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## **COMMUNITY CHALLENGES FOLLOWING DARB-E-ASTANEH (SILAKHORE) EARTHQUAKE OF MARCH 31, 2006**

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### **ABSTRACT**

On March 31, 2006, at 4:47 a.m., a moderate earthquake (ML=6.1) occurred in the South of Borujerd in the western part of Iran. Several foreshocks struck the area one day before the event. The largest foreshock measuring ML=5.1 resulted in many people abandoning their homes and setting up tents away from built-up areas. An aftershock was also recorded at 5:01 a.m. on March 31 with ML=4.9. Although the earthquake was not of high magnitude in comparison to the Bam earthquake, it still resulted in the loss of lives of tens of people and extensive structural damage. The earthquake claimed approximately 70 lives with a further 1400 injured, and partially destroyed or damaged more than 330 villages in the Silakhor region (between the cities of Borujerd and Dorud) with up to 55 percent damage. The occurrence of eight earthquakes in the period of May 3-5, 2005 in the Borujerd region, and 17 consecutive earthquakes with magnitudes of 2.5-4 between 21-27 of November 2004 in the Poledokhtar region is an indicator of the high seismicity of this area.

This paper addresses part of the challenges the affected community faced after this event, including the degree of emergency assistance; the gap between relief and recovery phase; the people coping mechanisms; and part of the reconstruction phase for destroyed buildings, etc. In addition, approaches to recovery, such as building on local and national capacities, risk management, and enhanced coordination are discussed. Key issues such as the need for education and training, the use of available resources and public awareness and on-time information dissemination are also addressed in this earthquake.

### **Introduction**

Lorestan Province covers 28064 square kilometers and is located in the west part of Iran. It borders Isfahan in east, Hamadan and Central provinces in north, Khozestan in south and Kermaanshah and Illam in the west. The highest point in Lorestan is Oshtorankooch which is 4050 meters above the sea level. The Lorestan weather is usually cold in winter and moderate in summer (Sarvghad Moghadam 2006). Within Lorestan province are the cities of Khorram Abad, Borujerd, Aligoodarz, Dorud, Kooch dasht, Delfan, Selseleh and Poledokhtar.

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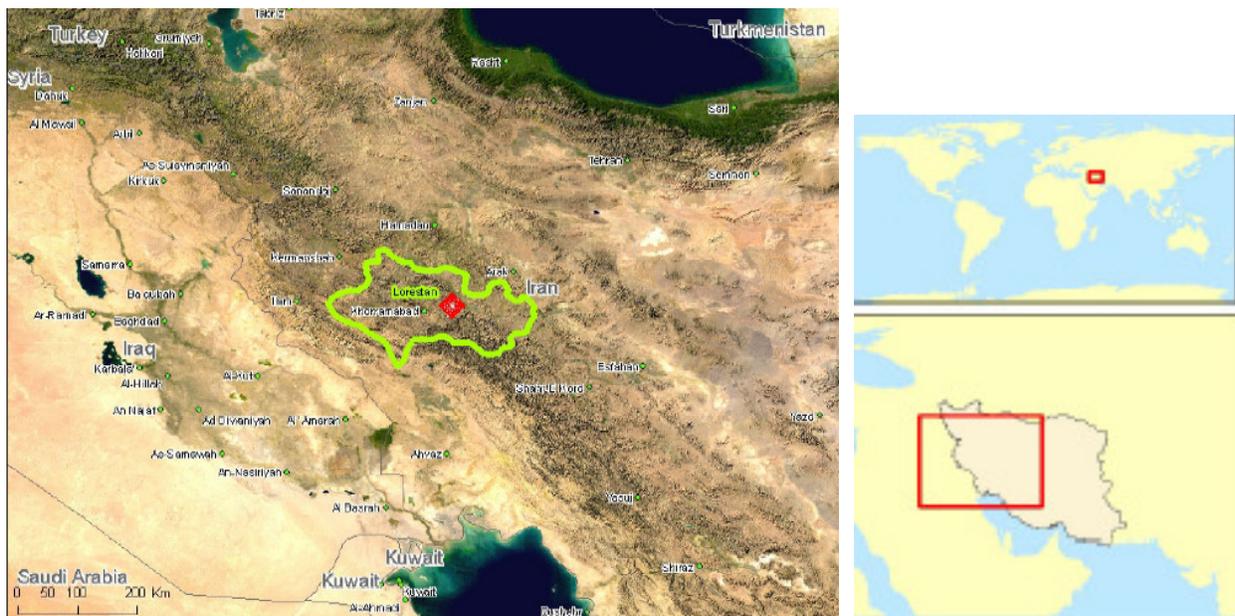
Borujerd is mountainous and is located in the Alborz heights and the Silakhore desert. The city is situated 1580 meters above sea level and is 33.09 degrees North and 48.08 East. Borujerd is one of the oldest cities in Iran, dating back to the Sassanian period. This city lies on the Tehran-Koozestan main road. The distance between Borujerd and Arak city is 110 kilometers, with Isfahan and Tehran 350 and 390 kilometers away respectively. Most of the people in the area (southern villages) belong to the Lors and Torks tribes and secure their livelihoods through agriculture and animal husbandry.

