

# Preparedness and Emergency Response Aspects of Sarpol-e Zahab (Kermanshah), Iran Earthquake of November 12, 2017

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## ABSTRACT

*On November 12, 2017, at 9:48 p.m. (local time), a destructive earthquake ( $M_f=7.3$ ) occurred in the border region between Iraq and Iran, followed by many weak to strong aftershocks. The earthquake claimed more than 620 lives with a further 10000 injured. At least eight cities including Qasr-e Shirin, Ezgeleh, Salas-e Babajani, Gilan-e Gharb, Sarpol-e Zahab, Dalahou, Eslamabad-e Gharb and Javanrud as well as around 2000 villages were damaged or affected severely by this earthquake and its aftershocks. Additionally, the earthquake was felt in many adjacent provinces and caused extreme fear and horror. Considering the time of earthquake and lack of appropriate damage assessment tools, it took few hours to evaluate the location of the most stricken areas and to estimate the number of casualties. Moreover, due to the wide extent of damaged areas, the local needs were much higher than the existing resources and capacities. These issues caused delay in providing emergency response services and dispatching the rescue and relief teams to the affected areas. In this paper, the most important challenges in preparedness and emergency response aspects regarding this earthquake will be addressed and discussed. Lessons learnt and recommendations are provided based on the authors' field observation undertaken few days after the earthquake.*

### Keywords:

Emergency Response;  
Preparedness;  
Challenges;  
Sarpol-e Zahab  
Earthquake

## 1. Introduction

Although the affected areas by Sarpol-e Zahab, Iran Earthquake of 2017 is located in a seismic prone zone (Zagros Mountains), but during the last century, no strong earthquake has been recorded in this zone (most of the recent earthquakes occurred in this region had magnitude less than 5). This can be considered as one of the main reasons for neglecting safety on construction and high vulnerability of buildings and infrastructures in that area. As a result, the earthquake caused extreme damages in

Kermanshah province, northwest of Iran. Fortunately, the number of casualties of this earthquake was not compatible with the damage level. However, due to the extent of affected areas, providing necessary services to the victims was a challenge in this earthquake and there were many issues in emergency management, providing rescue and relief services, distributing tents, emergency shelters and materials, etc. that caused further difficulties for the survivors, considering the cold weather condition at the time of

earthquake. These issues will be discussed in this paper to be considered in future for improvement of disaster management capacities and capabilities in Iran.

The points indicated in the paper highlight some challenges of the government in disaster risk reduction and 'necessity to use the existing know-how on earthquakes risk management and its integration and effective implementation into the development programs' [1].

## **2. Damage Estimation**

The location of the epicenter of Sarpol-e Zahab earthquake was determined few minutes after the earthquake by many national and international organizations, with a few kilometers differences. However, the extent of affected areas and level of the damage were not clear for many hours, as there were no applicable quick loss assessment and decision support tools. Therefore, during the first couple of hours, there were only local assistance by people living in the area who attempted to help their families and neighbors. Additionally, the army bases in the affected areas provided considerable assistance to the victims. This has been documented in many regions and later it was appreciated by the survivors. Fortunately, despite severe damages to the residential buildings and infrastructures (Figure 1), the number of casualties was much less than the similar cases in Iran's earthquakes history. One reason was the foreshocks that struck the area few minutes before the event measuring  $M_1 = 4.6$ , which caused many people to leave their homes and stay away from built-up areas.

Lack of quick damage and loss assessment tools could be considered as one of the main challenges in that event. Of course, during few days after the earthquake, the extent of damage was studied by many researchers utilizing satellite imageries and remote sensing technologies. However, those methodologies could not be applicable in rapid response at present, since their procedures are time consuming and the results can only be accessible few days after the event. Therefore, the development of appropriate damage estimation systems, using seismographs and necessary databases and models should be considered as a main priority for disaster management in Iran.



