

# Disaster Preparedness and Management in Saudi Arabia: An Empirical Investigation

Shougi Suliman Abosuliman, Arun Kumar, Firoz Alam

**Abstract**—Disaster preparedness is a key success factor for any effective disaster management practices. This paper evaluates the disaster preparedness and management in Saudi Arabia using an empirical investigation approach. It presents the results of the survey conducted by interviewing representatives of the Saudi decision-makers and administrators responsible for disaster control in Jeddah before, during and after flooding in 2009 and 2010. First, demographics of the respondents are presented, followed by quantitative analysis of their views and experiences regarding the Kingdom's readiness before and after each flood. This is shown as a series of dependent and independent variables. Following this is a list of respondents' priorities for disaster preparation in the Kingdom.

**Keywords**—Disaster response policy, crisis management, effective service delivery.

## I. BACKGROUND

OVER the past half-century, as the international social environment was relatively peaceful, human society, economy and technology have developed rapidly. However, the rapid development has created numerous environmental problems such as global warming and geological damages due to mining and oil extraction and so on. Despite the absence of direct evidence that the recent years' natural disasters were created by human activities, the number of natural disasters has increased and become more destructive when compared to historical events. This situation is more obvious in Asia (Fig. 1) due to presence of large number of developing countries with dense population. People can use technology to predict some of the disasters, for instance the meteorological forecasting for rainstorm and hurricanes; however, prediction and prevention can only play a limited role in reducing losses and are powerless when facing unpredictable sudden events, such as flash floods and earthquake which is the focus of this research. In order to save lives and property as much as we can, ensuring the efficiency and effectiveness of relief operations are vital after natural disasters. Thus, emergency / humanitarian logistics, which is the extended, systematized and specialized branch of logistics and supply chain management, is now gaining more and more attention from academia and the public [1]. As a disaster-prone country, when compared with other countries in the region, Saudi Arabia was slow to begin developing emergency logistics

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systems while it is facing the increasing disaster challenges [2].

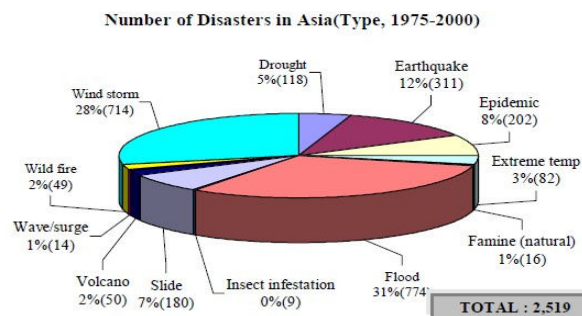


Fig. 1 Type of number of disasters in Asia

Saudi Arabia has been witnessing several manmade disasters such as terrorist attacks; however, less attention is paid to natural disasters, despite their frequent occurrence and the devastation they caused on people lives and property. Floods are the most frequently encountered disasters and have been the cause of 7 out of the 10 major disasters in Saudi Arabia between 1900 and 2010 as shown in Table I [3]. Flood disrupts the normal life patterns of individuals, families as well as the nation which are exposed to great material and personal losses. Jeddah city which is located on the Red Sea on the west coast of Saudi Arabia and has dry climate with little rainfall occurring only in winter, was flooded after a heavy rain on 25 November 2009 and caused the worst flood disaster in the history of Saudi Arabia. Situated on a plain beneath the 800m escarpment of the Jabal al-Hejaz in Saudi Arabia, as the desert city extends across numerous wadis off the escarpment, it is prone to flooding after exceptional storms; however at twice the city's yearly average, 90mm of rain fell in just four hours on that day. By noon, torrents struck many parts of the city, especially the poorer southern neighborhoods where thousands of vehicles were caught in a traffic jam trying to escape [4], [5]. The death toll was 163, with damage to 8,000 homes, over 7,000 vehicles and economic loss of US\$900. A number of children and women were also rescued and airlifted by helicopters in residential buildings. The lack of previous experience of dealing with flood crisis as well as the absence of the natural disaster plans made the situation difficult. The consequences of the floods drew criticism for wastewater management, flood mitigation and emergency response from the various responsible Saudi government organizations [6]. Saudi Arabia is yet to use the advancement of technologies to develop an efficient approach to forecast flash flood and warnings. It is still struggling to proactively manage current risks and vulnerabilities, and preparing for potential future disasters. Development of

models and provision of accurate information is crucial for local authorities in reducing vulnerability of people and flood prone areas from flash flood. The government bears the responsibility for implementing and organizing rescue operations, evacuation and providing assistance in the event of any disaster, and they should be able to take actions and policies to minimize losses [7].