Based on 2004 statistics, Borujerd's population was over 400,000, of which 30% live in the villages. The city suffers from this high density. In area, Borujerd is less than 6% of the whole Lorestan province, but its population is 20% of the Lorestan. It is the 24<sup>th</sup> biggest city in Iran and the second biggest city in Lorestan province after Khorram Abad (Ministry of Interior report 2006).

Dorud is located in the northeast of the Lorestan province and borders Borujerd from the west. Around 9% of Lorestan population live in Dorud. There are two main districts in Dorud: Central part and Challaan Chulan. As noted earlier, the epicenter of the earthquake was in Silakhore region between Borujerd and Dorud cities. Darb-e-Astaneh was the closest city to the earthquake epicenter.

### Darb-e-Astaneh (Silakhore) Earthquake

On March 31, 2006, at 4:47 a.m., a moderate earthquake (ML=6.1) occurred in south of Borujerd in western Iran. Several foreshocks struck the area one day before the event. The largest foreshock measuring ML=5.1 resulted in many people abandoning their homes and setting up tents away from built-up areas. An aftershock was also recorded at 5:01 a.m. on March 31 with ML=4.9. The Lorestan earthquake situation map is shown in Fig. 1, (ReliefWeb 2006).



Source: (IFRC 2006)

Figure 1. Lorestan earthquake, situation map.

The earthquake claimed around 70 lives, 1400 injuries, and partially destroyed or damaged more than 330 villages in the Silakhore region (between Borujerd and Dorud cities) suffered up to 55 percent damage as shown in Tables 1 and 2.

Table 1. Number of death and injured.

<b>Number of Death and Injured</b>	Number of Injured	Number of Death	Total
Borujerd	1140	45	1185
Khorram Abad	93	-	148
Dorud	130	18	93
Selseleh	55	-	55
<b>Total</b>	1418	63	1521

Table 2. Damaged infrastructures in Borujerd.

<b>Infrastructure</b>	<b>Damage (percent)</b>
Imam Khomeini Hospital	100
Chamran Hospital	30
8 units of Primary Schools	100
2 units of Health-Care Facilities	100
The Brojured-Chaghalvandi Bridges	30

Sources for Tables 1 and 2: (Ministry of Interior Report 2006)

## **Community Challenges**

### **Status of Immediate and Short-Term Response Activities**

In March 31st, after the occurrence of the foreshock at 23:06 p.m., the aid and rescue teams and the national disaster management organisation of the affected area were activated. The assessment teams were dispatched to the region within half an hour (12:30 a.m.). After this earthquake, which caused minor damage to the villages with few injured, people were informed through warning teams in the area which resulted in a reduction of the casualties when the main earthquake happened at 4:47 a.m. the next day. Meanwhile, all the aid personnel and a team of local people in Dorud were mobilised. One aid team comprising the Red Crescent of Iran personnel, and an operational team with equipment consisting of an ambulance and two dogs were located in the Chalaan Chulan area. Teams in Isfahan, Kermanshah, Ilam, Khoozestan and Central provinces were all mobilised and sent to the affected regions to speed up the aid process in the morning of the earthquake's occurrence. At the same time, an influx of people who had no expertise regarding the search and rescue was also evident in the area which in some way hampered the search and rescue efforts of the prepared teams.