**Figure 1.** Damage to residential complexes (photo: Izadkhah).

## **3. Evaluating Preparedness Level**

Various issues were evaluated in four areas in order to assess the level of people awareness and preparedness about earthquakes and ways to encounter it:

- ❖ The public awareness of earthquake risk reduction: The capability of a society to cope with destructive impacts of a seismic event is one of the key factors in minimizing the recovery time and effective emergency management [2]. Although people in the area had always been in danger of the earthquake threats, not many of them had considered safety issues in their homes. Many of them believe that the financial issue is an important reason for not taking any actions in risk reduction. Therefore, most buildings were not earthquake safe and severely damaged or collapsed by the event.
- ❖ Education for self-rescue measures: Same as previous earthquakes, the local people and neighbors in the area were the first responders who helped the victims in this event. However, their activities were not successful in some cases since many people in Iran are not familiar with the correct actions to help those who are trapped

under debris. Additionally, the earthquake occurred in the night time and therefore providing assistance by local people and without appropriate tools was quite difficult and dangerous in the darkness.

- ❖ Education for self-protection and emergency evacuation: Most of the adults in the area were not familiar with the correct actions to be taken during earthquakes. However, a majority of children who were questioned informed that they knew what to do during earthquakes due to relevant education they had learnt from their school textbooks or earthquake drills. They believed that this familiarity with the provisions could save their lives in this earthquake. This can be one of the successful outputs of the annual national "Earthquake and Safety" drills.
- ❖ Education for coordinating in related activities after earthquakes: One of the most important issues after this earthquake was the inappropriate use of resources and humanitarian aids. Lack of awareness in this regard resulted in a chaotic situation among those seeking help as well as inappropriate distribution of goods among the needy.

It seems that performing annual drills in schools plays an important role in increasing the awareness of students. In 1997, the International Institute of Earthquake Engineering and Seismology (IIEES) and the Ministry of Education (MoE) ran the country's first "Earthquake and Safety" drill as a pilot project in two boys' and one girls' high schools in the capital city of Tehran. An evaluation of the drill results revealed that the students were capable of responding appropriately to an earthquake event. The main objectives of the "Earthquake and Safety" drills were to increase the knowledge of students and teachers about earthquakes and to develop preparedness for appropriate responses during an earthquake. Following the successful pilot drill, IIEES and MoE sought to scale up the drills to all schools in Tehran and then in Iran. On the annual drill, the MoE coordinates the "Earthquake and Safety" alarm within schools, while the earthquake siren is broadcasted on the national radio. On cue, students, teachers, and all school staff perform 'Drop, Cover, and Hold on (DCH)' for 30 to 60 seconds, followed by emergency evacuation [3-5]. Each year, one or two schools are selected as

models of good implementation, and their drill, conducted with representatives from IIEES and the MoE, is also broadcasted on the radio to encourage student enthusiasm.

Inspired by the successful expansion of Iran's national school drill program and based on ex-periences of recent earthquakes in Iran that depict the roles of local residents in DRR, the IIEES and relevant authorities expanded their work in 2015 to engage the broader community in earthquake risk reduction activities. They initiated a new program called "Safe Schools - Resilient Communities", which aimed to raise public participation in DRR, risk assessment at community level and build resilience in the communities surrounding schools [6]. Furthermore, community members can make a substantial contribution to emergency planning and response because they are most familiar with their environment and have a personal incentive to reduce local risks [4, 7]. Additionally, IIEES has formulated the Safe Schools - Resilient Communities program in schools to emphasize the importance of a partnership between schools and the broader community in reducing overall community disaster risk management [8]. It is expected that all safe schools in Iran can be prepared to play the role of local disaster management center at each community by the vision of this program (2025). This will increase the preparedness for potential earthquake, drastically.

In regard to special courses for the personnel and the officials who work in areas related to disaster management, many courses have been organized during the last few years in Kermanshah province. Some of these courses have had a great role in increasing the performance of personnel during earthquakes. For example, the educational training and drills for various hospital personnel have resulted in appropriate reactions after earthquakes in helping patients and injured. They learnt how to establish Hospital Incident Command System (HICS) as well as implementing triage at the affected sites to manage emergency health care and decrease the risk of overwhelming hospitals by outpatients. Therefore, it is necessary to continue those training and develop other necessary training programs to be conducted in order to increase and promote the specified and required knowledge of those who work in disaster management fields.