TABLE I  
MAJOR DISASTERS IN SAUDI ARABIA BETWEEN 1941 AND 2011

| Type of disaster                | Death | Injured | Year    |
|---------------------------------|-------|---------|---------|
| Kabaa flash floods              | N.A.  | N.A.    | 1941    |
| Flash Flood                     | 20    | 1,000   | 1964    |
| Fire during Hajj                | 200   | N.A.    | 1975    |
| Occupation of Mosque in Makah   | 250   | 600     | 1979    |
| Floods in Northwest of Kingdom  | 32    | 5,000   | 1985    |
| Pilgrims Stampede inside tunnel | 1,426 | N.A.    | 1990    |
| Pilgrims Stampede inside tunnel | 270   | N.A.    | 1994    |
| Yanbu and Asir floods           | 26    | N.A.    | 1997    |
| Fire during Hajj                | 343   | 1555    | 1997    |
| Epidemic                        | 179   | 1700    | 2000/01 |
| Makah floods                    | 31    | N.A.    | 2002    |
| Medina flood                    | 29    | 43      | 2005    |
| Jeddah flood                    | 163   | 11,640  | 2009    |
| Jeddah flood                    | 10    | 5,000   | 2011    |

This study evaluates the disaster preparedness and management in Saudi Arabia using an empirical investigation approach. A questionnaire has been prepared and survey conducted with top authorities involved in disaster and emergency management sector. The findings have made a number of important managerial and academic implications. These findings provide valuable guidance for identifying the mechanisms to improve the disaster preparedness of Saudi government organizations.

## II. METHODOLOGY

The questionnaire was constructed in several sections to obtain information on the emergency response framework, to gather data on the organizational characteristics, and to investigate the views of the representatives of those organizations on the adequacy of the various entities' responses to the 2009 and 2010 Jeddah floods. The survey commenced with respondents' demographic details and position in the organization. The second part of the questionnaire, which concerned only the information sought allowed for a range of factual responses, from open or non-directed, to closed, yes/no answers. It was constructed by numbered sections as follows:

1-Organisation profile (5 questions), 2-Risk assessments (6 questions), 3-Policy and planning (4 questions), 4-Training (4 questions), 5- Government structures (15 questions), 6-Non-government and Red Crescent input (12 questions), 7-Disaster relief resources (17 questions), 8-Funding (6 questions), 9-International assistance (10 questions), 10-Strengths and weaknesses of current plan (7 questions). The third part of the questionnaire used a series of independent and dependent variables regarding respondents' views of factors regarding emergency response. These were based on a 5-point Likert

scale, 1 (excellent) to 5 (poor). The dependent variables were: 11-Response time (3 questions), 12-Duration of response (3 questions), 13-Adequate emergency teams (3 questions), 14-Cost efficiency (3 questions). The independent variables were: 15-Funding (3 questions), 16-Human resources (3 questions) 17-Training (3 questions), 18-Coordination between responsible organizations (4 questions). Other questions: 19 Opportunities for improvement (19 questions).

## III. DATA COLLECTION

There were 40 possible disaster management respondents in various agencies and organizations in Jeddah and after initial contact to establish researcher's credentials, the purpose and ethics of the study, these questions were sent to a central contact point in each organization for responses by an organizational representative. Thus, the research comprised a population of public entities, rather than a sample of respondents from each of the relevant organizations. This was considered acceptable, as the questions concerned public policy rather than respondents' views [8]. Of the 40 written surveys delivered in August 2012, 27 (79%) completed surveys were returned for analysis by October, 2012.

## IV. DEMOGRAPHICS

This section includes the ages, qualifications, and work experiences of the participants. The age profile is shown at Table II.

TABLE II  
AGE PROFILE OF STUDY PARTICIPANTS

| Age level (years) | Frequency and percentage |
|-------------------|--------------------------|
| < 30              | 2 (6%)                   |
| 30-40             | 3 (10%)                  |
| 41-50             | 20 (68%)                 |
| 51>               | 2 (6%)                   |
| Not shown         | 3 (10%)                  |
| Total             | 30 (100%)                |

Given the youthful profile of the Kingdom, it was surprising that 20 of the 30 respondents (68%) were aged from 40 to 49 years and this was reflected in the participants' years of experience, 16-20 years (Table III). Arguably, this is an indication that the offices were established during that period (1990s), as public servants have their jobs for life.

