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## RESEARCH ARTICLE

### DISASTER RISK MANAGEMENT IN KINGDOM OF SAUDI ARABIA – CURRENT PRACTICES AND WAY FORWARD FOR SUSTAINABLE DEVELOPMENT

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#### ABSTRACT

Recently, rising frequency and severity of disasters, occurring primarily due to climate change, emphasize the need for policy, legal, technical, financial and institutional measures aimed at minimizing detrimental impacts of disasters. This entails comprehensive review of Disaster Risk Management (DRM) including mitigation, preparedness, emergency response, recovery, rehabilitation and reconstruction. Modern concepts and practices entail a paradigm shift in approach to handling disasters from 'response centric' to 'proactive' risks management, leading to disaster-resilient development, integrated response capability and enhanced awareness in the societal context. The Kingdom of Saudi Arabia (KSA) has diverse topography, complex climate change pattern and historic profile of multifaceted disasters. The North western region is prone to earthquakes and volcanic hazards, the central and western region to floods, the south west mountainous region to landslides and the central and eastern regions to dust storms. KSA is confronting enormous challenges including, lack of formal training, professional expertise and coordination among various stakeholders. This coupled with the absence of hazard risk assessment, mapping or micro-zoning, building / services guidelines, specifications, codes, etc. further aggravates the situation. This paper evaluates the state of vulnerability, preparedness and management of disasters in KSA with a view to recommend way forward for sustainable development. The study presents the results of questionnaire surveys primarily aimed at assessing awareness of the community and preparedness of the DRM organizations. It recommends way forward including framework for establishment of DRM institute for indigenous capacity building.

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#### INTRODUCTION

Natural disasters are not restricted to political boundaries, they are borderless, impacting both developing and developed countries resulting into enormous losses. The Kingdom of Saudi Arabia (KSA), with a surface area of 2,149,690 km<sup>2</sup> and population of 30.77 million (Al-Bassam, 2014), covers most of the Arabian Peninsula and is vulnerable to different types of disasters owing to its inherent geographic, topographic, climatic and environmental settings. Realizing the potential threat, Saudi Directorate General of Civil Defense along with some other organizations were raised to undertake planning, coordination and management of disasters. The enormous losses in recent disastrous events suggest that their capacity to manage disasters remain questionable, identifying the need for appropriate institutional framework, enhanced professional expertise and resource optimization.

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Whereas, the absence of hazard risk assessment, mapping or micro-zoning, building / services guidelines, specifications, codes, etc. further aggravates the situation. Over the past few decades, the impacts of disaster have escalated rapidly which has greatly affected almost all of the countries across the globe. The disasters have killed 0.7 million people, injured more than 1.4 million, made 23 million homeless, overall affecting 1.5 billion, and caused over US\$ 1.3 trillion in economic losses ([http://www.wcdrr.org/uploads/Sendai\\_Framework\\_for\\_Disaster\\_Risk\\_Reduction\\_2015-2030.pdf](http://www.wcdrr.org/uploads/Sendai_Framework_for_Disaster_Risk_Reduction_2015-2030.pdf) on August 26, 2016.). It is contemplated that reasons behind enhanced disaster impact is mainly owing to increase in population vis-a-vis changed land used pattern, global climatic changes and the resulting environmental degradation. Consequently, the concept of Disaster Risk Management (DRM) is evolved to ascertain and reduce the damages due to disasters through systematic and institutional approach. The entire spectrum of DRM, i.e. prior, during and in the aftermath of disaster, is focused across social, economic, professional and governmental sectors.

The first ever guideline developed to prevent, mitigate and reduce the impact of disasters, known as Yokohama Strategy, was adopted in 1994. The gaps and challenges identified during the review of Yokohama Strategy lead to development of Hyogo Framework for Action (HFA) for the years 2005-2015. The successor to the HFA was Sendai Framework for Disaster Risk Reduction (SFDRR) 2015-2030, adopted at the Third UN World Conference in Sendai, Japan, on March 18, 2015. The common rules for management, legal mandates and plans needs to be developed, as articulated in the 2005 Hyogo Framework for Action and Sendai Framework for Disaster Risk Reduction (IFRC & UNDP, 2014; United Nations International Strategy for Disaster Reduction, 2005; [http://www.wcdrr.org/uploads/Sendai\\_Framework\\_for\\_Disaster\\_Risk\\_Reduction\\_2015-2030.pdf](http://www.wcdrr.org/uploads/Sendai_Framework_for_Disaster_Risk_Reduction_2015-2030.pdf) on August 26, 2016.).

The study aims at enhancing capacity of the Kingdom for sustainable construction by assessing the current state of practice and identifying deficient areas so as to minimize the risks and develop resilience in society against natural and man-made disasters. The study presents the findings of questionnaires survey undertaken for assessing the state of community awareness and preparedness of the DRM related organizations. Based on synthesis of information, analysis and findings of the surveys, conceptual framework and guidelines for disaster risk management is presented. Besides, a mechanism and organizational framework for establishing National Disaster Risk Management Institute (NDRMI) is proposed for formal training and capacity building.

## Review of Disaster Risk Management

1. Disaster is a serious disruption of functioning of society, causing widespread human, material or environmental losses that exceed the ability of the affected people to cope using their own resources. The risk of such a disaster is the probability of damage and disruption to the community's structure or geographic area by the impact of a particular hazard, on account of their nature, construction and proximity to a hazardous area. To mitigate the adverse impacts of disasters, DRM is undertaken which is defined by United Nation International Strategy for Disaster Reduction (UNISDR, 2009) as "The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster" (<https://www.unisdr.org/we/inform/terminology#letter-d> on May 27, 2016.). DRM encompasses all actions taken before, during and after the disasters and includes activities concerning mitigation, preparedness, emergency response, recovery, rehabilitation and reconstruction. The DRM mainly encompass three phases; prior, during and post disaster. The pre-disaster process essentially comprises four steps; risk identification, risk prevention / mitigation, risk transfer and preparedness. The identification of risks involve assessment and understanding of the hazards, which include exposure of the public, construction and economic activities to these hazards. The information obtained from the hazard assessment are integrated in risk analysis to estimate the probabilities of expected loss for a given disaster. With the identification of risks and assessment of potential impacts of the past events, decisions can be taken towards prevention / mitigation of the

potential impacts of the future disasters. Whereas, the risks transfer, involves the use of financial mechanism such as insurance that allows risks to be shared and redistributed. Finally, preparedness involves building an emergency response and management capability before a disaster occurs. The during and post-disaster process comprises, emergency response, rehabilitation and reconstruction. Emergency response involves actions taken immediately before, during and after the inception of a major disaster to minimize the losses to life and property and thereby enhance the effectiveness of recovery. The emergency response is further divided into rescue, relief and recovery. Rehabilitation and reconstruction activities include programs for long term assistance to disaster affected communities so as to enable them to return to the pre-disaster condition. This includes repairing and reconstructing buildings, infrastructures and lifelines in the affected areas besides restoring and coordinating necessary community services.