However, it should be mentioned that unfortunately, training related to earthquake retrofitting and building safety have not been successful as it did not result in reducing the vulnerability of the area. Moreover, the disaster management authorities could not provide necessary standard services to the victims, due to shortages of resources, lack of information and insufficient level of knowledge on appropriate response measures in such circumstances.

#### 4. Evaluating Emergency Management

Many people have been affected by the Sarpol-e Zahab Earthquake. Although, there are no precise figures of injured and homeless people, but according to the announcement by local authorities, it is estimated that around 10.000 have been injured and approximately 100.000 have lost their houses and were in need of emergency shelters. The next section will address the most critical issues in emergency management.

##### 4.1. Emergency Management Command System

According to the Iranian legislative, National

Disaster Management Organization (NDMO) is responsible for management of all aspects of natural hazards, including earthquakes in Iran. Based on the extent of affected areas by the disaster, the hierarchy of disaster management responsibility may change from city level to national level as shown in Figure (2).

Due to the extent of those areas affected by Sarpol-e Zahab earthquake, disaster management taskforces were established both in national and provincial levels. In the national level, the operation was headed by the Minister of Interior, while in Kermanshah province it was controlled by the governor-general. However, due to the lack of sufficient information regarding the extent of damaged areas and unclear data on the potential consequences of the earthquake, it was quite difficult for those taskforces to make appropriate and on-time decisions in the first couple of hours. Therefore, most of the assistance was provided by local residents and army forces which were based in the affected areas. This revealed the necessity of having decision support tools as well as standard operation plans in different levels.

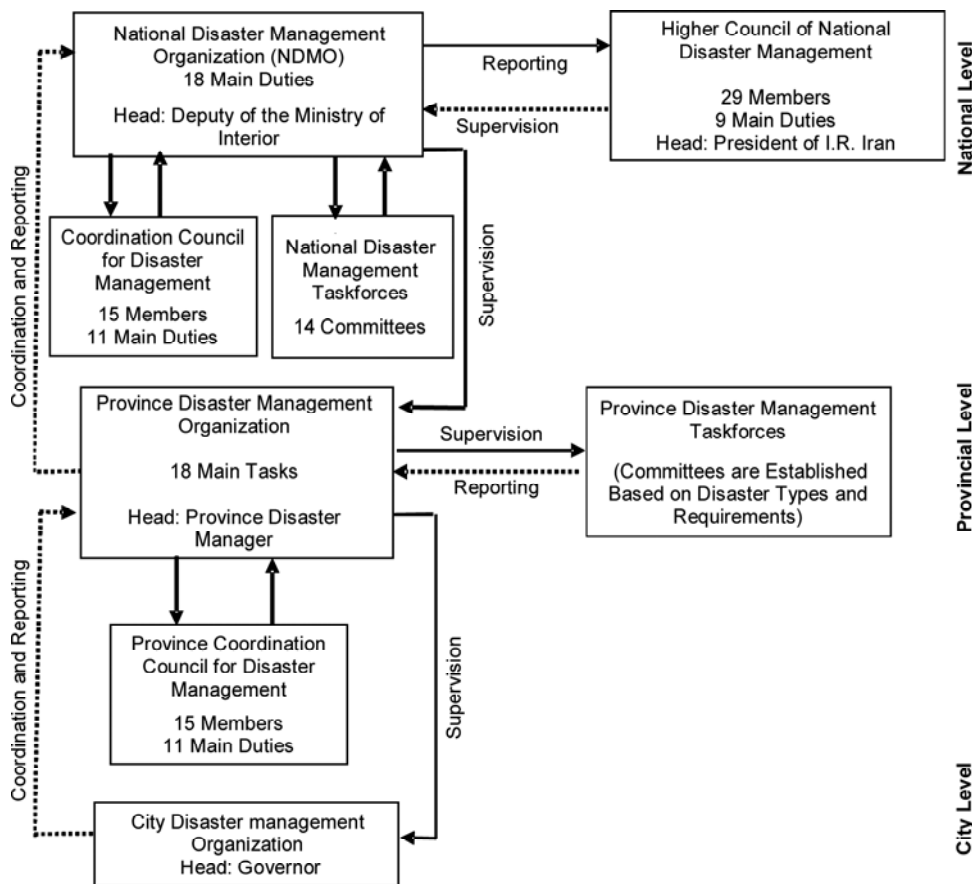


Figure 2. Disaster Management structure based on DM laws and regulations in Iran.