Based on the statistics obtained from the Borujerd disaster committee, the preliminary assessment was undertaken within a day of the earthquake occurrence which identified the damaged regions and villages. Based on a UNICEF report undertaken after the disaster, the Rapid Assessment team suggested a two-pronged strategy for the people of the affected area: 1) immediate emergency relief interventions and 2) short and medium-term recovery measures (UNICEF 2006).

The Red Crescent Society of Iran and the military played key roles in the preliminary response and the provision of emergency aid to affected population, similar to Bam earthquake (Tierney et al 2004). The distribution of foods was undertaken by the Red Crescent Society of Iran based on the region's need assessment. Most of the injured were given aid identify cards. In light of the number of villages, one main committee and seven sub-committees were organised in Borujerd.

After the immediate search and rescue was activated and very basic needs were met, the next process

started which included the provision of emergency shelters. Due to the amount of the damage, the villages were prioritised according to a three-level classification:

- 1) Villages with above 60% damage
- 2) Villages with 30%-60% damage
- 3) Villages with damage less than 30%.

According to this division, Darb-e-Astaneh and neighboring villages had suffered the most damage, so the distribution of tents by the operational committees started in those villages. Many houses and residential complexes were completely affected or damaged in the whole area presented in Table 3.

Table 3. Estimated number of affected residential houses.

Village	Number of affected units in rural areas	Number of affected units in urban areas	<b>Total</b>
Borujerd	12999	13529	26528
Khorram Abad	4350	1990	6340
Dorud	10950	3386	14336
Selseleh	3050	1100	4150
<b>Total</b>	<b>31349</b>	<b>20005</b>	<b>51354</b>

Source: (Ministry of Interior Report 2006)

The occurrence of a few foreshocks before the main shock was one of the reasons why casualties were low. It allowed people to leave their homes and stay outdoors during the night before the earthquake. In spite of the small number of casualties in this earthquake, the structural damage and social and economical problems existed. The social damage to people in the area created a negative effect on the quality and process of the aid distribution.

Due to the occurrence of aftershocks, many people preferred to stay outdoors in open areas such as streets and parks and use fires to protect themselves against cold weather or stay out of their homes waiting for assistance, Fig. 2.



Photos: Mahdavifar

Figure 2. People awaiting outside their damaged houses looking for help.

Tents were provided by the Red Crescent Society of Iran to many of the homeless, Fig.3. However, it was stated that although 26,000 tents were distributed among the survivors, 15 to 20 thousands family in the stricken areas were still in need of temporary housing (Red Crescent Society of Iran 2006). It appeared that people were encountering a lot of problems in spite of the help provided by the search and rescue teams. Also, there was the threat of looting from homes with broken windows.



Photo: Tajik

Figure 3. Temporary tents set up on the top of the destroyed houses.

Interviews with people in the affected areas revealed that some of them were not satisfied with the distribution of tents and the aid received from the supportive teams. As a result, people were forced to keep themselves warm by wrapping themselves in duvets around in the streets. As noted earlier, many people preferred to stay out doors in fear of another aftershock or an earthquake. At the same time, major population shifts occurred as a consequence of the earthquake.

A majority of schools were partially damaged or destroyed in the areas worst affected by the earthquake and aftershocks. Many other buildings were damaged beyond repair or considered unsafe to use. Unfortunately, from 88 health-care facilities in the area, 16 were completely destroyed and 4 were partially damaged (Sarvghad Moghadam et al 2006). However, the houses were notably less damaged in comparison to the Bam earthquake.

One of the main problems that people faced immediately after the earthquake was lack of security and enough regional forces to maintain public order. The main reasons for public disorder were the lack of proper public awareness, shortages of food, the closure of the banks, offices and lack of tents for people to use. These all led into the increase of black market activity. (Sarvghad Moghadam et al 2006). Similar problems had been identified following other earlier earthquakes in Iran. Problems included the inappropriate distribution of aid equipment and resources, improper assistance to survivors, lack of proper sanitation, lack of money, psychological damage mostly to children and women, and food shortages. There were also problems with rumors circulating, which escalated the chaotic situation. In addition, rubble had been removed in rush without paying much attention to the fact that some people might still be buried alive under the piles. The reason behind all these was the lack of an organised system to properly respond to people's needs immediately after the earthquake.

Sanitation services in the stricken area were inadequate for the number of people without toilets and showers and did not match the number of injured and homeless. As mentioned earlier, assistance from search and rescue personnel and from teams who distributed foods was not properly organised. Lack of coordination among the involved staff was observed almost everywhere. Many survivors also suffered immediate psychological problems due to the loss of their close relatives. People were panic-stricken by the likely prospect of further tremors.