Since disasters are beyond human control and are recurring events with variation in magnitude, complexity and severity, the community / society must understand and recognize the risks and impacts of disasters and explore modern ways / technologies to cope with them. Also, disasters do not respect borders thereby making all countries across the globe equally vulnerable necessitating partnership amongst countries for a safer world. This disaster risk reduction is not only a cost effective investment but also a contributor to sustainable development. In the aim of sustainable development and reducing impacts of disasters, state members of United Nations along with other states developed "Yokohama Strategy and Plan of Action for a safer World" at the World Conference on Natural Disaster Reduction in Yokohama, Japan in 1994. The Yokohama Strategy was implemented in the member states and its progress was reviewed which revealed gaps and challenges relating to governance, risk management, capacity building and human resource development (Retrieved from <http://www.unisdr.org/we/inform/publications/8241> on August 26, 2016.).

In order to address these issues, "Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters" was adopted during The World Conference on Disaster Reduction held in 2005 in Kobe, Hyogo, Japan. The strategic goals of HFA were to enhance integration of DRM into sustainable development policies, framework at all levels; development and strengthening of institutional mechanism and capacity building; and systematic incorporation of risk reduction approaches into emergency management and recovery (United Nations International Strategy for Disaster Reduction, 2005). The implementation of Hyogo Framework for Action resulted in achieving disaster risk reduction at local, national, regional and global levels. Overall, it raised public and institutional awareness, increased political commitment, extended international coordination & partnership development and enhanced stakeholder participation (United Nations International Strategy for Disaster Reduction, 2015). However, its implementation also highlighted gaps in addressing the underlying disaster risk factors, formulation of goals and prioritization of actions, fostering disaster resilience at all levels and ensuring proper implementation. The review of HFA further revealed that for disaster risk reduction, existing and future challenges need to be addressed with focus on monitoring, assessing and

understanding disaster risk and sharing such information; strengthening disaster risk governance and institutional coordination with enhanced stakeholder participation at appropriate levels; increased community resilience through investment in the economic, social, health, cultural and educational sectors as well as through technology and research; enhanced multi-hazard early warning systems, preparedness, response, recovery, rehabilitation and reconstruction; extended international cooperation to complement national action and capacity. These gaps signified the importance of development of an action-oriented framework that can be implemented by Governments and relevant stakeholders in a supportive and complementary manner to identify disaster risks and to improve resilience. The present Framework called as The Sendai Framework for Disaster Risk Reduction 2015-2030 applies to the risk of every scale, recurrent and non-recurrent, unexpected and gradual disasters, natural or man-made, as well as related environmental, technological and biological hazards and risks ([http://www.wcdrr.org/uploads/Sendai\\_Framework\\_for\\_Disaster\\_Risk\\_Reduction\\_2015-2030.pdf](http://www.wcdrr.org/uploads/Sendai_Framework_for_Disaster_Risk_Reduction_2015-2030.pdf) on August).

#### The primary objectives of a typical DRM include

- Develop resilience in society against disasters.
- Minimize damages from recurring disasters through sustainable development.
- Reduce disaster risks and vulnerabilities.
- Develop institutional framework, defining roles & responsibilities of stakeholders.

DRM requires a policy consideration and an operational framework. The DRM policy framework generally encompasses:

- Strengthening DRM at all levels, i.e., national, regional and district.
- Enhancing DRM system for all stages, pre-, during, and post disaster.
- Establishing mechanism for early warning, monitoring and assessment.
- Mainstreaming disaster risk reduction into infrastructure development.
- Human resource development and capacity building of all stakeholders.

#### Disaster Profile of KSA

Saudi Arabia has experienced numerous disastrous situations and remains vulnerable to a variety of natural and man-made hazards that threaten the lives and livelihood of its citizens. These include floods, earthquakes, volcanoes, tsunami, cyclones, sand storms, landslides / rockfall etc. besides human induced disasters such as fires, collapse of structures, terrorist acts, industrial / chemical related accidents, epidemics, transport accidents and other complex emergencies.

**Geography:** The geography of Saudi Arabia is varied, from coastal regions in the eastern and western parts, to mountainous regions in the south-west, and finally to the Rub' al Khali desert in the South where almost no population exists. KSA is divided into 13 regions each having its own capital and further divided into governorates (Wikipedia, 2016). The map of Kingdom of Saudi Arabia is shown in Figure 1.

- **Desert region** - characterized by desert and sand storm.
- **Mountainous region** - characterized by flash floods and landslides.
- **Coastal Belts** - vulnerable to Cyclones and Tsunamis.
- **Common to All** - fires, collapse of structures, terrorist acts, industrial / chemical related accidents, epidemics, transport accidents.

#### Significant Disasters in KSA

KSA has experienced numerous devastating events, suffering enormous human and material losses. Saudi Geological Survey (SGS) describes floods, rock falls and ground collapse as the most frequent geological hazards affecting the Kingdom whereas volcanic eruptions and damaging earthquakes are potential hazards but occur relatively infrequently (<http://www.sgs.org.sa/English/NaturalHazards/Pages/default.aspx> on August 26, 2016.). The top 10 disasters in Saudi Arabia till August 2016 sorted by the number of killed and number of affected are shown in Table 1 & Table 2. A chronological list of all the disaster events that have affected the Kingdom are listed in Table 3, whereas salient aspects of various disasters are briefly summarized in succeeding sub paragraphs.

#### Flood

Floods are the most frequent events in the country that account for 7 of the 10 most damaging disasters between 1900 and 2010 despite the fact that rains have been relatively scarce in Saudi Arabia (Pararas-Carayannis, 2013). However, the country's vulnerability to floods has been actually linked to the infrequency of floods, which resulted in the under-development of proper drainage systems in most cities. A statistical analysis of natural hazards in Saudi Arabia between 1982 and 2005 showed that the most frequent hazard type was floods with an average return period of 7 times per years with the average economic losses amounting to about 19 million USD per year (16).

