

# A critical review on disaster preparedness and management of the emirati energy sector

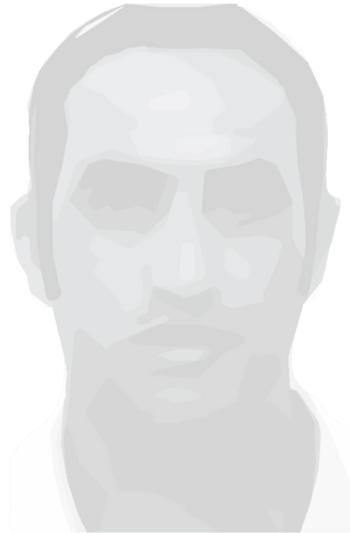
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*Análisis crítico sobre la preparación para desastres y gestión energética en los Emiratos Árabes*

*Etude critique de l'anticipation des catastrophes et de la gestion du secteur énergétique émirati*

*Revisão crítica da preparação para desastres e o gerenciamento do setor energético dos EAU*



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## RESUMEN

*Se dice que todos los desastres siguen un patrón cíclico conocido como el ciclo de los desastres. El ciclo es una vista general de las etapas dentro de una órbita continua de prevención, mitigación, preparación, respuesta y recuperación. La preparación para desastres es una de las etapas del ciclo de gestión de desastres. La preparación para desastres está orientada de manera que proteja adecuadamente a las comunidades. Incluye la identificación de potenciales peligros y vulnerabilidades a través de evaluaciones de riesgos, el desarrollo de sistemas de predicción y aviso, elaboración de modelos y capacitación para una serie de escenarios de desastres con diferentes niveles de peligro y en diferentes magnitudes, el desarrollo de seguros para infraestructura y el crecimiento de una comunidad inteligente. El sector energético domina en los Emiratos Árabes Unidos y se compone de diferentes elementos - electricidad, petróleo y gas natural que están geográficamente dispersos y conectados por sistemas y redes. La protección de estos sistemas y de estos activos, y especialmente en el sector energético la protección de la infraestructura de petróleo y gas de cualquiera y todas las amenazas internas y externas deben ser la máxima prioridad en los Emiratos Árabes Unidos. Las amenazas a la estabilidad geopolítica y económica que se deben tener en cuenta y para las que se debe estar preparado incluyen la actividad tectónica, el cambio climático, la energía nuclear, terrorismo y guerra.*

*En este trabajo se analiza el nivel actual de la capacidad de recuperación en el sector energético de los Emiratos y qué se puede hacer para mejorarlo. La información secundaria se tomó de diversas fuentes académicas y profesionales, mientras que los datos primarios, que constituye 35 cuestionarios con datos cualitativos y cuantitativos, se reunieron en campo en dos plantas de generación de electricidad, una en Abu Dhabi y la otra en Dubai.*

## ABSTRACT

*All disasters are said to follow a cyclical pattern referred to as the disaster cycle. The cycle is an overall view of stages within a continual loop of prevention, mitigation, preparedness, response and recovery. Disaster preparedness is one of the stages of the disaster management cycle guided in a manner that adequately protects communities. It involves the identification of potential hazards and vulnerabilities through risk assessments, forecast development and warning systems, modelling and training for a number of disaster scenarios of different hazards and at different magnitudes, development of insurance infrastructure and the growth of an intelligent community. The energy sector dominates in the UAE and consists of various assets - electricity, oil and natural gas that are geographically dispersed and connected by systems and networks. The protection of these systems and assets and within the energy sector especially, the safeguarding of oil and gas infrastructure from any and all internal and external threats should become top priority in the UAE. Threats to geopolitical and economic stability that need to be considered and prepared to include tectonic activity, climate change, nuclear energy, terrorism and war.*

*This paper discusses the current level of resilience in the Emirati energy sector and what can be done to improve it. The secondary data was taken from various academic and professional sources whilst the primary data, which constitutes 35 questionnaires with both qualitative and quantitative data, were collected on site at two electricity generating plants, one in Abu Dhabi and one in Dubai.*



## Palabras clave

*Desastre  
Preparación  
Emiratos Arabes Unidos  
(EAU)  
Sector energético  
Gestión.*



## Keywords

*Disaster  
Preparedness  
UAE  
Energy sector  
Management*

## RESUMÉE

Toutes les catastrophes suivent généralement un schéma cyclique, appelé cycle de la catastrophe. Ce cycle correspond à une vue d'ensemble des étapes de prévention, d'atténuation, de préparation, d'intervention et de rétablissement des conséquences possibles du phénomène. La préparation aux catastrophes est une des étapes du cycle de gestion des catastrophes. Cette préparation est mise en place de façon à protéger les communautés contre les risques encourus. Cela implique l'identification des dangers potentiels au moyen d'évaluations des risques, du développement de systèmes préventifs d'alerte, de la modélisation et de la formation à des scénarios-catastrophes d'amplitudes différentes. Le secteur énergétique est largement dominant aux Émirats Arabes Unis et se compose de différents types d'actifs - électricité, pétrole et gaz naturel- qui sont géographiquement dispersés mais reliés en réseaux. La protection de ces réseaux et de leurs actifs, la sauvegarde du pétrole et des infrastructures gazières de toutes les menaces intérieures et extérieures doit devenir une priorité absolue pour le pays du Golf. Les menaces contre la stabilité géopolitique et économique doivent être minutieusement anticipées et inclure aussi bien l'activité tectonique que le changement climatique, l'énergie nucléaire, le terrorisme et les guerres. Cet article analyse le niveau actuel de résilience du secteur énergétique émirati et ses possibilités d'amélioration. Les données secondaires proviennent de différentes sources académiques et professionnelles et représentent 35 questionnaires offrant des données qualitatives et quantitatives ayant été collectées sur les sites deux centrales de production d'électricité, à Abou Dhabi et à Dubai.