#### **4.2. Search and Rescue Activities**

The Iranian Red Crescent Society (RCS) is the responsible organization for search and rescue (S&R) after disasters in Iran. Following this earthquake, the Red Crescent Society of Iran (RCS) Emergency Operation Center (EOC) of Kermanshah province were mobilized and sent rescue teams to the earthquake stricken area to help the people. However, due to the high number of affected villages (around 2000 towns and villages), they could only reach few accessible affected areas. Thus, local people and neighbors in most of the stricken areas were the first responders to help people immediately after the earthquake, especially in remote villages.

The role of army in search and rescue especially in the immediate hours after the event has been highlighted more than other relief organizations. Before sending the professional and voluntary teams, the army was present in the area helping the locals. Many of the survivors showed their gratitude to the army for their assistance. Accordingly, the main challenges in regard to search and rescue can be summarized as follows:

- ❖ Lack of enough and precise information on the extent of damage and the number of casualties: Due to the lack of evaluation systems for quick loss estimation, it was impossible to evaluate the effects of the earthquake immediately after the disaster. It should be mentioned that after the Sarpol-e Zahab earthquake, the satellite data were available and was processed for loss assessment, but they were not applicable for quick response.
- ❖ Lack of special programs for systematic search and rescue: This resulted in delay in search and rescue operations, and many villages remained indistinguishable for many hours after the event. Additionally the systematic search and rescue (using GIS and GPS tracking systems) was not implemented by RCS teams to facilitate access to those areas that needed further assistance.
- ❖ Delay in dispatching search and rescue teams: Due to the lack of information, the mobilization of S&R teams was done with delay. In addition, there was no unified plan for sending the search and rescue to many stricken villages. Considering the importance of first hours for saving lives, this

could cause further casualties.

- ❖ Lack of enough knowledge of local people for search and rescue operation: Due to the delay in dispatching professional teams to the affected areas by this earthquake, the local people were the first responders to the victims. The locals tried to help those who were trapped under the debris. However, in some cases, the lack of their knowledge in first aid measures as well as inappropriate methods to move and transport the injured people resulted in severe injuries.

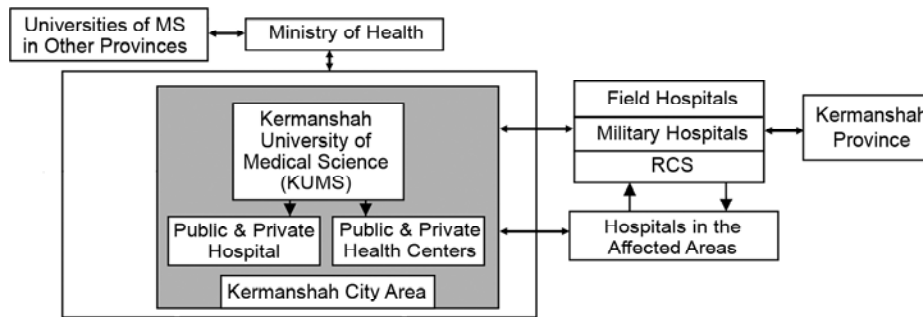
#### **4.3. Emergency Medical Care**

Most of the medical centers in the affected areas (especially in Sarpol-e Zahab, Kerend, Islam Abad) have been damaged by earthquake, even the newly constructed ones. The blackout after the earthquake was also another important issue that caused problems for providing necessary services to the injured people. This caused a big challenge for providing medical care to those injured by the earthquake. Accordingly, they had to be transferred to the city of Kermanshah that was quite far from the affected area. Based on the available reports [9], the medical centers in Kermanshah were mobilized to provide necessary services to the injured, but rush of outpatients caused some difficulties especially during the first three hours after the earthquake. Therefore, many people who were in need for emergency cares could not receive appropriate medical services during the first couple of hours. However, the situation improved after about eight hours due to implementing triage and HICS and allocating additional resources to the rural and urban areas. The systematic procedure established after this event can be summarized in Figure (3).