The vulnerability of many important cities is enhanced owing to their location on lower elevations surrounded by mountains vis-a-vis poor drainage and increased rainfall intensity. Consequently, floods may become more frequent as a result of climate change, leading to huge economic losses. The Jeddah floods which occurred on the 25th of November, 2009 as a result of more than 90 mm of rainfall falling within a span of 4 hours was described as the worst in the past 27 years by the civil defense. More than 100 people died and about 350 people went missing along with business damages to the tune of 1 Billion Saudi Riyal (Al-Bassam *et al.*, 2014). The SGS is studying all those valleys across the Kingdom which are cause of flash floods with the aim to carry out detailed hydrological analysis and suggest remedial measures (<http://www.sgs.org.sa/English/NaturalHazards/Pages/default.aspx> on August 26, 2016.). However, the problem with urban drainage systems is still unattended.

#### Earthquake

The Peninsula is bounded by the Persian Gulf on its northeast side, the Red Sea on its west side, and the Arabian Sea, the Gulf of Aden, and the Indian Ocean to its east and south. Each of these areas is very different geographically and tectonically.

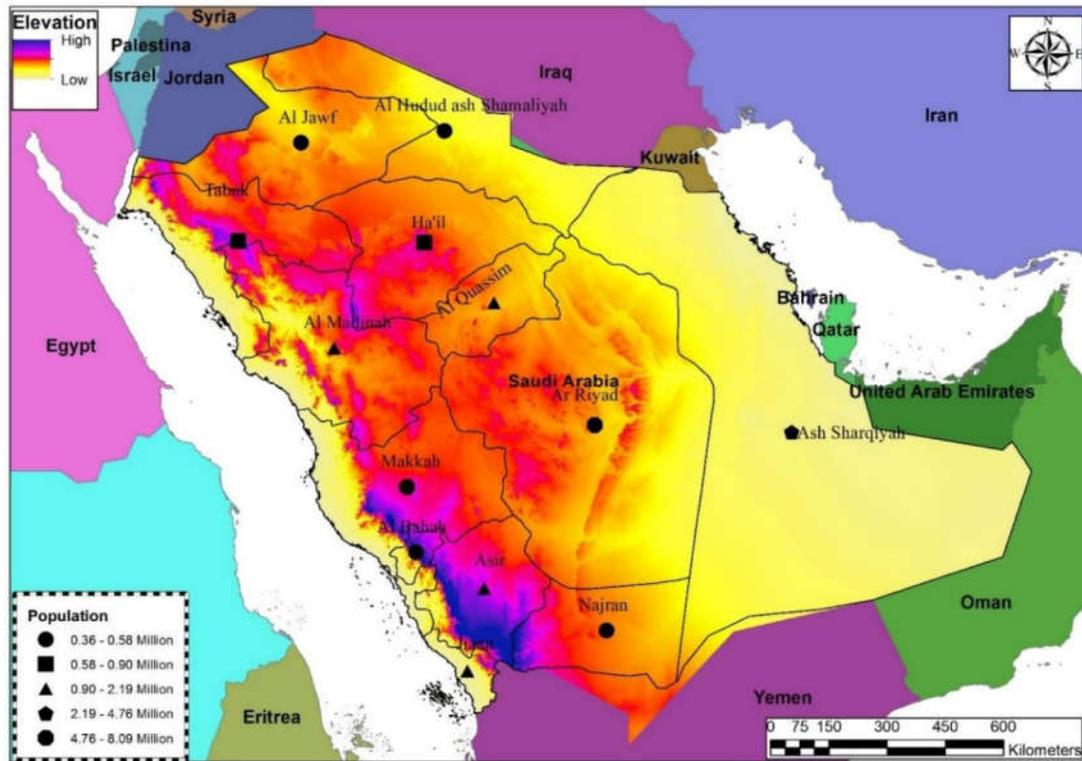


Figure 1. Map of the Kingdom of Saudi Arabia

Table 1. Top 10 disasters in Saudi Arabia up to August 2016 sorted by number of killed

Disaster Type	Date	No. of Killed	Reference
Stampede during Hajj	Sep, 2015	> 2,000	(Wikipedia, 2005)
Stampede during Hajj	Jul, 1990	1,426	(Robert, 2004)
Riots during Hajj	Jul, 1987	402	(Robert, 2004)
Stampede during Hajj	Jan, 2006	346	( <a href="http://news.bbc.co.uk/2/hi/middle_east/4606002.stm">http://news.bbc.co.uk/2/hi/middle_east/4606002.stm</a> on May 27, 2016.)
Fire during Hajj	Apr, 1997	343	(Robert, 2004)
Stampede during Hajj	May, 1994	270	(Robert, 2004)
Stampede during Hajj	Feb, 2004	251	(Robert, 2004)
Militant Occupation of Holy Mosque in Makkah	Nov, 1979	250	(Yassar, 2010)
Fire during Hajj	Dec, 1975	200	(Robert, 2004)
Flood	Nov, 2009	163	( <a href="http://www.emdat.be/country-profile">http://www.emdat.be/country-profile</a> on May 27, 2016)

Table 2. Top 10 disasters in Saudi Arabia up to August 2016 sorted by number of affected

Disaster Type	Date	No. of Affected	Reference
Earthquake	May, 2009	40,000	(Pallister, 2010)
Flood	Aug, 2003	13,000	( <a href="http://www.emdat.be/country-profile">http://www.emdat.be/country-profile</a> on May 27, 2016)
Flood	Nov, 2009	10,000	( <a href="http://www.emdat.be/country-profile">http://www.emdat.be/country-profile</a> on May 27, 2016)
Flood	Dec, 1985	5,000	( <a href="http://www.emdat.be/country-profile">http://www.emdat.be/country-profile</a> on May 27, 2016)
Stampede during Hajj	Sep, 2015	> 2,000	(Wikipedia, 2005)
Fire	Apr, 1997	> 1,500	(Robert, 2004)
Flood	2005	1,400	(Yassar, 2010)
Flood	Apr, 1964	1,000	( <a href="http://www.emdat.be/country-profile">http://www.emdat.be/country-profile</a> on May 27, 2016)
Flood	Apr, 2016	915	( <a href="http://english.alarabiya.net/en/News/middle-east/2016/04/14/Heavy-rains-flooding-kill-18-people-in-Saudi-Arabia.html">http://english.alarabiya.net/en/News/middle-east/2016/04/14/Heavy-rains-flooding-kill-18-people-in-Saudi-Arabia.html</a> on May 27, 2016.)
Flood	May, 2013	900	( <a href="http://www.emdat.be/country-profile">http://www.emdat.be/country-profile</a> on May 27, 2016)

Most of the earthquakes occur along the collision boundaries of the Arabian Plate, which reduces potential vulnerability of KSA, being located in the center of the Peninsula (Al-Bassam *et al.*, 2014). In the past major earthquakes occurred along the Zagros mountain range, and did not have an impact on Saudi Arabia. The latest recorded earthquake occurred near the Gulf of Aquaba along the Jordan-Saudi border on 8 October 2012.