## Status of Stricken Area after Four Months

The stricken area including Valaashan, Karvaneh, Ganjineh, Darb-e-Astaneh villages and Chalaan-Chulan area were visited again on June 1, 2006, exactly four months after the earthquake. The main observations of the general situation can be stated as follows:

Walking through the villages, piles of rubbles were still seen everywhere reminding everyone of the occurrence of a major earthquake in the area. However, the difference of people's mood and enthusiasm in comparison to what was observed in Bam earthquake was noticeable. People seemed more active and energetic in rebuilding their houses and continuing with their routines. There was an optimistic spirit spread around the area.

Sanitation problems though still existed after four months. Although there were prefabricated toilets and showers installed by the government and by other volunteer organisations, long queues of people waiting to use these facilities were observed in many places, Fig. 4. Children, mainly boys, preferred to take showers in the river instead of waiting in the long queues at the door of one of the official houses, Fig. 5. Women and girls though were the exception, as they could only take shower in special places assigned for them which were not enough for their population. Skin problems were common due to the lack of and access to enough water resulting in some long-term life-threatening diseases.



Photos: Izadkhah

Figure 4. Children standing close to a prefabricated showers installed by the government.

Figure 5. Children taking their daily shower in the river in Karvaneh village.

Still after four months, many people were sheltering in basic tents that were distributed to them in the first days after the earthquake, see Figs. 6 and 7.



Figure 6. Basic tents for people in Darb-e-Astaneh.

Figure 7. People living in large numbers in tents.

Some tents were not in good condition or water-tight, forcing people to move out due to the high rate of rainfall at that time of year. In interviews, many families were requesting more assistance from the government in this regard. The situation resulting from shortages of tents even after a few months increased the chaotic atmosphere among those families who were in need of tents and were obliged to live with their relatives in large numbers. However, ironically, some seemed to use the distributed tents for other purposes as shown in Fig. 8.



Photo: Izadkhah

Figure 8. Red Crescent tents used for protecting a car in Ganjineh village.

Some businesses had been established in prefabricated containers, stalls and makeshift sheds in the cities near their villages. Most of the villagers continued to rely on their livelihood through agriculture. Although in a few areas, it was observed that the situation after the earthquake caused many survivors to leave the area on at least temporary basis to search for new jobs.

Given cold night time temperatures, the situation left children and elderly highly vulnerable to diseases, Fig. 9, (Sethna 2006).



Photos: Izadkhah

Figure 9. Children and elderly vulnerable to this earthquake in Karvaneh village.

Visiting the villages, there were few non-governmental organizations and agencies present in the area after four months. This was different in comparison to the Bam earthquake where several various NGO's were active in the area a year or more after the earthquake.

Almost everywhere in the villages, children were somehow trying to help their parents in securing their family livelihood. They were waiting near where their parents worked and were called upon to fetch and carry lighter building materials or food for their families or to look after the younger children in the family, Fig. 10a. As in many disasters in the past, women played a crucial role in the recovery and reconstruction process, Fig.10b. In some cases, they show themselves to be stronger in terms of recovering from the immediate consequences of the earthquake and helping to secure the livelihoods of their entire family.



Photos: Izadkhah

Figure 10. Children and women helping in the process of reconstruction in Darb-e-Astaneh village.

While passing one of the villages, one could observe that the reconstruction of roads had started in many places. The reconstruction process was more organized than after the Bam earthquake. Local people seemed to show much interest to assist in rebuilding their houses. In some places such as Darb-e-Astaneh (the most affected area), many houses were under construction, Fig. 11. However, in many places under construction, the distance between the tents and the destroyed houses was less than it should be according to the safety rules, as it is shown in Fig. 10b.



Photos: Izadkhah

Figure 11. The reconstruction process was started with the partial financial support from government in Darb-e-Astaneh and other affected villages.

Schools were operating in tents and prefabricated units, however, it seemed that the students of one village were obliged to use the same class for all the various age groups. The first author interviewed a

few children of different ages in Karvaneh village, though surprisingly, all of them seemed to attend the 3<sup>rd</sup> grade class. Few schools were recently built or installed in various villages with the support of the government for the children to attend in the following months, Figs. 12-13.