The field hospitals that were installed in the affected areas played very important roles to provide necessary medical and health services (Figure 4). In general, most of local residents were content by the medical service that was provided after this event.

#### **4.4. Emergency Shelters**

One of the main and basic needs of those affected by earthquake is emergency shelter. In Iran, the Red Crescent Society (RCS) is responsible for providing



**Figure 3.** The structure of medical care system in Kermanshah after the earthquake.



**Figure 4.** Mobile field hospitals in Sarpol-e Zahab (Photo: Amini Hosseini).

shelters. Due to the extent of damage, the emergency sheltering were considered as a priority after a few hours following the Kermanshah earthquake and RCS provided tents for several days aftermath. Of course, the delay in sending tents and their inappropriate distribution was a major challenge in the area. Considering the season of earthquake occurrence and the cold weather condition, delay in providing emergency shelter caused serious problems for the survivors and this caused many chaos and tension in the area. However, coordination improved gradually by dispatching additional tents to the earthquake affected areas.

Another challenge was the shortage of showers and toilets around the camps. This problem has been resolved in some areas few days after the event, by installation of pre-fabricated bathrooms (Figure 5).

Additionally, emergency public free telephones (Figure 6a) were installed in some places near to the shelters. Providing electricity power in shelters (tents) was also among other important tasks that were done gradually in the next few days following the earthquake (Figure 6b).



**Figure 5.** Sample of showers and toilets in the area (Photo: Amini Hosseini).

#### 4.5. Distribution of Relief Items

Although sufficient aids were sent to the affected areas through governmental and private sectors, the distribution of goods was inappropriate. In many villages adjacent to the main roads, people could receive many items, while in far villages, the received assistance was insufficient.

It took several days before RCS could manage the situation and distributed the relief packages to all families. This problem has also been observed in many other past events, which some part is related to the lack of public awareness and participation in distributing the aid and insufficient cooperation among relevant organizations [10].

#### 4.6. Information Dissemination

NDMO, as the responsible organization for





(a)



(b)

**Figure 6.** Installation of public emergency telephones and distribution of electricity to the tents (photo: Amini Hosseini).

disaster management in Iran, assigned a speaker to provide official information to people through broadcasting in radio and TV channels. However, massive number of correct and incorrect news was also disseminated to people through other unofficial networks and social media such as WhatsApp and Telegram at the same time. Rumors and false information caused difficulties for the responsible organizations to some extent. For example, in some of those social media, it was requested to send items that were not necessary in the affected areas or people were asked to help victims directly, while there were no need to dispatch untrained and inexperienced people to the sites. It was observed that in many places, those people have been an overburden to the rescue activities.

Another shortage in information dissemination was the lack of a reliable ICT system to be accessible to all residents. For instance, a cloud-hosted emergency information website with mapping capabilities could be useful to inform residents about the extent of damage in their area, of road closures, open petrol stations, distribution centers of essential supplies, as well as the medical and shelter sites [11].

#### 4.7. Community Participation

People participation in the recovery and reconstruction process after an earthquake is highly important [12]. In this earthquake, interviews with people reported the high level of community assistance after the earthquake. As was stated, the relief groups were unable to reach the area immediately and many injured could survive with the help of

neighbors and local people [13].

Additionally, the assistance from people of adjacent areas and cities in providing tents, blankets and food for the stricken area was remarkable. Many of the rescued people stated the reasonable amount of assistance they received from local people much earlier than the rescue and relief forces could reach the area.