Its magnitude was only 3.9 and its focal depth was 8 km (Al-Bassam *et al.*, 2014). North western Saudi Arabia experienced 19 earthquakes of magnitude 4 or greater during April - June 2009. The maximum recorded magnitude was 5.4 on Richter Scale, which caused minor structural damages in the town of Al-Eis about 40 km from the city of Madinah (Pallister *et al.*, 2010).

Table 3. Disasters causing major damages in KSA

Disaster Type	Date	No. of Affected	No. of Killed	Effect Estimates	Reference
Heavy Rains	Apr, 1964	1,000	20	NDA	( <a href="http://www.emdat.be/country-profile">http://www.emdat.be/country-profile</a> on May 27, 2016)
Fire during Hajj	Dec, 1975	NDA	200	NDA	(Robert, 2004)
Militant Occupation of Holy Mosque in Makkah	Nov, 1979	600	250	NDA	(Yassar, 2010)
Ras al-Khaffi thunderstorm	Oct, 1982	NDA	11	NDA	(Yassar, 2010)
Floods in North-Western Saudi	Dec, 1985	5,000	32	\$450,000	( <a href="http://www.emdat.be/country-profile">http://www.emdat.be/country-profile</a> on May 27, 2016)
Iranian Riots during Hajj	Jul, 1987	649	402	NDA	(Robert, 2004)
Bomb Explosion during Hajj	Jul, 1989	16	1	NDA	(Robert, 2004)
Stampede inside Pedestrian Tunnel during Hajj	Jul, 1990	NDA	1,426	NDA	(Robert, 2004)
Stampede at Jamaraat during Hajj	May, 1994	NDA	270	NDA	(Robert, 2004)
Bomb Explosion at Khobar Tower in Dhahran, eastern Saudi Arabia	Jun, 1996	555	19	NDA	(Yassar, 2010)
Yanbu flood	Jan, 1997	NDA	10	More than 130,000 km <sup>2</sup> of land damaged.	(Yassar, 2010)
Asir flood	Mar, 1997	NDA	16	Around 100,000 km <sup>2</sup> of land damaged.	(Yassar, 2010)
Fire during Hajj	Apr, 1997	> 1,500	343	NDA	(Robert, 2004)
Stampede at Jamaraat during Hajj	Apr, 1998	298	118	NDA	(Robert, 2004)
Epidemic	Mar, 2000	NDA	57	NDA	( <a href="http://www.emdat.be/country-profile">http://www.emdat.be/country-profile</a> on May 27, 2016)
Rift Valley Fever	Sep, 2000	500	87	NDA	( <a href="http://www.emdat.be/country-profile">http://www.emdat.be/country-profile</a> on May 27, 2016)
Epidemic	Feb, 2001	NDA	35	NDA	( <a href="http://www.emdat.be/country-profile">http://www.emdat.be/country-profile</a> on May 27, 2016)
Stampede at Jamaraat during Hajj	Mar, 2001	NDA	35	NDA	(Robert, 2004)
Flood in Makkah	Apr, 2002	NDA	19	NDA	( <a href="http://www.emdat.be/country-profile">http://www.emdat.be/country-profile</a> on May 27, 2016)
Disaster Type	Date	No. of Affected	No. of Killed	Effect Estimates	Reference
Stampede at Jamaraat during Hajj	Feb, 2003	NDA	14	NDA	( <a href="http://news.bbc.co.uk/2/hi/middle_east/2749231.stm">http://news.bbc.co.uk/2/hi/middle_east/2749231.stm</a> on May 27, 2016.)
Bombing in Riyadh	May, 2003	228	34	NDA	(Yassar, 2010)
Flood	Aug, 2003	NDA	13,000	NDA	( <a href="http://www.emdat.be/country-profile">http://www.emdat.be/country-profile</a> on May 27, 2016)
Flood in Makkah	Nov, 2003	62	12	NDA	( <a href="http://www.emdat.be/country-profile">http://www.emdat.be/country-profile</a> on May 27, 2016)
Stampede at Jamaraat during Hajj	Feb, 2004	495	251	NDA	(Robert, 2004)
Jizan Floods	Apr, 2004	430	5	Destroyed 2,680 Km <sup>2</sup> of houses, lands and roads.	(Yassar, 2010)
Flood in Riyadh	2005	1,400	7	NDA	(Yassar, 2010)
Flood in Madinah	Jan, 2005	NDA	29	NDA	( <a href="http://www.emdat.be/country-profile">http://www.emdat.be/country-profile</a> on May 27, 2016)
Flood	Apr, 2005	NDA	34	NDA	( <a href="http://www.emdat.be/country-profile">http://www.emdat.be/country-profile</a> on May 27, 2016)
Hotel Collapse during Hajj	Jan, 2006	140	76	NDA	(Mohamed, 2008 )
Stampede at Jamaraat during Hajj	Jan, 2006	635	346	NDA	( <a href="http://news.bbc.co.uk/2/hi/middle_east/4606002.stm">http://news.bbc.co.uk/2/hi/middle_east/4606002.stm</a> on May 27, 2016.)
Evacuation of People from the Harrat Lunayyir province due to Earthquake	May, 2009	40,000	-	NDA	(Pallister et al., 2010)
Jiddah Floods	Nov, 2009	>10,000	163	\$900,000	( <a href="http://www.emdat.be/country-profile">http://www.emdat.be/country-profile</a> on May 27, 2016)
Flood in Riyadh	May, 2010	NDA	2	275 Car crashes	(Yassar, 2010)
Flood	May, 2013	NDA	900	NDA	( <a href="http://www.emdat.be/country-profile">http://www.emdat.be/country-profile</a> on May 27, 2016)
Crane Collapse in Makkah	Sep, 2015	394	111	NDA	(Wikipedia, 2016)
Stampede during Hajj	Sep, 2015	950	>2000	1,250 are missing	(Wikipedia, 2015)
Flood	Apr, 2016	915	18	NDA	(Al Arabiya, 2016)

NDA = No Data Available

SGS is primarily responsible for monitoring of earthquakes across the Kingdom. SGS uses the earthquake database to predict recurrence of earthquakes of different magnitudes in areas of interest, from which statistical estimates of risk are derived. The location can then be placed in the correct zone or level in the building code so that appropriate methods of construction are used.