Photos: Izadkhah

Figure 12. Children were almost everywhere to help. Figure 13. One of the newly built schools.

As in most major earthquakes, the impacts on the health and psychological well-being of survivors worsened in the weeks following the earthquake.

### **Recommendations and Conclusions**

The sections above have attempted to provide a broad picture of both earthquake impacts and the community challenges in an immediate, short and long term basis. There is much more to say, however it is beyond the limit of this paper. Many of the lessons learnt are in common with what have been observed in previous earthquakes. To sum up, a few recommendations based on the authors' observation in short and long term after the earthquake is as follows:

#### **Short Term Issues**

- The security systems of the big cities can be vulnerable in the earthquakes, resulting in civil disorder in the short term. Therefore, there is a need to create a local security system with the help of the Red Crescent Society as well as training the young volunteers in villages to provide assistance to these forces if necessary.
- In the first hours after the earthquake, attention should be focused on appropriate and organized search and rescue for people trapped under the rubble. The use of heavy equipment in clearing destroyed areas needs careful assessment and action.
- There is a need to pay attention to the quality of the material used in tents for survivors in order to prevent further difficulties. Tents without any bottoms can not resist the rainfall and will force people to resort in living outdoors.
- The role of the army is very important after the earthquakes. They can be trained beforehand and mobilized quickly in order to help efficiently in search and rescue efforts. They can also assist in balancing the security of the area after a disastrous earthquake and controlling the chaotic situation as is proved in many previous disasters around the world.
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- There is a need to increase the public awareness of earthquakes for all levels of society, especially the school children, women and elderly in rural areas. This can be achieved through performing preparedness drills in schools or by teaching the elderly and women in mosques and other public places where people normally gather.

### Long Term Issues

- The transitions through the phases of response, early recovery, and long- term recovery need to be more managed. This needs the coordination of many groups involved.
- People should be kept informed and updated of the aid process in order to become more active and enthusiastic in contributing to the recovery and reconstruction phases based on their ability.
- With regard to the motivation of the people in the stricken area, they can be trained by the structural experts to assist in rebuilding their houses. The importance of local people's participation in rebuilding their cities is one of the issues that have also been observed in many previous major earthquakes, such as Gujarat 2001 in India and Bam 2003 in Iran.
- Further research is needed to evaluate the provision of services to affected populations, including physical health care and temporary and permanent housing.
- The impacts on the psychological well-beings of survivors increase in no time. Particular attention should be paid to these indirect and secondary but important effects of the earthquakes.

Earthquakes are regular threats to countries such as Iran and people continue to be challenged by them. Therefore increasing the culture of seismic safety among all levels of society is one of the priorities that need the full attention of all related authorities. Improving the quality of related organizations involved in search and rescue efforts during and after earthquakes also requires further attention. A scenario-based emergency management plan and approach can lead to a more efficient use of the human resources and better distribution of goods, etc. Finally, education and training should be emphasized more than ever to make people more resilient to the consequences of the earthquakes.

### References

Ministry of Interior Report, 2006. The performance of operational activities of national organisations after the Silakhore Earthquake, *Preliminary Report, Iran*.

Red Crescent Society of Iran, 2006. Website: [www.rcs.ir](http://www.rcs.ir).

Relief Web, 2006. Silakhore Earthquake, Situation map.  
<http://www.reliefweb.int/rw/RWB.NSF/db900SID/AHAA-6NEJZD?OpenDocument>, Information Bulletin 01/2006. Issued 31 March 2006. Source: International Federation of Red Cross and Red Crescent Societies (IFRC), Map data sources: ESRI.

Sarvghad Moghadam, A. et al, 2006. "Report of the Darb-e-Astaneh Silakhore earthquake", March 31, 2006. *International Institute of Earthquake Engineering and Seismology Report, Iran*.

Sethna, Z., 2006. Children among the most vulnerable after quake and aftershocks in Lorestan, Iran, UNICEF, <http://reliefweb.int/rw/RWB.NSF/db900SID/LSGZ-6NLGM9?OpenDocument>.

Tierney, K. et al., 2004. Reconnaissance report on Bam earthquake: Social and public policy issues, *Journal of Seismology and Earthquake Engineering, Bam Special Edition 5 (4)*, 209-215.

UNICEF, 2006. Earthquakes in Lorestan, *Outlook Special Edition*, April.