The following Table IV shows that all the respondents were university graduates and that a majority (47%) had Master's degrees. Further, seven (23%) of the respondents had further qualifications, either postgraduate studies in disaster management or higher degrees.

TABLE III  
WORK EXPERIENCE OF STUDY PARTICIPANTS

| Years of work experience | Frequency and percentage |
|--------------------------|--------------------------|
| <10                      | 2 (7%)                   |
| 11-15                    | 4 (13%)                  |
| 16-20                    | 19 (63%)                 |
| >21                      | 2 (7%)                   |
| Not shown                | 3 (10%)                  |
| Total                    | 30 (100%)                |

TABLE IV  
QUALIFICATIONS OF STUDY PARTICIPANTS

| Qualifications       | Frequency and percentage |
|----------------------|--------------------------|
| Secondary school     | 0 (0%)                   |
| Bachelor's degree    | 6 (20%)                  |
| Master's             | 14 (47%)                 |
| Other qualifications | 7 (23%)                  |
| Not shown            | 3 (10%)                  |
| Total                | 30 (100%)                |

The Methodology section above outlined the nature of the questions. This section presents the responses of the questions using a 5-point Likert scale of 1= poor, 2 = fair, 3 = good, 4 = very good, and 5 = excellent. The results are compared and discussed in next section.

#### V. QUALITY OF RESPONSE (DEPENDENT VARIABLES)

These questions asked for the participant's response in relation to the lead disaster response agency for the Kingdom, the Civil Defense Organization. Each question required a response for years 2009 and 2010. The results are presented in Table V.

TABLE V  
QUALITY OF RESPONSE OF CIVIL DEFENSE ORGANIZATION

| Year | Item           | W. A.<br>n=30 | S.D.  | Ranking |
|------|----------------|---------------|-------|---------|
| 2009 | Response time  | 2.778         | 1.500 | 1       |
|      | Efficiency     | 2.776         | 1.066 | 2       |
|      | Resources      | 1.949         | 1.000 | 4       |
|      | Cost structure | 1.998         | 1.333 | 3       |
| 2010 | Response time  | 2.001         | 1.100 | 3       |
|      | Efficiency     | 2.112         | 1.033 | 1       |
|      | Resources      | 1.991         | 1.333 | 4       |
|      | Cost structure | 2.111         | 1.666 | 2       |
| 2009 |                | 2.375         | 1.224 |         |
| 2010 |                | 2.530         | 1.283 |         |

Table V shows four dependent variables depicting the study participants' views regarding the quality of the item relating to emergency responses from Civil Defence organization to the Jeddah floods in 2009 and 2010. The participants were less satisfied with these responses for the 2009 the weighted average at 2.375 and standard deviation 1.224, than the comparable 2010 weighted average, 2.530, and S.D. of 1.283. Other results for 2009 flood disaster showed that the variable *response time* was of primary interest to the participants (W.A. 2.778, S.D. 1.500), followed by *efficiency* (W.A. 2.776, S.D. 1.066), *cost structure* (W.A. 1.998, S.D. 1.333), and *resources available*, (W.A. 1.949, S.D. 1.000). The 2010 results, on the other hand, ranked variables *efficiency* (W.A. 2.112, S.D.1.0333), *cost structure* (W.A. 2.111, S.D. 1.666), *response time* (W.A. 2.001, S.D. 1.100) and then *resources available* (W.A. 1.991, S.D. 1.333) as the least important factor. The next organization examined was the Red Crescent. It is the lead agency in administering medical aid for the Kingdom, working with the ambulance services and the hospitals. Each of these items asked for the participant's views on the quality of Red Crescent's response for 2009 and 2010.

The results are presented at Table VI.