## RESUMO

Diz-se que os desastres seguem um padrão cíclico chamado do ciclo do desastre. O ciclo é uma vista geral de etapas dentro de um loop contínuo de prevenção, mitigação, preparação, resposta e recuperação. A preparação para desastres é uma das etapas do ciclo da administração do desastre. A preparação para desastres é manejada de maneira que possa proteger as comunidades adequadamente. Involucra a identificação de riscos potenciais e vulnerabilidades através de avaliações de risco, desenvolvimento de sistemas de previsão e alerta, modelamento e treinamento para certo número de cenários de desastre de diferentes riscos e em diferentes magnitudes, desenvolvimento de uma infraestrutura de seguros e a criação de uma comunidade inteligente. O setor energético domina nos EAU e consiste em vários recursos – eletricidade, petróleo e gás natural, os quais estão dispersos geograficamente e conectados por sistemas e redes. A proteção destes sistemas e recursos, especialmente dentro do setor energético, a proteção da infraestrutura de petróleo e gás de qualquer ameaça interna e externa deveria ser uma prioridade nos EAU. As ameaças à estabilidade geopolítica e econômica que precisam ser consideradas e para as quais é preciso estar preparado, incluem atividade tectônica, mudança do clima, guerra nuclear, terrorismo e guerra.

Este artigo discute o nível atual de resiliência no setor energético dos EAU e o que pode ser feito para melhorá-lo. Os dados secundários foram obtidos de várias fontes acadêmicas e profissionais; enquanto os dados primários, que estão constituídos por 35 questionários com informação qualitativa e quantitativa, foram obtidos on-site em duas plantas de geração eléctrica, uma em Abu Dhabi e outra em Dubai.



## Mots clefs

Catastrophe  
Anticipation  
Émirats Arabes Unis  
Secteur de l'énergie  
Gestion



## Palavras-chave

Desastre  
Preparação  
EAU  
Setor energético  
Gerenciamento

# 1. INTRODUCTION

In 2011, a total of 332 natural disasters were registered, killing a total of 30,773 people and causing 244.7 million victims worldwide (Guha Sapir et al., 2012). It is important that any potential disaster or threat of disaster is managed. Preventative management focuses strongly on disaster preparedness as it puts together the processes, action and steps that should occur in the event of an emergency, before such an emergency. Disaster preparedness, consequently, plays a significant role in disaster mitigation and strategic planning, and if done properly, it presents a significant reduction in the recovery period. It is also likely to result in welcome improvements to infrastructure, particularly critical infrastructure, such as that of electricity and energy.

The protection of these systems and assets, and within the energy sector especially, the safeguarding of oil and gas infrastructure from any and all internal and

external threats, should become the top priority of the UAE and other oil-providing nations against asymmetric threats (Bi, 2006). One important, if not the most important issue to the long-security of a national or even a regional energy system, is the failure of international supply whether on technical or political grounds. Any resilient energy network requires cooperation and the shared interests of all involved to work towards protection from “shocks”. This is the case especially if long-term resilience is regarded as a secure supply. Resilient critical infrastructure, based on Olinsky-Paul (2013), is defined by the author as that which has the self-sustaining ability to supply emergency electricity provision during outages where normal operations are absent or disrupted.

This paper explores the disaster preparedness of the Emirati energy sector by specifically focusing, through worker surveys, on two electricity plants located in Abu Dhabi and Dubai.

# 2. DISASTER MANAGEMENT

The ultimate goal of disaster risk management is to break the disaster life cycle (Frumkin, 2010). All disasters are said to follow a cyclical pattern (Figure 1) referred to as the disaster cycle (Hogan & Burstein, 2007). The cycle is an overall view of stages within a continual loop (Forsman, 2007) such as that described by Ciottone (2006), prevention, mitigation, preparedness, response and recovery. The method of dividing the disaster process into various, albeit overlapping stages is a useful heuristic device driving better understanding (Levinson & Granot, 2002) from which a disaster management plan can be implemented.

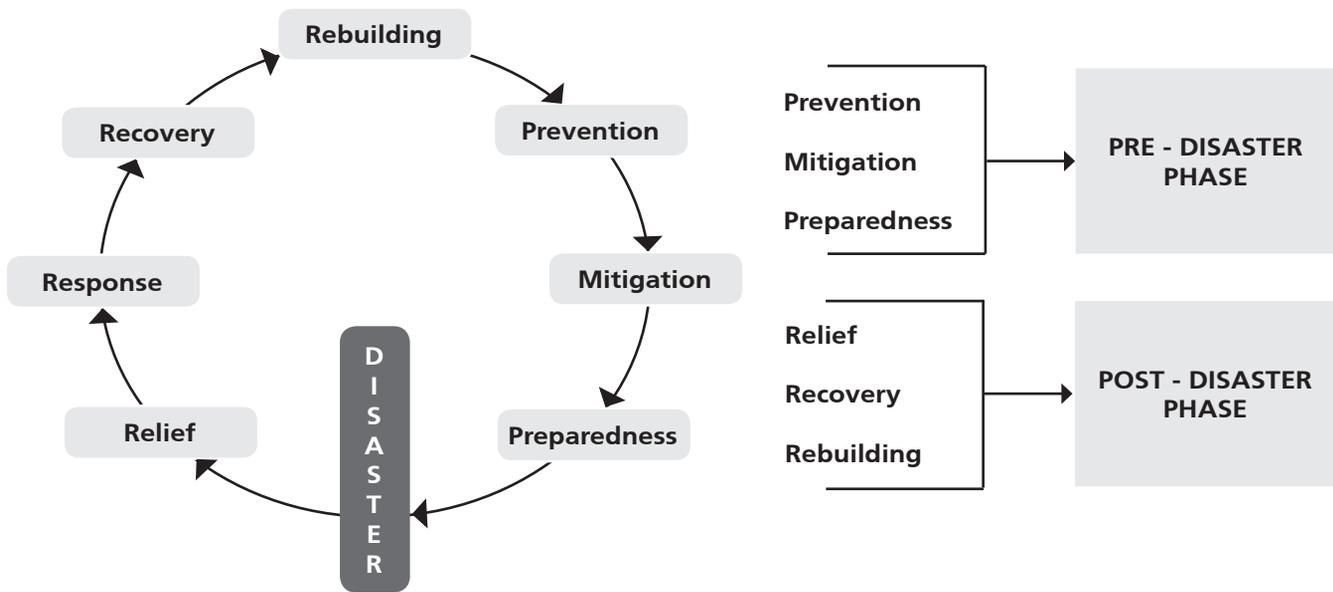
Disaster preparedness is a step in the disaster cycle. It focuses on the pre-disaster phase and the in-

