (2014). Using GIS in The Flood Management – Flood Maps (Troubky, Czech Republic). *Geographia Technia, 9*(2), 44-53

Lund, A., & Lund, M. (2018). *Laerd Statistics - Descriptive and Inferential Statistics 2018.* Retrieved March 5, 2020, from https://statistics.laerd.com/statistical-guides/descriptive-inferential-statistics.php

Martin, G. L. (2006). Descriptive Statistics and Graphical Displays. *ahajournals, 144*(1), 76-81. DOI: 10.1161/CIRCULATIONAHA.105.584474

Mohamad, A. R., Komoo, I., Che Jusof, M. J., & Ismail, M. F. (2012). Pengujian Pengaplikasian Sistem Pengurusan Sistem Pengurusan Banjir Bersepadu Dalam Analisis Limpahan Banjir, *Proceedings of Malaysia Geospatial Forum,* Melaka, Malaysia. Retrieved April 16, 2020, from http://www.malaysiageospatialforum.org/2012/proceeding/ppt/mohamad%20abdul%20rahman.pdf

Ghazali, M. N. H. (2019). Flood Adaptation and Mitigation, *Proceedings of the Second Malaysia – Netherlands Water Dialogue*, Kuala Lumpur, Malaysia. Retrieved May 6, 2020, from http://www.ketsa.gov.my/msmy/Documents/Pengumuman/2019/JPS%20-%20FLOOD%20MANAGEMENT%20MALAYSIA.pdf

Muis, S., Guneralp, B., Jongman, B., Aerts, J. C. J. H., & Ward, P. J. (2015). Flood risk and adaptation strategies under climate change and urban expansion: A probabilistic analysis using global data. *Science of The Total Environment, 538*, 445-457. DOI: 10.1016/j.scitotenv.2015.08.068

Rahmah E., Syamimi, H., Pauzi, M. A., Mazlin, M., Ekhwan, M. T., Ahmad, F. E., Maimon, A., Lee, Y. H., Khairul, N. A. M., Syafinaz, S., Maizurah, M., & Nurlina, M. R. (2017). Pahang Flood Disaster: The Potential Flood Drivers. Malaysian Journal of Geosciences. 1(1):34-37 https://doi.org/10.26480/mjg.01.2017.34.37

Abdul Mulok, S. (n.d). The Use of GIS in Flood Mitigation Programmes. (unpublished).

Saifulsyahira, J., Edre, M. A., Farhan, A. F,, & Hanafiah, M. J. (2016). Governance of Flood Disaster Management: Malaysian Case Study. *International Journal of Public Health and Clinical Sciences, 3*(1), 17-30

Sani, G. D., Gasim, M. B., Toriman, M. E., & Abdullahi, M. G. (2018). Flood in Malaysia: Historical Reviews, Causes, Effects and Mitigations Approach. *International Journal of Interdisciplinary Research and Innovations, 2*(4), 59-65

Stephanie. (2020). *Crosstabs in SPSS*. Retrieved March 14, 2020, from https://www.statisticshowto.com/how-to-use-crosstabs-in-spss/

Wallemacq, P., Guha-Sapir, D., MacClean, D., & UNISDR. (2015). *The Human Cost of Weather-Related Disasters - 1995 – 2015* [Adobe Digital Editions version]. DOI: 10.13140/RG.2.2.17677.33769

World Health Organization. (2020). *Humanitarian Health Action: Flooding and communicable diseases fact sheet*. Retrieved May 3, 2020, from https://www.who.int/hac/techguidance/ems/flood_cds/en/

Yahya, H., Ahmad, M. N., Mohamad, R., & Rodzi, M. Z. (2016). Essential Knowledge Transfer Process Model. *Journal of Theoretical and Applied Information Technology, 87*(3), 404-414

Zaidi, S. M., Akbari, A., & Ishak, W. M. F. (2014). A Critical review of Floods History in Kuantan River Basin: Challenges and Potential Solutions. *International Journal of Civil Engineering and Geo-Environment, 5*(2014), 58-62

Zakaria, S. F., Zin, M. R., Mohamad, I., Balubaid, S., Mydin, S. H., & Roodienyanto, E. M. (2017). *Proceedings of the 3rd International Conference on Construction and Building Engineering (ICONBUILD) 2017.* Retrieved April 12, 2020, from https://aip.scitation.org/doi/pdf/10.1063/1.5011632