#### 4.8. National Security Issues

Kermanshah province is near the Iraq borders. Considering the security issues in Iraq, there is always special attention to this place and the military forces have many bases in the area. After the earthquake, the army forces were dispatched to the stricken area and provided considerable assistance to the victims and survivors. Additionally, they participated in restoring safety and security in the affected areas. Although they were successful in maintaining the security, there were also some challenges. For example, few residents of undamaged zones rushed into the city in order to get the tents and other assistance. In few cases, the looters rubbed the belonging of the affected people. Therefore, many survivors preferred to stay near their houses in order to safeguard their properties. For this reason, many tents were erected near buildings that were damaged or unusable. Besides, many tents were set near the main roads with no sufficient safety; as they were in danger of car accidents (Figure 7).

#### 4.9. Problems Concerning Fire

Although some gas pipelines have been damaged



**Figure 7.** Threat of car accidents to the tents near the main roads (Photo: Amini Hosseini).



**Figure 8.** Playground was prepared for children amusement near the tents (Photo: Amini Hosseini).

in the affected areas by the earthquake, fortunately, there was no serious problem of fire or explosion due to this earthquake, and the responsible agencies could manage the situation immediately. However, some tents caught fire due to the misuse of ovens or heaters. Considering the cold weather at the time of earthquake, many people used gas or electrical heaters inside their tents. This caused fire ignition in some cases and caused more injuries.

#### 4.10. Mental and Psychological Issues

One of the most important issues after any earthquake is to consider the mental and psychological issues of the affected people. Various programs were organized in this regard to improve the mental condition of people. One of the most active organizations was the Iranian Welfare Organization which has accomplished extensive provisions and programs in the area from the second day after the earthquake. In addition, RSC (Youth Organization) provided considerable efforts in this aspect. Moreover, Welfare Science universities provided voluntary services to people in the area. Accordingly, many teams were sent including psychologists, psychiatrists and nurses to check affected people in their tents and to provide the following services and consultation:

- ❖ Visiting the tents: In the first days after the earthquake, visits were taken place at the tents to talk to people about what had happened and to provide them with sincere consultation and care;
- ❖ Restating the event among everyone: Creating a sincere and friendly situation among the affected people helps them cope with the situation. Sitting

together and talk about their feeling can also help them;

- ❖ Providing sanitation tips to women;
- ❖ Organizing musical performances for the kids, showing movies and cartoons;
- ❖ Giving story books and toys such as balls, dolls, etc. to children as gifts and creating a calm and enjoyable environment for them;
- ❖ Identifying the homeless children and introducing them to the Welfare Organization;
- ❖ Evaluating the mental needs of the affected people.

Children were among the groups that suffered more after the earthquake. Therefore, some playgrounds were installed for children near their tents in order to reduce their moral tensions few weeks after the earthquake (Figure 8).

Besides, volunteer groups were present in the area to help and amuse children in order to release their tension. There were also teams who were active to help the elderly and to assist them with their special needs.

## 5. Temporary Shelters

Few weeks after the earthquake, providing temporary settlement for the survivors was the first priority in managing the situation. The temporary houses were prepared and distributed by the governmental organizations as well as private sectors and individuals.

It was decided to provide pre-fabricated houses to all victims. However, this was agreed to be distributed in different stages. The first urgency was to those survivors who have lost at least one of their



families in the earthquake. The next priority was for those with destroyed houses, and then to ones with damaged houses.

While there was a big effort to distribute pre-fabricated houses to all survivors, but due to the huge number of requests, it was not possible to procure such houses for many people in few weeks after the earthquake. Therefore, many of the survivors were settled in tents and this was not ideal due to the weather condition in that area. Additionally, providing clean water for drinking and sanitation was a big challenge especially in places where temporary houses were installed. To resolve this issue, water pumps and tanks were installed near prefabricated houses in some areas to provide clean water for drinking and sanitation purposes (Figure 9).

Although prefabricated houses are much better than tents, it should also be mentioned that using them are not always the best solution for temporary settlement of the survivors. As noted, the climatology of the affected area is somehow that the prefabricated houses are not compatible with the cold weather. Therefore, it was seen that in some rural areas, people used their traditional shelters, which needed to be sealed against wind, rain and cold weather (Figure 10).