depth investigation on disaster mitigation and strategic planning in order to build resilience. Pre-disaster, when used in this paper, refers to the extensive data collection, maintaining directories of resource, development of action plans, capacity building, training and community awareness activities (Sundar & Sezhiyan, 2007) required to prevent, prepare and mitigate. Indeed, disaster preparedness is, according to Hays (2013a, 2013b) one of the “five pillars of resilience” (the others being protection, early warning, emergency response, recovery and reconstruction). In his definition, he involves the identification of potential hazards and vulnerabilities through risk assessments, development of forecast and warning systems, modelling and training for a number of disaster scenarios of different

hazards and at different magnitudes, development of insurance infrastructure and the growth of an intelligent community. In this way, disaster preparedness and the other elements of this phase, are guided in a manner that adequately protects communities due to its comprehensive, multi-sector, community based and culturally sensitive approach (Ciottono, 2006). It also helps with strategic planning and resilience

enhancement in such communities. Indeed, Jha and Stanton-Geddes (2013) propose education and communication, higher levels of preparedness and investments, better urban planning, coordination and development as the main tools with which to address the risks that a vulnerable community might face in the event of a disaster. Following section describes disasters in the UAE.

Figure 1. The Disaster Management Cycle and Phases



Source. Miththapala (IUCN), 2008



### 3. DISASTERS IN THE UAE

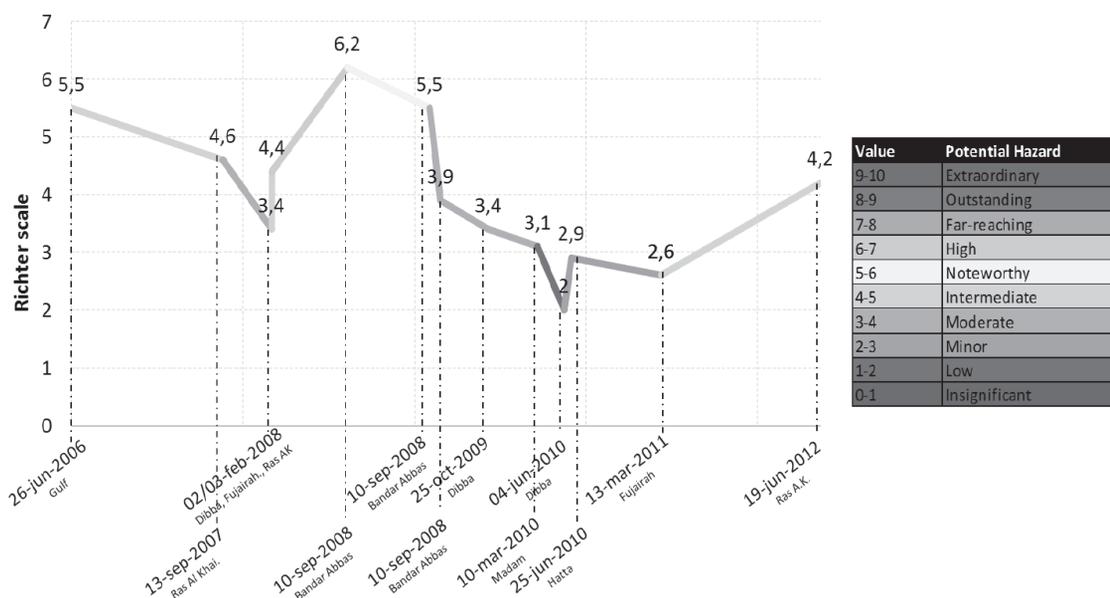
The UAE is prone to various natural hazards including those atmospheric, geological and anthropogenic in origin. As development continues in the nation, the country and its people become even more vulnerable to the effects of those hazards (Al Ghasyah et al., 2010). Currently, there are limited, reliable national statistical data regarding disasters in the UAE. Information as to events is sporadic with the Dubai Emirate providing the best source of information (Saseendran, 2011).

Terrorism presents a key issue that could easily affect the geopolitical stability of the region, if not the entire globe (given the number of energy installations), global trade, economy and operations. There are also metrological and tectonic hazards to consider. For one, the Arabian Gulf is shallow, about 200 meters or less in most areas and as observed by Hafez and Halim (2007), the terrain is flat, with most of the oil installations either on the shore or in shallow water areas, major oil fields

are either in the shallow area of the gulf or in the desert adjacent to the gulf shores. This makes them vulnerable to large tidal waves or sea storms. In February 2014, for example, Shamal winds helped contribute to unstable cool weather and strong offshore waves that led to shipping warnings. In land small dust storms were also reported (Kazmi, 2014).

Tectonically, there are 25 seismogenic source zones in the Arabian Peninsula (Al-Amri, 2005) including the Zagros Thrust fault that readily generates earthquakes measuring 5 on the Richter scale such as the Masafi Earthquake (magnitude ~5). Other potential threats come from the Hurmuz Straits, north of which is one of the most notoriously seismic active zones in the world (Shanableh et al., 2005). Below it shows the tectonic activity experienced in the country since 2006 (Figure 2). Most activity has been moderate or minor but there has been notable and even hig

**Figure 2.** UAE Earthquakes experienced in the last 8 years: Magnitude and Place.



**Source.** Authors, data taken from Gulf News (2013c)

Preparations for any impending disaster have been slow and in fact, due to the country's recent establishment, large-scale disaster preparation has featured on a national scene at an appropriate scale only recently. Every year brings more encompassing disaster management legislation and initiatives (Al Ghanim, 2010). This is particularly important in the energy sector because of the four-fold nuclear reactor

development at the coast of Barakah. The UAE must thus act in a proactive manner and must prepare adequately so that it remains resilient should any disaster event occur. Critical energy infrastructure plays a vital role in the UAE. Therefore, the preparedness of energy sector is very important. Next section describes the critical energy infrastructure in the UAE.