### Sand Storms

Dust storms and strong winds are also environmental hazards that occur frequently in the Arabian Peninsula. The dust originates mainly from the arid areas across the Arabian Peninsula and transported by the southwesterly winds towards the east (Ackerman, 1989). In recent years, major cities in Saudi Arabia were struck by dust storms, which disrupted road traffic, caused automobile accidents, downed trees, forced the closing of schools and brought public life almost to a standstill. Strong northwesterly winter winds, "Shamals", which blow over the Persian Gulf states are source of potential hazard. Dust storms are other potential and common natural hazards in Saudi Arabia and affect the daily life for short time interval. The most important issue with dust storms is the reduction of visibility that causes traffic accidents (Dayan, 1991; Kutiel and Furman, 2003). The frequency of sandstorms increases during the months of March, April and May. A dense wall of dust barreled across the Arabian Peninsula on March 26-27, 2011. The massive storm stretched for more than 500 kilometers across the Arabian Peninsula (Al-Bassam *et al.*, 2014).

### Landslides/ Rockfall

Most of the rock slopes along the descents between the Arabian Shield mountains and the Red Sea coast that cut through the escarpment are subject to slope instability and rock falls, especially after rain storms. It has been determined that landslides may be more devastating than all other natural hazards combined, and can affect utilities, transportation and infrastructure. The Saudi Geological Survey has reported that studies are underway to understand causes of landslides occurrence and prevention measures in order to mitigate the risks (<http://www.sgs.org.sa/English/NaturalHazards/Pages/default.aspx> on August 26, 2016.).

### Epidemics

In early September 2000, goats and sheep were found dead in some areas south of Saudi Arabia. Subsequently, reports of hemorrhagic fevers started to come from the same region and ultimately it was identified as Rift Valley Fever.

The Saudi Ministry of Health declared an epidemic, and advised citizens to wear mosquito repellants. At least 87 people died and more than 500 people were afflicted by this infection (Alamri, 2010).

### Stampedes / Others

Recently, grave incident of stampede took place in Mina during Hajj 2015, which caused over 2000 deaths, besides many suffered injuries and also remained unaccounted for. This also remains a potentially serious hazard since millions of pilgrims have to regularly visit KSA for performing Hajj and Umrah (2015).

## State of Disaster Risk Management in KSA

Several studies have also been undertaken by local and international researchers about disaster risk management in KSA. Floods have hit KSA many times but preparations to such disasters are still lacking due to serious coordination issues between various emergency management departments (Alamri, 2011). Similarly, Saudi decision makers and administrators responsible for disaster control in Jeddah strongly agree on need for training of response teams, identification and coordination of the organizational responsibilities, community awareness and preparedness (Abosuliman *et al.*, 2013). Likewise, community awareness and preparedness is critical to mitigate the adverse impact of disasters in KSA and therefore, community must assess its own disaster vulnerability and risks to develop specific strategies (Pararas-Carayannis, 2013). The establishment of early warning system linked with the relevant stakeholder organizations is extremely important so that disaster affected communities and relevant organizations can be timely warned (Momani, 2010).

### Organizations with Disaster related Responsibilities

Historically, the development of emergency management plans in Saudi Arabia started more than 80 years ago, and has been progressing slowly since then. The first nucleus of an emergency management body was a fire brigade that was formed in Makkah in 1927 (Ministry of Interior, 2001). Its purpose was to serve pilgrims that came to Makkah every year.

It was the first of its kind in Saudi Arabia, and it was managed by the Makkah Provincial Council. In 1948, the Makkah Fire Brigade joined the later-established Center of General Security to form the General Security and Fire Services. Over the following 32 years, the General Security and Fire Services grew to include other major cities of KSA as well. The organizations currently responsible for disaster risk management are discussed in the succeeding paragraphs:

### Directorate General of Civil Defense

In 1965, the General Security and Fire Services was dissolved, and instead General Directorate of Civil Defense (GDCD) was raised, which is currently the main organization responsible for DRM. The scope of the GDCD was wider than previous emergency management bodies because it was made the official body of civilian defense during peace and in times of instability. In 1987, GDCD's structure, goals and responsibilities were reformed. The current structure of the GDCD is divided into three levels: Board of GDCD, Executive Committee, and volunteers, each with well-defined role and responsibilities. The salient roles of GDCD in emergencies and wars are summarized as under (Alamri, 2010):

- Organizing and operating the national alarm system in cases of emergencies.
- Managing electrical power, and organizing evacuation and shelter plans.
- Extinguishing fires and rescuing civilians and providing basic life-support measures in affected areas.
- Marking areas afflicted by nuclear damage, and directing civilians away from them.

- Coordination with other governmental bodies to ensure safe transportation of civilians.

### **Makkah Area Crisis and Disaster Management Centre (MACDMC)**

The MACDMC is responsible for providing the necessary mechanisms to manage crises and disasters, monitoring performance, coordinating between various sectors and providing necessary information for fast decision-making to deal with disastrous situations. The Center is equipped with hi-tech communication and visual systems to manage any crisis. The MACDMC works in harmony with civil defense and other relevant sectors to ensure efficient performance and smooth coordination between various stakeholders. The representatives of various departments are attached with the center, including the governor's office, Municipality, Civil Defense, Police Department, Department of Health Affairs, Red Crescent and the Border Guard team. The center highlights the problems and issues to the representatives which help them in taking prompt action and developing contingency plan.

The center has operating rooms for analyzing data and running technical queries that enables provision of true and accurate information to media. The center is also equipped with an event management system to link up the systems of civil defense, traffic security patrol, meteorological department, etc. in one place. There are 20 main DRM stakeholders given in Annex A, which need to work in unison for optimum performance.

### **Saudi Red Crescent**

The Saudi Red Crescent offers emergent and fast medical service of first aid with a skill and effective result for citizens and residents in ordinary circumstances and at time of catastrophes. It has about 21 departments most prominent of which are emergency services department, mass media and awareness department, security and safety department, medical supply department, transportation and service department, training and human resource development, etc.

### **KSA Priorities in the Context of Hyogo Framework of Action & Sendai Framework for Disaster Reduction**

Saudi Arabia is also a signatory of the Hyogo Framework of Action (2005-2015) & Sendai Framework for Disaster Risk Reduction (2015-2030) signed by 168 countries that was introduced by the United Nations International Strategy for Disaster Reduction (UNISDR) with paradigm shift from a reactive to a proactive approach.