TABLE VI  
QUALITY OF RESPONSE OF RED CRESCENT

| Year | Item           | W.A.<br>n=30 | S.D.  | Ranking |
|------|----------------|--------------|-------|---------|
| 2009 | Response time  | 2.500        | 1.581 | 1       |
|      | Efficiency     | 1.889        | 1.666 | 4       |
|      | Resources      | 1.904        | 1.833 | 3       |
|      | Cost structure | 2.000        | 1.003 | 2       |
| 2010 | Response time  | 3.166        | 0.888 | 2       |
|      | Efficiency     | 3.500        | 0.667 | 1       |
|      | Resources      | 2.833        | 1.007 | 3       |
|      | Cost structure | 2.333        | 1.223 | 4       |
| 2009 |                | 1.999        | 1.594 |         |
| 2010 |                | 2.958        | 0.946 |         |

Table VI shows the analysis of participants' views of the Red Crescent and the quality of its response to the flood events of 2009 and 2010. The results show that participants were less satisfied with these responses for the 2009 flood, with the W.A. at 1.999 and S.D. 1.564, than the comparable 2010 W.A., 2.985, and S.D. 0.946. Other results for 2009 flood disaster show that the variable *response time* was ranked of interest (W.A. 2.500, S.D. 1.581); followed by *cost structure* (W.A. 2.000, S.D. 1.003), *resources available* (W.A. 1.903, S.D. 1.333); and of less interest, *efficiency* (W.A. 1.889, S.D. 1.666). For the 2010 flood event, the rankings were *efficiency* (W.A. 3.500, S.D. 0.667), followed by *response time* (W.A. 3.166, S.D. 0.888) resources available (W.A. 2.833, S.D. 1.007); and finally cost structure (W.A. 2.333, S.D. 1.223).

Local and national emergency response groups provide immediate relief in the event of an emergency in their neighborhoods. The participants were asked for their views on the ad hoc groups' responses in 2009 and again in 2010 (Table VII). Table VII depicts the respondents' views on the standards for local response groups to the Jeddah floods in 2009 and 2010. The participants were less satisfied with these responses for the 2009 event (W.A. 1.707, S.D. 1.553) compared to 2010 (W.A. 3.216, S.D. 1.219). Ranked results for the 2009 event show that the variable cost structure was of statistical interest (W.A. 2.168, S.D. 1.366); followed by resources available (W.A. 1.966, S.D. 1.402), response time (W.A. 1.833, S.D. 1.353), and efficiency (W.A. 1.666, S.D. 1.290). Other results for the 2010 flood disaster show that response time ranked first (W.A. 3.833, S.D. 0.957), then resources available (W.A. 3.300, S.D. 1.002) efficiency (W.A.3.166, S.D. 1.033) and last, cost structure (W.A. 2.566, S.D. 1.887).

TABLE VII  
 QUALITY OF RESPONSE OF LOCAL EMERGENCY GROUPS

| Year | Item           | W.A.<br>n=30 | S.D.  | Ranking |
|------|----------------|--------------|-------|---------|
| 2009 | Response time  | 1.833        | 1.353 | 3       |
|      | Efficiency     | 1.666        | 1.290 | 4       |
|      | Resources      | 1.966        | 1.402 | 2       |
|      | Cost structure | 2.168        | 1.366 | 1       |
| 2010 | Response time  | 3.833        | 0.957 | 1       |
|      | Efficiency     | 3.166        | 1.033 | 3       |
|      | Resources      | 3.300        | 1.002 | 2       |
| 2009 | Cost structure | 2.566        | 1.887 | 4       |
|      | Response time  | 1.707        | 1.553 |         |
| 2010 | Cost structure | 3.216        | 1.219 |         |

#### VI. QUALITY PREPARATION (INDEPENDENT VARIABLES)

The independent variables, those factors available to address disaster response before the event, were funding, people, training and coordination. These were questions for the study participants to respond in regards of the two lead organizations, the Civil Defense Organization and the Red Crescent, and also ad hoc emergency response groups. These questions were answered using a 5-point Likert scale of 1= poor, 2 = fair, 3 = good, 4 = very good, and 5 = excellent. The results are compared and discussed in next section.

The first table in this section, Table VIII, shows analysis of participants' responses to items critical to the country's preparation to respond to a crisis, and this is for the lead agency, Civil Defense Organization.