## 4. CRITICAL ENERGY INFRASTRUCTURE IN THE UAE

The energy sector generally dominates in the UAE and the gulf region. The Emirati economy is the second largest in the region, after Saudi Arabia, and remains on course for five percent growth protection within the next four years –largely due to rising oil prices (Karach, 2011). Some OPEC nations and many non-OPEC nations have seen production decline, but the UAE has increased its total production of crude oil by approximately 31 percent and thus plays a highly significant role in global energy markets (EUAEW, 2011). The energy sector is therefore very much an economic powerhouse responsible for the positive development of the nation. Energy security and supply must

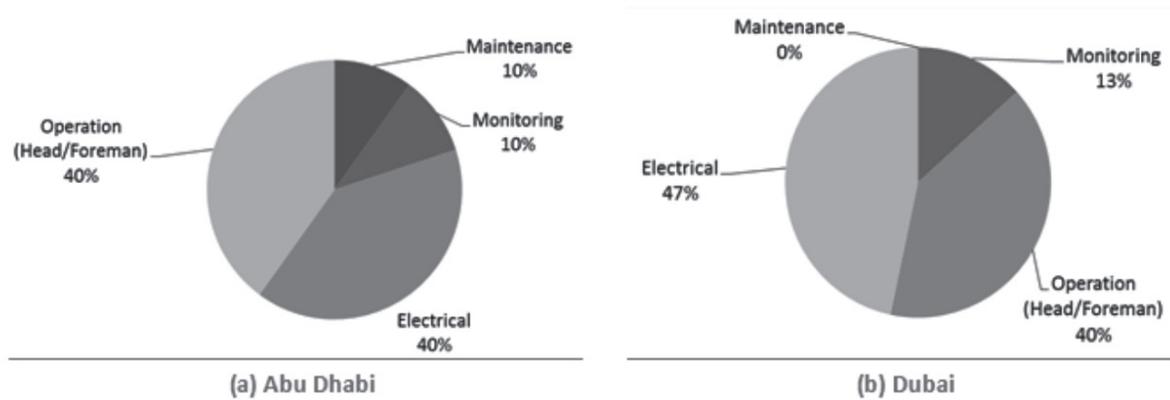
consequently be a priority for a country that has built its reputation as the region's most stable country, both politically and economically with attractive business opportunities that are not found elsewhere (Dalli & Wilcox, 2006). The new development of nuclear power at Braqa, 33 miles from the coast, provides another prime reason for comprehensive strategic planning in the mitigation of disaster. The technological choice of Generation III "APR1400", which has enhanced safety features (Al Farra & Abu-Jijleh, 2012) is a good example of man-made prevention (as opposed to hazard preparation), but there is the need for further research into disaster management within the energy sector.

## 5. METHODOLOGY

The primary research of this study involved questionnaires consisting of both qualitative and quantitative style questions. In order to examine the disaster preparedness of the UAE energy sector, they were conducted in the official language of the UAE, Arabic. The location was at two electricity generating plants, one in Abu Dhabi and the other one in Dubai.

From forty questionnaires distributed, 35 were answered (20 Abu Dhabi and 15 Dubai) and 5 refused. All

participants were men between the ages of 30 and 40. The mean number of years employed at the Abu Dhabi plant was 4.5, a figure slightly higher than the years of experience in the current position at 4.4. In Dubai the mean of the years employed was lower 4.2 and likewise the years of experience in the current position was 3.8. Now, it shows the work area distribution of the survey respondents (Figure 3). All participants belong either to the operational or technical areas that have the most direct contact with threats in the field.

**Figure 3.** Work area distribution of the respondents (a) Abu Dhabi (b) Dubai

**Source.** Authors.

The questionnaires contained both qualitative and quantitative questions and most of them were multiple choice or structured in a matrix. In the latter case, the respondent was given a scale from 1 to 10 to make his choice. In addition, yes/no answer options were often used. In order to ensure a collective understanding of the questionnaire and the purpose behind it, an information session and introduction was given by the researcher.

The questionnaire contained questions on the following topics:

- Preparation of the Emirati energy sector for natural and man-made hazards.

- Perceived state of preparedness.
- Barriers to be overcome to reduce vulnerability and increase preparedness.

Steps in data analysis included: (a) editing and coding survey data; (b) processing them in proper software; and (c) providing a descriptive statistical analysis for all the questions to generate insights. There are three basic measures of central tendency—mean, median and mode. In order to give some quantitative indication of the results, such as relative preparation for example, an index using the mean was constructed for each situation. Following section presents the findings from the surveys on preparedness of the Emirati energy sector.

## 6. RESULTS

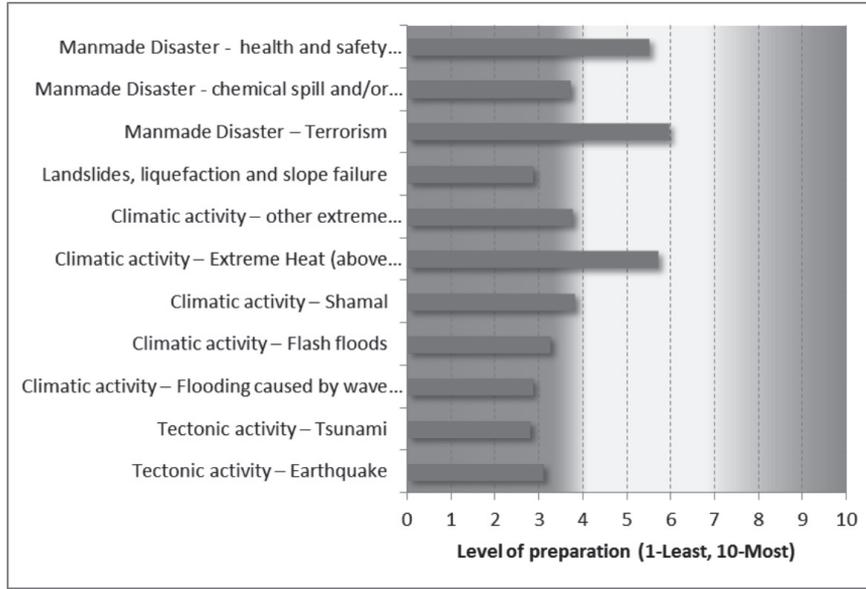
### 6.1 Preparation of the Emirati energy sector for natural and man-made hazards

The first question asked by the researcher included a list of hazards that people think the Emirati energy sector is best prepared for.