The vision, mission and priorities of the National Framework should be developed in harmony with the Sendai Framework for Disaster Risk Reduction 2015-2030, which was agreed by all nations at the Third UN World Conference on Disaster Reduction in Sendai, Japan, in March 2015. The expected outcome of SFDRR at the end of fifteen year period is "the substantial reduction of disaster losses, in lives and in the social, economic and environmental assets of communities and countries". KSA has prioritized its line of action as following;

- Make disaster risk reduction a priority.
- Know the risk and take action.

- Build understanding and awareness.
- Reduce risk.
- Preparedness for active action.

### **Questionnaire Survey**

#### **Overview**

Two survey questionnaires were developed to determine the state of community awareness and the preparedness of DRM organization. The focus of community awareness questionnaire was mainly on five areas and it was responded by 147 persons. Whereas, questionnaire pertaining to DRM organization had 19 questions, which was responded by 14 DRM stakeholder organizations. The results and analysis of the survey is presented in the succeeding paragraphs.

#### **Community Awareness Survey**

##### **Disaster related Knowledge**

The respondents mostly reported having knowledge of the disasters and about 84% even got a chance to acquire basic education about the nature of disasters. However, less than 30% reported having attended formal training. Whereas, majority of the community understands the importance of disseminating disaster related knowledge.

##### **Disaster Preparedness and Readiness**

The community showed immense confidence in the government that it has the capacity to extend requisite support in the event of any disaster. Whereas, around 90% believe that the Government will undertake post disaster reconstruction activities.

##### **Disaster Adaptation**

The community mostly lacks awareness about disaster prone and evacuation areas, whereas almost 50% even do not know about the organization to be contacted in the event of disaster. The majority also lacks concept of community participation in DRM activities.

##### **Disaster Awareness**

The majority of community believes that early recovery after disaster is crucial but they never participated in voluntary activities related to disaster awareness. As a result, 76% lack knowledge about requirement of emergency aid for disaster victims and retrofitting of disaster affected buildings.

##### **Disaster Risk Perception**

The community is generally sure that large-scale disasters could occur in next 10 years. Seventy nine percent of the respondents consider that their locality is not safe against disasters and even their buildings are not well designed to withstand earthquakes.

#### **DRM Stakeholder Organizations Survey**

##### **Probability of Occurrence and Vulnerability**

The disasters are most likely or likely to occur in the following order: fire, collapse of structures, terrorist acts, epidemics, cyclones, landslides / rockfalls, sand storms, floods and industrial accidents. Whereas, the damage potential of disasters is reported in the following order: floods, fire, epidemics, cyclone, collapse of structure, terrorist acts, earthquake, tsunamis, landslides / rockfalls, industrial accidents and sand storms.

### **State of Preparedness and Response**

The DRM organizations are either not prepared or the state of preparedness is below satisfactory for almost all disasters. Also, the planning to respond to various disasters is not satisfactory. The DRM Organizations are either not properly equipped or the state of equipment held is below satisfactory. Whereas, the level of DRM training is also reported unsatisfactory. The majority contemplated that in the present state of preparedness, organizations would not be able to respond efficiently.

### **Major Areas of DRM related concerns**

Majority of the stakeholders showed concern about budget allocations, community participation, community resistance towards adaption of codal formalities, DRM planning and coordination between various departments. Whereas, infrastructure lacks resilience against various disasters and the Multi-Hazard Early Warning & Dissemination Systems are virtually non-existent.

### **Need for DRM Plans**

The need for planning in the following areas are strongly endorsed: hazard mapping and urban planning, education and awareness, sufficient shelter, foods and cloths, antibiotics and medical kits, transportation of victims, community involvement and participation and early warning mechanism.

### **Salient Conclusions of the Questionnaire Surveys**

#### **Community Awareness**

The respondents of community awareness survey are generally confident about their knowledge of various disasters, but feel concerned about lack of formal education and training. This perception is reinforced by the DRM organizations. The community as well as DRM organizations have also reported that the existing infrastructure is not resilient enough to withstand various disasters.

#### **Community Perception about DRM Organizations**

The community is generally confident that the DRM organization would be able to manage any kind of disaster efficiently and also provide the requisite support during and post-disaster. Whereas, the DRM organizations reported that they are neither well prepared nor properly trained and equipped to manage various disasters, except fire.

#### **DRM Framework**

The respondents have shown serious concerns about institutional mechanism, coordination among various

stakeholders and lack of proper planning to handle disasters. DRM organizations strongly endorsed for hazard mapping, urban planning, contingency arrangements and early warning mechanism.

### **Proposal for National Disaster Risk Management Institute at Makkah**

A Centre of excellence for DRM training is required to undertake much needed human resource development. Umm Al-Qura University being a premier university, a nodal point for national level training with its useful linkages, located in Haramain that is visited by millions every years, is a unique place to establish a National Disaster Risk Management Institute (NDRMI). This paper presents feasibility of establishment of a premier Centre of excellence for providing training and research services on DRM, endeavoring to actively promote national awareness as well as integration of disaster management into sustainable development to make the Kingdom a disaster resilient nation. The aim is to "To layout broad contours on establishment of KSA NDRMI".

### **Significance of National Disaster Risk Management Institute at Makkah**

To manage disaster, KSA is required to establish institutional and technical mechanism for preparedness, mitigation, end to end early warning as well as response and recovery activities. Realizing these needs, the Centre of Excellence for Disaster Risk Management Training has to be raised at Umm Al-Qura University to conduct courses for civil, military and paramilitary personnel in DRM in active collaboration with GDCD. This centre would serve as a lynchpin and coordinate the services of relevant disciplines and the guidance of the sensitive and responsive stakeholders. It is pertinent to highlight that the Umm Al-Qura University being a premier academic institution of Makkah and linkages with renowned national and international institution organizations has the capacity to position itself in the forefront of academic education due to its most desirable location and set-up. There are few campuses in the world that unite such a variety of different departments and institutions in a close proximity of disaster prone areas.

### **Contours of National Disaster Risk Management Institute**

#### **Location**

It will be located in the premises of Umm Al-Qura University, initially utilizing the training and building infrastructure of Umm Al-Qura University, and later transform into an independent National Institute in a progressive phase wise implementation Plan.