TABLE VIII  
 PREPARATION FOR DISASTER RESPONSE BY CIVIL DEFENSE ORGANIZATION

| Year | Item         | W.A.<br>n=30 | S.D.  | Ranking |
|------|--------------|--------------|-------|---------|
| 2009 | Funding      | 2.000        | 1.445 | 4       |
|      | People       | 4.000        | 0.305 | 3       |
|      | Training     | 5.000        | 0.101 | 1       |
|      | Coordination | 5.000        | 0.112 | 2       |
| 2010 | Funding      | 2.000        | 1.433 | 4       |
|      | People       | 5.000        | 0.110 | 1       |
|      | Training     | 5.000        | 0.117 | 2       |
| 2009 | Coordination | 5.000        | 0.201 | 3       |
|      | Funding      | 4.000        | 0.490 |         |
| 2010 | Coordination | 4.250        | 0.436 |         |

Again there are four variables for the participants' response for this section of the analysis on the lead agency, Civil Defence Organisation, and again the respondents were found to be mildly less satisfied with preparations for the 2009 flood event (W.A. 4.000, S.D. 0.490) than 2010 (W.A. 4.250, S.D. 0.436), with more people being available in 2010. Other results for the 2009 flood disaster preparation show that the variables *training* (5.000, S.D. 0.101) and *coordination* (W.A. 5.000, S.D. 0.112) as of significance, followed in ranking by *people availability* (W.A. 4.000, S.D. 0.305), and last, *funding* (W.A. 2.000, S.D. 1.445). Analysis of participants' views on preparations for 2010, with the exception of *funding*, were fairly uniform: *people* (W.A. 5.000, S.D. 0.110), *training* (W.A. 5.000, S.D. 0.117), and *coordination* (W.A. 5.000, S.D.

0.201). *Funding* in the disaster planning phase, as noted, was last (W.A. 2.000, S.D. 1.433).

TABLE IX  
 PREPARATION FOR DISASTER RESPONSE BY RED CRESCENT

| Year | Item         | W.A.<br>n=30 | S.D.  | Ranking |
|------|--------------|--------------|-------|---------|
| 2009 | Funding      | 2.000        | 1.414 | 4       |
|      | People       | 4.000        | 0.998 | 3       |
|      | Training     | 5.000        | 0.301 | 2       |
|      | Coordination | 5.000        | 0.112 | 1       |
| 2010 | Funding      | 2.000        | 1.512 | 4       |
|      | People       | 5.000        | 0.222 | 2       |
|      | Training     | 5.000        | 0.189 | 1       |
| 2009 | Coordination | 5.000        | 0.300 | 3       |
|      | Funding      | 4.000        | 0.706 |         |
| 2010 | Coordination | 4.250        | 0.555 |         |

As Table IX shows, there are four variables analyzed to report study participants' views regarding emergency response by Red Crescent to the Jeddah floods in 2009 and 2010. The participants were somewhat less satisfied with Red Crescent's preparations before the 2009 floods (W.A. 4.000, S.D. 0.706) than compared to preparations for 2010 (W.A. 4.250, S.D. 0.555). Rankings for preparation reported by the study participants were similar for *coordination* (W.A. 5.000, S.D. 0.112) and *training* (W.A. 5.000, S.D. 0.301), followed by *people availability* (W.A. 4.000, S.D. 0.998) and last, *funding* (W.A. 2.000, S.D. 1.414). For preparation in the next year, the study participants viewed *training*, *people* and *coordination* similarly (W.A. 5.000; S.D.s 0.189, 0.222 and 0.300 respectively). However, funding preparation gained their disapproval yet again (W.A. 2.000, S.D. 1.512).

The last set of questions concerned local emergency response groups and their preparation. As ad hoc organizations which were formed when a response was necessary, respondents' views obviously reflected different groups. Nevertheless, their responses were an indicator of the community's risk awareness and capacity to respond (Table X).

The responses from the participants were relatively unchanged between 2009 (W.A. 4.991, S.D. 0.095) and 2010 (W.A. 4.908, S.D. 0.137), although there was slightly less satisfaction for the 2010 preparation for the groups. Otherwise, the 2009 rankings for groups' preparation were people, training and coordination (W.A. 5.00 and S.D.s respectively 0.003, 0.011 and 0.022) with funding obviously last (W.A. 4.966, S.D. 0.344), as ad hoc groups were volunteers. Similarly, 2010 group preparation was people, coordination and training (W.A. 5.00 and S.D.s respectively 0.004, 0.014 and 0.110), signifying less training preparation.