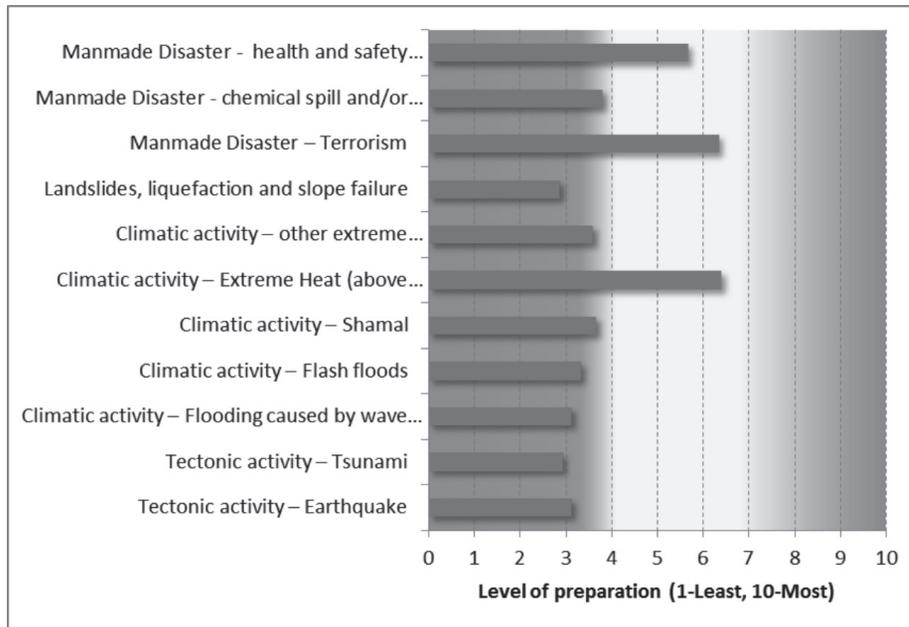
In terms of preparation both, Abu Dhabi and Dubai survey respondents believe that the sector is the

most prepared against terrorism, extreme heat and health and safety related accidents. In general, the energy sector is ill-prepared when it comes to facing natural disaster. This is seen in the fact that in many cases the modal value is “3” whilst the mean value also lies in the 2-3 range. State of preparation rarely climbs above 5. It can be stated, based on the maximum values of Dubai that its workers feel more prepared for disaster than in Abu Dhabi (Figure 4a & 4b).

**Figure 4.** Level of preparation of the Emirati energy sector by hazard (a) Abu Dhabi (b) Dubai



(a) Abu Dhabi



(b) Dubai

Source. Authors.

## 6.2 Perceived state of preparedness

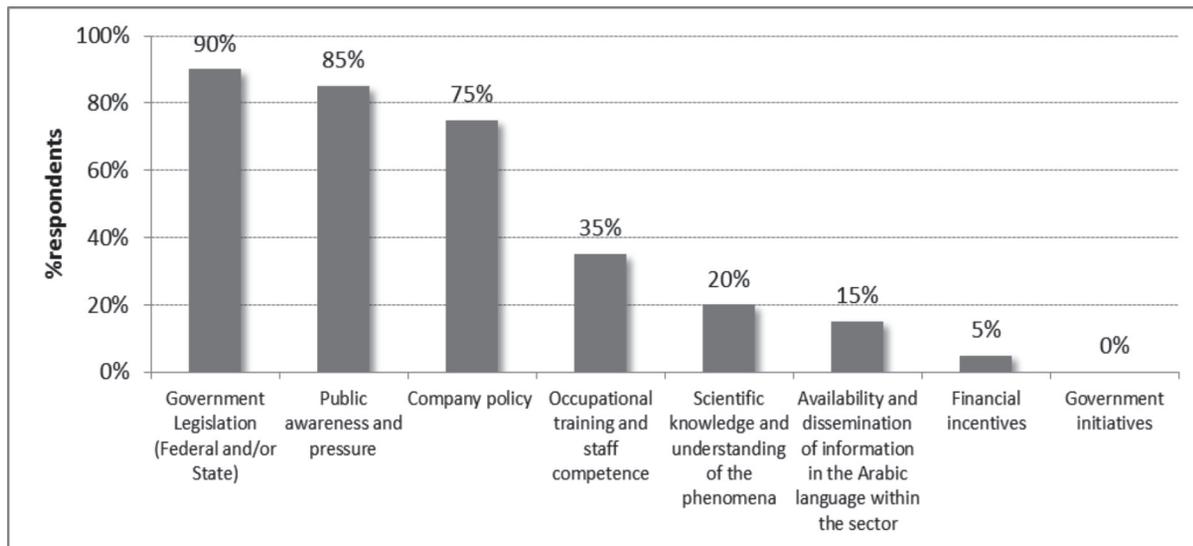
Seeing as 10 represents the disaster that the energy sector is most prepared for and 1 the least, it follows that the UAE energy sector is most vulnerable to those hazards that fall into the red area, partly vulnerable

if in the yellow, and not vulnerable if in the green. Some 73% of the hazards listed fall below 4 (high vulnerability).