#### **Purpose**

To work as focal point for promoting formal training including academic and professional courses on DRM in KSA. The training services will be intended for law enforcement agencies, government / civil servants and key personnel of civil society. NDRMI will provide platform for undertaking quality research covering both natural & human induced disasters, with a multi-hazard approach and build working partnerships with the Government, universities, corporate bodies and other national and international Institutes of

eminence. This will create reservoir of professionally trained first responders, emergency and mitigation managers, relief workers and organizations with improved operational readiness in pre / post disaster arrangements. NDRMI will function as a National Resource Center in KSA through effective knowledge management and sharing of best practices.

### **Vision**

To be a leading Center of Excellence in the field of disaster risk mitigation and management in KSA.

### **Mission**

To work as a think tank by providing policy advice and facilitating capacity building services including strategic learning, research, training, system development for effective disaster preparedness and mitigation to public and private sector on sustainable basis.

### **Implementation Plan for NDRMI**

The establishment of Institute is proposed mainly in three phases. The phase one should span for a period of five years and devoted to raising of essential infrastructure, establishment of nucleus facilities, induction of core staff and commencement of certificate / diploma level courses. Phase 2 should include commencement of bachelor's degree program in various DRM related disciplines, alongwith raising of requisite infrastructure. Whereas, Phase 3 should encompass commencement of graduate / post graduate program and upgrading the Institute to Centre of Excellence with establishment of state of the art laboratories and related facilities. The raising of NDRMI at Umm Al-Qura University in Makkah Al Mukarramah would be further expedited by using existing infrastructure, laboratories and staff / facility in the initial phase. This will facilitate commencement of training of core faculty / staff as Master Trainers through fast track faculty development program. Meanwhile, funding and development of dedicated infrastructure can be initiated.

### **Findings of the study**

#### **State of DRM in KSA**

Saudi Arabia is vulnerable to multifaceted natural and manmade disasters, whereas floods, sand storms, fires, collapse of structure and epidemics are considered recurring and most hazardous. The public is generally aware of the nature and consequences of various disasters, but lack formal education, training and exposure to any kind of formal community awareness or participation programs.

The DRM organizations generally pursue response oriented event specific approach, whereas modern concepts emphasize proactive integrated disaster risk management.

#### **Areas identified for capacity building**

The recurring incidents of collapse of structures indicate that resilience of existing infrastructure is questionable. The DRM organizations are deficient of requisite training, professional expertise and modern equipment to manage various disasters efficiently, besides absence of framework for coordinated

response. KSA lacks hazard risk assessment, mapping or micro-zoning, building / services guidelines, specifications, codes and regulatory frameworks, which are essential for sustainable development.

### **Way Forward**

#### **Summary**

There is a need to build a safe and disaster-resilient country by developing a holistic, proactive, multi-disaster and technology-driven strategy for DRM. This will be achieved through a culture of prevention, mitigation and preparedness to generate a prompt and efficient response at the time of disasters. The NDRMI will function as nodal centre for Human Resource Development in the area of Disaster Mitigation and Response. The NDRMI, in partnership with other research institutions will focus on capacity development as one of its major responsibilities, along with training, research, documentation and development of a national-level information base. The institution will network with other knowledge-based institutions. It shall also be responsible for synthesizing research activities by enhancing scope towards Post Graduate Studies and will be geared towards emerging as a 'centre of excellence' at the national, regional as well as international levels.

#### **Overview of Implementation Framework**

Disaster Management has to be a multi-disciplinary and proactive approach. Institutional arrangements for disaster response are at the heart of disaster management systems. There is certainly a pressing need for improvement and strengthening of existing institutional arrangements and systems in this regard to make the initial response to a disaster more effective and professional.

### **Recommendations**

#### **Conceptual Approach**

The study recommends that a paradigm shift in concept and approach to handle disasters in KSA is essentially required. The enormous challenges relating to community awareness, education, training and capacity building have to be addressed on urgent basis. There is a need to formulate DRM institutional framework outlining roles and responsibilities of various stakeholders, along with addressing training and capacity building needs, with focus on innovation, technology and integration. The DRM strategy, plans and manuals, containing specifications, standards and codal formalities would serve as bedrock for developing well planned, technically sound, environmentally compatible and socially acceptable sustainable urban infrastructure.

#### **Establishment of DRM Institute**

National Disaster Risk Management Institute need to be established for DRM education, training and awareness programs, besides introducing academic and research activities, like degree program, certification short courses, seminars and workshops. The government has already launched many initiatives and allocated considerable budget for the safety of public and visitors, which can be supported and monitored by experts from NDRMI.

## Compliance of Global Initiatives

KSA being signatory of the UNISDR's Hyogo Framework for Action 2005-2015: Building the resilience of nations and communities to disaster & Sendai Framework for Disaster Risk Reduction 2015-2030, entailing paradigm shift from reactive to proactive approach, is re-emphasized for compliance. A national level effective body needs to be established to develop framework, ensure phased implementation and enforce monitoring mechanism.