## 6. Debris Removal

As noted, many houses were destroyed in the stricken area due to the earthquake. Therefore, the debris removal was undertaken for search and rescue as well as clearing the path and preparing the land for temporary settlement. There were although some problems that can be mentioned. For example, not enough space could be found to pile the debris and there was pileup in places that could make environmental consequences. Near roads, rivers and slopes were the most places used to dump the debris.

In addition, there was no plan to recycle the debris. Only the steel materials were bought by the local buyers and were sent outside the affected cities or villages for recycling.

## 7. Discussion and Lessons Learnt

Sarpol-e Zahab, Iran Earthquake revealed many challenges in disaster management system of Iran



Figure 9. Providing clean water near temporary houses sites (photo: IZADKHAH).



(a)



(b)

Figure 10. Inside and outside traditional tents used as temporary shelters (photo: Amini Hosseini).

and provided new horizons for improving the existing situation. Fortunately, the main earthquake occurred after a foreshock that caused many people to leave their houses and most of them were outside their buildings during the main shock. It could be expected that a tragedy could have happened if there was no foreshock or if the earthquake epicenter was closer to the high populated city of Kermanshah. Therefore, there are many lessons in this event that can be learnt to improve the existing condition and to be more prepared for future destructive events. These lessons can be listed as follows:

- ❖ Necessity to improve local capacities: As depicted, the first responders in that event were the family members and neighbors. The rescue teams dispatched some hours after the event, when most of rescue activities were undertaken by the local residents. If appropriate training to residents can be provided at local levels and necessary tools and materials be kept at each community, the effectiveness of local activities can be improved drastically. A safe public building (such as school or mosque) that is available at each community can be considered as local base for disaster management and local people can be responsible to manage it using local and governmental financial and technical assistance. In this line, a program is now implementing in Iran called as "Safe Schools - Resilient Communities". The main purpose of this program is to reduce risk and to improve capacities for response activities using local resources to increase the resilience of each community. Additionally, necessary incentives and encouragement should be provided by municipalities or other related officials to motivate the active participation of local people in disaster management issues, including risk reduction and emergency response.
- ❖ Importance of increasing public awareness and preparedness: The analysis of data gathered after this earthquake demonstrated that most of those people living in the affected areas were not familiar with the culture of safety. They were unaware about the importance of living in safe buildings and what is appropriate behavior during and after an earthquake. Therefore, necessary training should be provided using all available means and media. Additionally, preparedness level has to be monitored and measured occasionally during public drills and practices. Such programs may improve public awareness and participation in risk reduction and response management and may resolve many challenges observed after that earthquake.
- ❖ Expansion of disaster management plans and instructions: It is very important that each organization knows its responsibilities immediately after an earthquake to provide necessary services in the most appropriate time and suitable manner. Therefore, Standard Operation Plans (SOPs) as well as Initial Action Plans (IAPs) should be prepared for relevant organizations in different time intervals based on the potential earthquake scenarios. By having such plans immediately after an earthquake (even before organizing Disaster Management Taskforce meeting), each organization knows its duties and can provide necessary services. This can avoid overlaps in responsibilities and roles. Such plans should be prepared at each city based on socio-cultural considerations of each specified community.
- ❖ Developing disaster management capacities and tools: As discussed, during the first couples of hours after the Sarpol-e Zahab earthquake, there was no clear picture about its potential impacts. This showed the necessity of developing decision support tools in each province and city. One of the most important tools for such purpose is to develop quick damage and loss assessment systems. By using this tool, the first estimation about potential casualties and damage can be provided based on data gathered by seismographs or accelerometers during the first couple of minutes after an earthquake and it could help to understand the priorities for dispatching the rescue teams to the most stricken areas as quickly as possible.
- ❖ Acquiring online and rapid data acquisition from satellite imagery providers: One of the main difficulties in that event was to obtain high quality satellite images right after the earthquake. Basically, acquiring both before and after high quality imagery is not always possible in Iran at the moment. Therefore, a systematic data acquisition or operating a dedicated satellite

constellation for the country is recommended. Additionally, it is necessary to develop mobile-GIS data collection system in compiling ground data (i.e. damage data to be used in empirical fragility curves, etc.).