TABLE X  
PREPARATION FOR DISASTER RESPONSE BY LOCAL GROUPS

| Year | Item         | W.A.<br>n=30 | S.D.  | Ranking |
|------|--------------|--------------|-------|---------|
| 2009 | Funding      | 4.966        | 0.344 | 4       |
|      | People       | 5.000        | 0.003 | 1       |
|      | Training     | 5.000        | 0.011 | 2       |
|      | Coordination | 5.000        | 0.022 | 3       |
| 2010 | Funding      | 4.633        | 0.422 | 4       |
|      | People       | 5.000        | 0.004 | 1       |
|      | Training     | 5.000        | 0.110 | 3       |
| 2009 | Coordination | 5.000        | 0.014 | 2       |
|      |              | 4.991        | 0.095 |         |
| 2010 |              | 4.908        | 0.137 |         |

#### VII. PRIORITIES FOR EMERGENCY RESPONSE PLANNING

The respondents were asked their views on elements for improving the country's emergency response. Again a 5-point Likert scale was used of 1 = disagree strongly, 2 = disagree, 3 = neutral, 4 = agree, and 5 = agree strongly. The results are shown at Table XI and discussed in next section.

TABLE XI  
RESPONDENTS' PRIORITIES ON EMERGENCY RESPONSE PLANNING ELEMENTS

| Item                                    | W.A.<br>n=30 | S.D.  | Ranking |
|---|--------------|-------|---------|
| Communications                          | 4.833        | 0.498 | 6       |
| Existing plan unchanged                 | 00           | 00    | --      |
| Coordinate all organisations            | 4.933        | 0.401 | 4       |
| Organisational training                 | 5.000        | 0.001 | 1       |
| Public awareness                        | 4.900        | 0.321 | 5       |
| Experienced resources                   | 4.500        | 0.603 | 7       |
| Community preparedness                  | 4.966        | 0.399 | 3       |
| Policy making                           | 4.066        | 0.723 | 11      |
| Infrastructure                          | 4.166        | 0.643 | 10      |
| Organisational preparedness             | 4.333        | 0.334 | 8       |
| Finance                                 | 3.866        | 0.767 | 15      |
| International advice                    | 3.300        | 0.987 | 17      |
| Public preparedness                     | 4.333        | 0.311 | 9       |
| Interorganisational responsibilities    | 5.000        | 0.012 | 2       |
| Interorganisational information sharing | 3.933        | 0.712 | 14      |
| Interorganisational communications      | 3.766        | 0.822 | 16      |
| Interorganisational practices           | 4.000        | 0.664 | 13      |
| Physical resources                      | 4.000        | 0.643 | 12      |
| Average                                 | 3.889        | 0.465 |         |

Rankings shown in Table XI indicate that emergency response policy makers and administrators viewed training of response teams across all organizations (W.A. 5.000, S.D. 0.001) as vital for future preparedness of the country to respond to floods or other disasters. This was followed by defining the responsibilities of each group in the response system (W.A. 5.000, S.D. 0.012) to ensure they were allocating their resources to the greatest effect. Next was community preparedness (W.A. 4.966, S.D. 0.399), followed by coordination of all response organizations (W.A. 4.933, S.D. 0.401) communications (W.A. 4.833, S.D. 0.498), and at priority 5, public awareness (W.A. 4.900, S.D. 0.321). Of least interest was to leave the system as it was, which attracted no answers, and to increase international advice and input W.A.

3.300, S.D. 0.987). Due to the number of choices, the average agreement to all the items was low (W.A. 3.889, S.D. 0.465).

#### VIII. CONCLUSIONS

Jeddah flood disaster in 2009 was a good lesson for all government authorities and agencies to revise their natural disaster management plans. It is important for all agencies, entities and organizations to learn from past experience and implement plans for interventions and management. Based on our findings, the participants were overwhelmingly in agreement on the top five areas for future attention: training of response teams, identification and coordination of the organizational responsibilities, community awareness and preparedness. Disaster mitigation was found to be very important for the representatives of public authorities. They felt that the population acknowledged the risk of natural and human-initiated disasters, and were generally responsive to disaster threats, but lacked community-based organization. Participants are willing to accept improved disaster management policy changes. However, one-quarter of the respondents avoided to commit on their own training in an emergency capacity, although the remaining three-quarters were positive in their responses to performance enhancing training opportunities. Continually training responders with best practices and preparedness is paramount to successful disaster crisis prevention and management. The recommendations from this finding is that further research is necessary to follow the progress of policy initiatives, including a well-coordinated organization that can be established to manage disaster responses among the population in the event of flood or further such disturbance.

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