## REFERENCES

- Abosuliman, S. S., Kumar, A., Alam, F., Disaster preparedness and management in Saudi Arabia: an empirical investigation, *International Journal of Social, Human Science and Engineering*, 7(12), pp 295-299, 2013.
- Ackerman and Cox, 1989 S.A. Ackerman and S.K. Cox, Surface weather observations of atmospheric dust over the southwest summer monsoon region, *Meteorology and Atmospheric Physics*, Vol. 41, pp. 19–34, 1989.
- Al Arabiya, Heavy rains, flooding kill 18 people in Saudi Arabia, Retrieved from <http://english.alarabiya.net/en/News/middle-east/2016/04/14/Heavy-rains-flooding-kill-18-people-in-Saudi-Arabia.html> on May 27, 2016.
- Alamri, Y. A., Emergency management in Saudi Arabia: Past, present and future. *University of Christchurch Report*, New Zealand, 2010.
- Alamri, Y. A., Rains and floods in Saudi Arabia. Crying of the sky or of the people?, *Saudi Medical Journal*, 32(3), pp 311-313, 2011.
- Al-Bassam, A. M., Zaidi, F. K., Hussein, M. T., Natural hazards in Saudi Arabia. *Extreme Natural Hazards, Disaster Risks and Societal Implications*, 243(1), 2014.
- Al-Saud, M., Map of flood risk and torrents in the City of Jeddah, *Journal of Water Resource and Protection*, 2(9), 839-847, 2010.
- BBC NEWS Middle East, Fourteen killed in Hajj stampede, Retrieved from [http://news.bbc.co.uk/2/hi/middle\\_east/2749231.stm](http://news.bbc.co.uk/2/hi/middle_east/2749231.stm) on May 27, 2016.
- BBC NEWS Middle East, Hundreds killed in Hajj stampede, Retrieved from [http://news.bbc.co.uk/2/hi/middle\\_east/4606002.stm](http://news.bbc.co.uk/2/hi/middle_east/4606002.stm) on May 27, 2016.
- Dayan *et al.*, 1991 U. Dayan, J. Heffter, J. Miller and G. Gutman, Dust intrusion events into the Mediterranean Basin, *Journal of Applied Meteorology*, Vol. 30, pp. 1185–1199, 1991.
- Fritz H. M., Blount C. D., Albusaidi F. B., Hamoud A., Al-Harthy M., 2010. Cyclone Gonu storm surge in Oman. *Estuarine, Coastal and Shelf Science*, 86(1), pp 102–106, 2010.
- IFRC & UNDP, Effective law and regulation for disaster risk reduction: a multi country report, New York, 2014.
- International Disaster Database, Centre for Research on the Epidemiology of Disasters, Country Profile; natural disasters, Data version: v12.07, Retrieved from <http://www.emdat.be/country-profile> on May 27, 2016.
- Kutieli and Furman, 2003 H. Kutieli and H. Furman, Dust storms in the Middle East: sources of origin and their temporal characteristics, *Indoor and Built Environment*, 12(6), pp. 419–426, 2003.
- Ministry of Interior, Concepts and structural organization of Civil Defense, *In General Directorate of Civil Defense (Ed.)*, Riyadh, Saudi Arabia, 2001.
- Mohamed G., “Large-Scale Disasters: Prediction, Control, and Mitigation”, Cambridge University Press, 2008.
- Momani, N. M., Fadil, A. S., Changing public policy due to Saudi City of Jeddah flood disaster. *Journal of Social Sciences*, 6(3), pp 424-428, 2010.
- Pallister J. S., McCausland, W. A., Jónsson, S., Lu, A. Zahran, H. M., El-Hadidy, S., Aburukbah, A., Stewart, I. C. F., Lundgren, P. R., White, R. A., Moufti, M. R. H., Broad accommodation of rift-related extension recorded by dyke intrusion in Saudi Arabia, *Nature Geoscience*, 3, pp 705–712, 2010.
- Pallister, J., McCausland, W., Jónsson, S., Lu, Z., Zahran, H., Hadidy, S., Aburukbah, A., Stewart, I., Lundgren, P., White, R., & Moufti, M., Broad accommodation of rift-related extension recorded by dyke intrusion in Saudi Arabia, *Nature Geoscience*, 2010.
- Pararas-Carayannis, G., Critical Assessment of Disaster Vulnerabilities in the Kingdom of Saudi Arabia-Strategies for mitigating impacts and managing future crises. *The first Saudi International Conference on Crisis and Disaster Management*, Riyadh, Saudi Arabia, 2013.
- Robert R. B., “Guests of God: Pilgrimage and Politics in the Islamic World: Pilgrimage and Politics in the Islamic World”, Table 1.1: Hajj related disasters in recent years, Oxford University Press, 2004.
- Saudi Geological Survey, Natural Hazards, Retrieved from <http://www.sgs.org.sa/English/NaturalHazards/Pages/default.aspx> on August 26, 2016.
- The Geologic Evolution of Saudi Arabia, Compiled and written by David Grainger, Saudi Geological Survey, Jeddah. ISBN: 9781905755073, 2007.
- UNISDR, Terminology on DRR, [www.unisdr.org](http://www.unisdr.org), August 30, 2007. Retrieved from <https://www.unisdr.org/we/inform/terminology#letter-d> on May 27, 2016.
- United Nations International Strategy for Disaster Reduction, Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters, *The World Conference on Disaster Reduction*, Hyogo, Japan, 2005, Retrieved from <http://www.unisdr.org/2005/wcdr/intergover/official-doc/L-docs/Hyogo-framework-for-action-english.pdf> on August 26, 2016.
- United Nations International Strategy for Disaster Reduction, Sendai framework for disaster risk reduction 2015–2030, *The World Conference on Disaster Reduction*, Sendai, Japan, 2015, Retrieved from [http://www.wcdrr.org/uploads/Sendai\\_Framework\\_for\\_Disaster\\_Risk\\_Reduction\\_2015-2030.pdf](http://www.wcdrr.org/uploads/Sendai_Framework_for_Disaster_Risk_Reduction_2015-2030.pdf) on August 26, 2016.
- United Nations, Yokohama strategy and plan of action for a safer world: Guidelines for natural disaster prevention, preparedness and mitigation, *World Conference on Natural Disaster Reduction*, Yokohama, Japan, 1994, Retrieved from <http://www.unisdr.org/we/inform/publications/8241> on August 26, 2016.
- Wikipedia, 2015 Mina stampede. Retrieved from [https://en.wikipedia.org/wiki/2015\\_Mina\\_stampede](https://en.wikipedia.org/wiki/2015_Mina_stampede) on May 27, 2016.
- Wikipedia, List of governorates of Saudi Arabia. Retrieved from [https://en.wikipedia.org/wiki/List\\_of\\_governorates\\_of\\_Saudi\\_Arabia](https://en.wikipedia.org/wiki/List_of_governorates_of_Saudi_Arabia) on May 27, 2016.

Wikipedia, Mecca crane collapse, Retrieved from [https://en.wikipedia.org/wiki/Mecca\\_crane\\_collapse](https://en.wikipedia.org/wiki/Mecca_crane_collapse) on May 27, 2016.

Yassar A. Alamri, Emergency Management in Saudi Arabia: Past, Present and Future, University of Christchurch report, New Zealand, 2010.

#### **List of Stakeholders**

##### **Annex-A**

1. Directorate General of Civil Defence
2. Makkah Area Crisis and Disaster Management Centre (MACDMC)
3. Saudi Red Crescent
4. Hajj and Umrah Special Forces
5. Ministry of Transportation

6. Ministry of Interior
7. Ministry of Municipal and Rural Affairs
8. Ministry of Hajj
9. Ministry of Agriculture
10. Ministry of Commerce and Industry
11. Ministry of Finance and Planning
12. Ministry of Water and Electricity
13. Ministry of Petrol and Mineral Resources
14. Central Department of Statistics
15. Directorate General of Traffic
16. Saudi Commission of Tourism and Antiquities
17. Saudi Railway Organization
18. Custom Department
19. Regional Development Authorities
20. Saudi General Investment Authorities

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