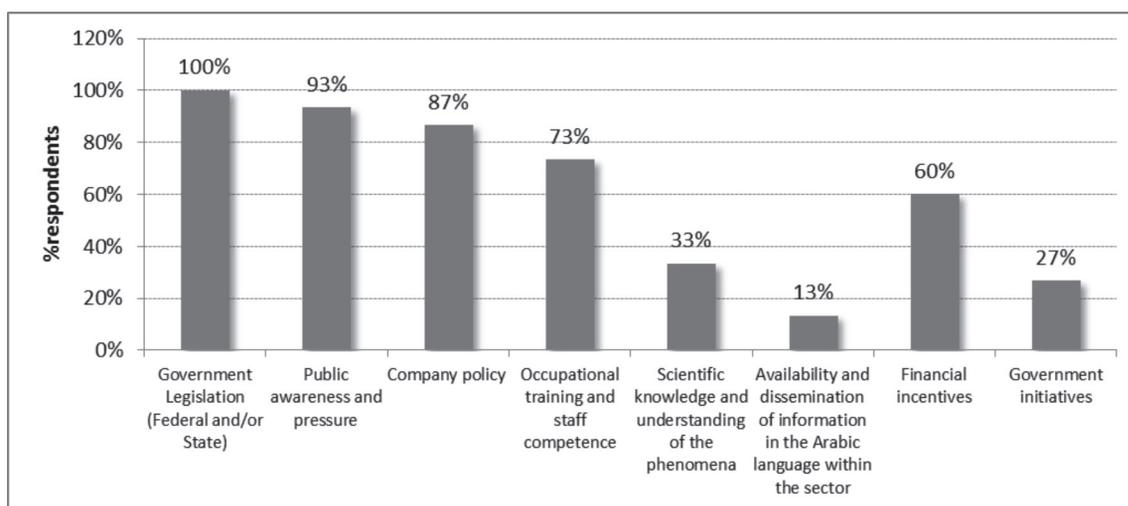
Respondents were asked to provide reasons as to why a given hazard scored highly (i.e. > 8). Although

not all respondents scored any hazard greater than 7, given that the highest mode for Abu Dhabi is 6, they nevertheless attributed a number of reasons to the greater state of preparedness (Figure 5 ). There is a strong degree of consistency between the two cities.

**Figure 5.** Greater state of preparedness of the Emirati energy sector (a) Abu Dhabi (b) Dubai



(a) Abu Dhabi

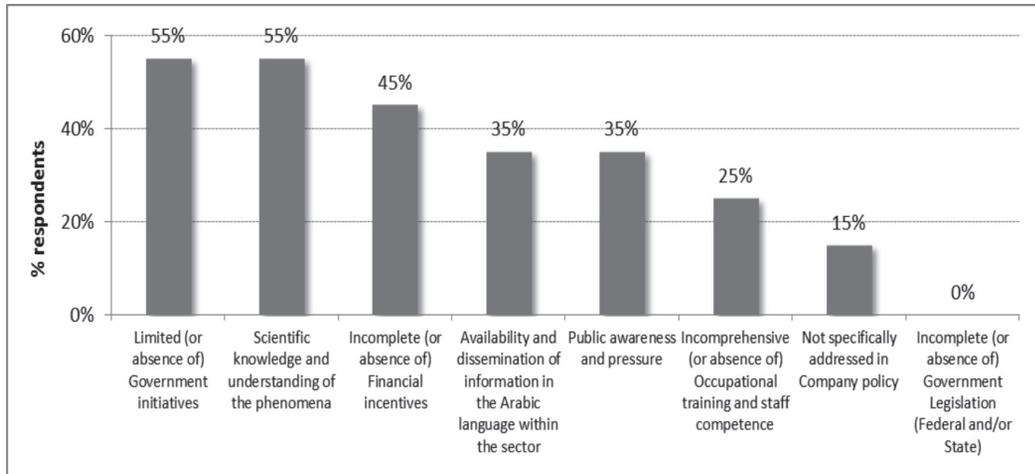


(b) Dubai

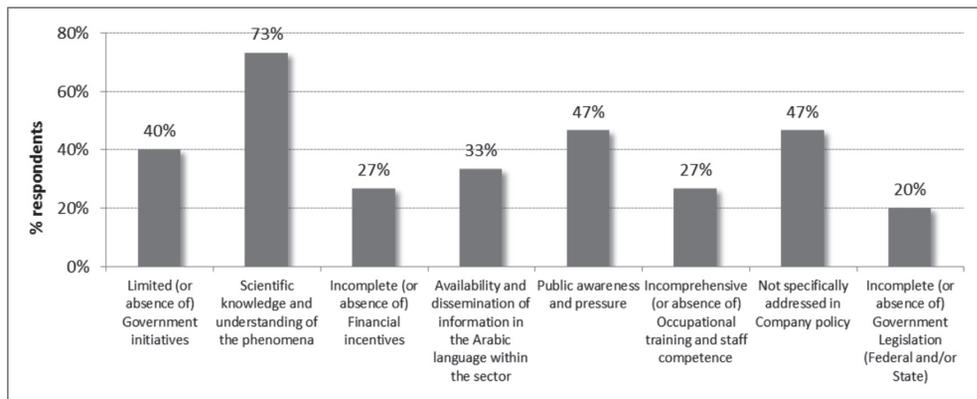
Source. Authors.

The reasons attributed to the lack of state of preparedness to disaster are shown below (Figure 6). The answers between the two cities were distinct, except in the case of “Scientific Knowledge”.

**Figure 6.** Lack state of preparedness of the Emirati energy sector (a) Abu Dhabi (b) Dubai



(a) Abu Dhabi



(b) Dubai

Source. Authors.

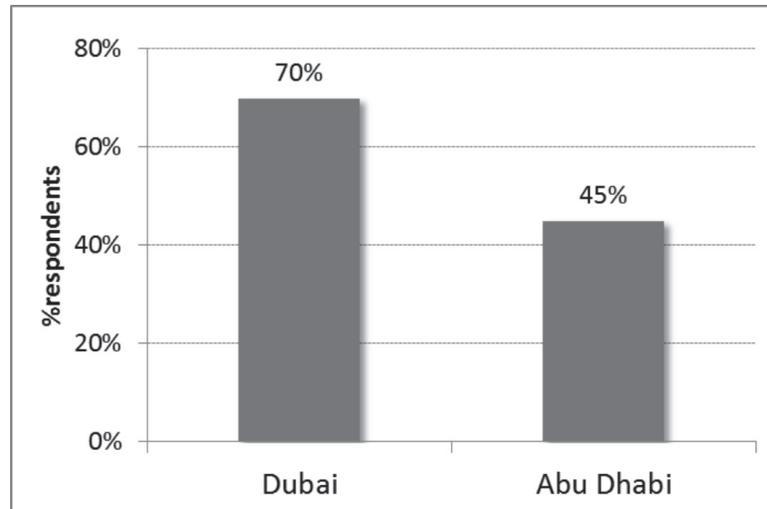
Below it shows that both sets of respondents view Dubai as the most prepared Emirate state for natural disaster, indeed more in Abu Dhabi think Dubai is the best prepared than in Dubai itself (Figure 7). The given reasons are presented later (Table 1).