- ❖ Enhancing cooperation among governmental and non-governmental organizations: In this event, it was shown that the lack of coordination between governmental and non-governmental organizations caused some challenges in providing necessary services to the survivors. In order to prevent the duplication in providing services, clarifying the responsibilities and organizing distribution of materials, it is necessary to manage relevant activities of different stakeholders. It can also maximize the speed of recovery.
- ❖ Capacity building for search and rescue: It is clear that in case of a major earthquake in a high populated area, RCS does not have enough capacity to respond to all needs during the first couple of days. Therefore, it is necessary to make plans to use the capacities of local people, military forces and other volunteers in advance. Such plans and opportunities should be prepared and practiced based on local conditions and available resources to clearly show the roles and duties of each group in the aftermath of an earthquake;
- ❖ Improving emergency medical care: As depicted, most of the hospitals in the affected areas have been damaged by this earthquake and were out of service for several days. Since the medical care centers are considered among the most important facilities after the earthquake, it is important to retrofit all structural and non-structural elements in such facilities to be assured about their correct and functional performance after an earthquake. Additionally, the medical staff should be trained about the potential impacts of an earthquake and what they should expect to do in such disastrous conditions. It is also necessary to prepare HICS as well as Hospital Disaster Plan (HDP). In order to prevent the overwhelming of hospitals by outpatient, it is necessary to make appropriate plans such as implementing Mass Casualty Management (MCM) procedures.
- ❖ Providing socio-economic recovery solutions: Besides the reconstruction of houses, it is

important to recover socio-economic as well as cultural consequences of earthquake. Such aspects can be normally neglected during the reconstruction phase. Considering the experiences of recent earthquakes in Iran, it can be predicted that lack of sufficient attention to such aspects in reconstruction of damaged cities and villages by Sarpol-e Zahab earthquake may result in irrecoverable negative socio-economic impacts. Additionally, it is important that physiological and psychological treatment be continuously provided for those who lost their families or properties, especially children, women and the elders.

- ❖ Developing national building inventory: This can be done according to different sources of data and exploring methods in fusing the data together for augmenting the quality (i.e. spatial resolution, reliability, etc.) of the information regarding elements at risks (i.e. buildings and population). Producing high spatial resolution data (i.e. at building level) is sought ideally.
- ❖ Considering local conditions in providing emergency and temporary shelters: Almost after all earthquakes in Iran, tents are used for emergency sheltering and some types of pre-fabricated houses are provided for temporary housing. With regard to the variety of climate in different parts of Iran, local and traditional methods should be studied and developed for providing such services to victims.

Developing online and rapid damage mapping techniques: This is important for citywide, region-wide and country-wide quick loss estimation.

## **8. Conclusion**

The main challenges in preparedness and emergency response of recent Sarpol-e Zahab (Kermanshah), Iran earthquake were introduced in this paper. In addition, the relevant positive and negative aspects which should be considered in future probable earthquakes were highlighted. In short, the positive aspects included the cooperation of local people and army in search and rescue and appropriate performance in providing medical care to the survivors. The effectiveness of public awareness in reducing casualties was also another important lesson of this earthquake. Besides,

capacity for mobilizing huge amount of donations for the survivors from all around the country was an important point that needs to be studied in more detail for disaster management planning. Negative aspects though included lack of information in first hours after the earthquake, difficulties of providing necessary search and rescue services and inappropriate distribution of tents, goods and materials for the affected people especially during the first couple of days that should all be overlooked in future earthquakes.

The results of this study may reveal the shortages and weaknesses as well as capacities and strengths for earthquake risk management in Iran that should be improved for future potential events. Additionally, lessons learnt in this study would help countries with similar situations to cope with probable impending earthquakes.

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