**Table 1.** Reasons given in each Emirate state as to the be the better prepared state.

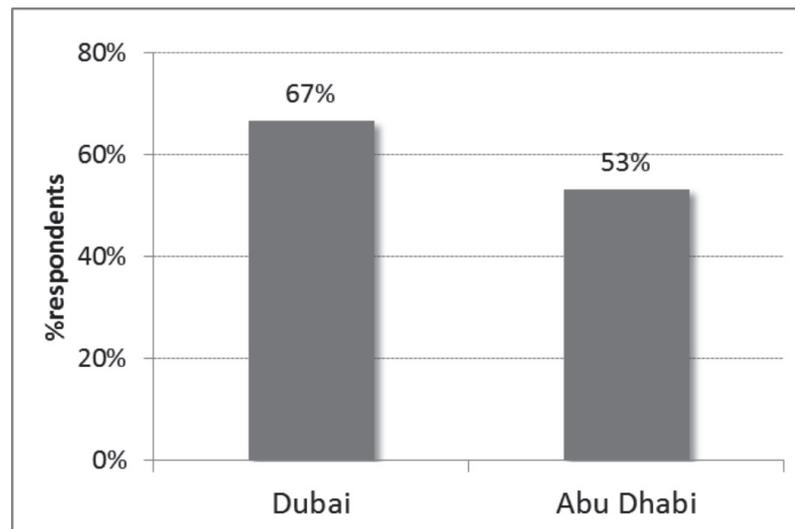
Opinions	Abu Dhabi	Dubai
Better corporate policy for preparedness and response to disaster	25%	7%
Better planning standard for energy distribution and preparation against hazardous	25%	33%
Being a more organized and disciplined company		
20%	7%	
Human development e.g. through training, motivation and salary	15%	33%
Creation of a specialized area for the disaster management	15%	-
Being pioneers in the field by innovation and better practices		
10%	27%	
More resources for equipment	-	7%

Source. Authors.

**Figure 7.** Well prepared Emirati states for hazards in the energy sector (a) Abu Dhabi (b) Dubai



(a) Abu Dhabi



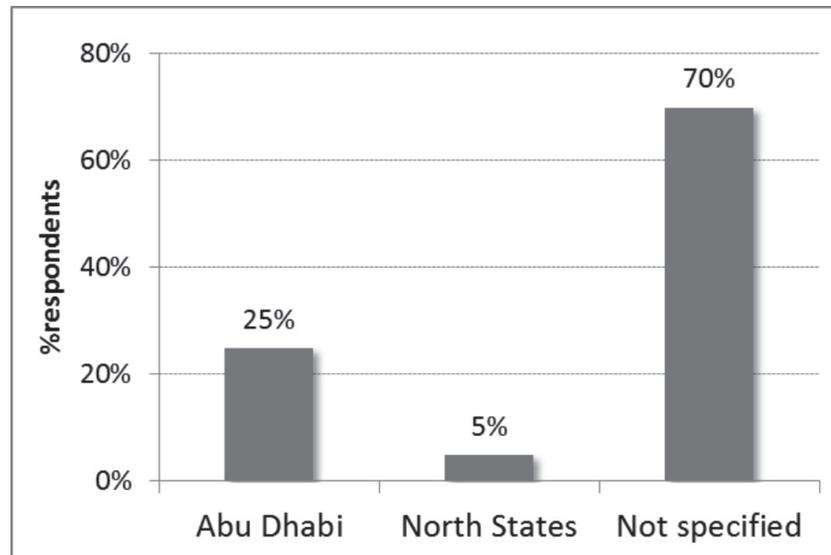
(b) Dubai

**Source.** Authors.

When asked which Emirate state is the worst prepared, few people answered the question. Most who answered, stated Abu Dhabi, and attributed the limited preparation to human resources policies of the companies (training, development) and poor operation planning (Figure 8). The absence of response may relate to social desirability bias. Social desirability bias, a problematic recognised as early as 1954 (Maccoby &

Maccoby, 1954), is a social phenomenon which can be considered as the common courtesy and acceptability shown to strangers or acquaintances (or researchers) before they penetrate your circle of friends or enemies. It can occur in research due to issues of trust as respondents may not truly believe or understand what the researcher will really use the information for.

**Figure 8.** Ill prepared Emirati states for natural hazards in the energy sector by Abu Dhabi respondents



**Source.** Authors.

### 6.3 Barriers to be overcome to reduce vulnerability and increase preparedness

The main barriers (Figure 9) identified by the survey respondents are:

- Disaster management training in the energy sector remains to be addressed (71% of the respondents)
- Staff competences, especially through education, to support the understanding of climate change and its related disasters (31%).

To complement the above, it is considered necessary to:

- Undertake verification simulations to assess the stage of personnel preparation, organisational structure in disaster response and resource capacity installed (31%)
- Develop a better planning stage for disaster preparation (26%)
- Achieve greater awareness, which means to give more priority to the issue (23%)
- Improve the human management policies in companies, such as safe work practices especially when it comes to time pressures (6%)

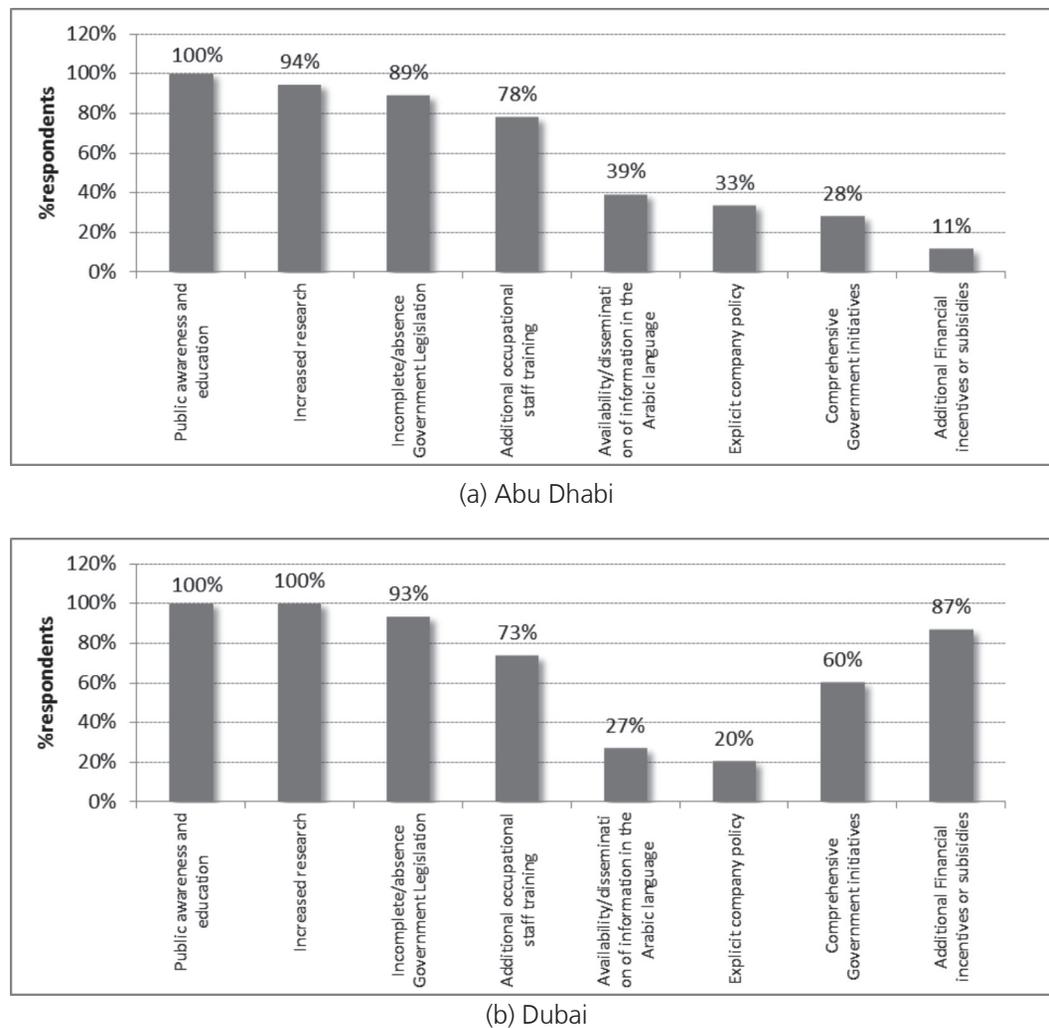
- Set more regulations in this line with sound disaster management practice (3%)

It is notable that the majority of responses were aimed at human resource improvement more so than other variables including technical or financial resources, policies or research.

Considering the importance given to training by respondents, relevant courses should be designed to develop skills and awareness using effective and participatory methodologies. Such an approach could be an effective way to improve safety lead to prevention. Also, a revised training programme assures the effectiveness of training.

Finally, the authors looked at how to identify what is thought to enhance the resilience in the energy sector. The following were proposed by three-quarters of the respondents as a way to develop a sound disaster management plan for hazards affecting the energy sector:

- More public awareness and education.
- Increased research.
- More comprehensive government legislation.
- Additional occupational staff training.

**Figure 9.** Ways in which to enhance the resilience in the energy sector (a) Abu Dhabi (b) Dubai

Source. Authors.

## 7. DISCUSSION

In terms of preparation, respondents believe that the sector is best prepared against terrorism, extreme heat, and health and safety related accidents. In general, with the exception of terrorism at a mean of 6, limited error and a higher concentration to the right of the mean, respondents believe that the energy sector is ill-prepared when it comes to facing disaster. This is seen in the fact that in many cases the modal value is "3" whilst the mean value also lies in the 2-3 range. State of preparation rarely climbs above 5. It can be stated, based on the maximum values of Dubai that workers

feel more prepared in the event of disaster than in Abu Dhabi.

Other key findings of the primary data are that the results obtained from the two sites are very similar. This may be due to the similarities in training received, the way management operates or even the education received by the staff. Further research is required into this consideration, as it may well influence latent failures of the energy sector.

War and terrorism are seen as key threats to the Emirati sector. War, despite not having been specifically listed as a possible answer, was stated in the other category. In fact, 50% of respondents said that "terrorism" presented the greatest risk. This is, in some respects, unusual because of the lack of geopolitical instability in the country. There have been regional issues such as historical problems with Iran or the political climate in Arab regions following the Arab Spring. Climate change is also recognised as an issue.

The main barriers to resilience in the energy sector are said to be disaster management training in the energy sector, remains to be addressed (71% of the respondents); and staff competences, especially through education, to support the understanding of climate change and its related disasters (31%).

The solutions put forward by the respondents to tackle such problems include programmes of public awareness and education, more stringent government legislation (at Federal and/or State level), and increased research to enhance scientific knowledge and understanding of the phenomena that influence the resilience and preparedness of the energy sector. Further research via in depth interviews is required to fully evaluate the effectiveness of such solutions.

Finally, the authors believe that this study should be extended across the entire energy sector to see whether the results of this case study can be validated; such results could then form the basis of the UAE's future energy sector strategies for the development of resilience in the face of both man-made and natural disasters.

## 8. CONCLUSION

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Disaster preparedness is a key component of the disaster cycle that can build resilience into the energy sector. There is however various improvements that need to be made in the UAE to improve the energy sector's performance. Dubai is said to be more resilient than Abu Dhabi to disaster. The sector is also said to be more resilient when it comes to man-made disasters

and natural ones involving extreme heat. Employees of energy facilities do however state the need to increase the level of preparedness through public awareness and education, government legislation (at Federal and/or State level) and increased research to enhance scientific knowledge and understanding of the phenomena.

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