TOWARDS A CULTURE OF RESILIENCE AND EARTHQUAKE DISASTER RISK REDUCTION IN IRAN – "LESSONS-LEARNED" FROM EARTHQUAKE DISASTERS

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ABSTRACT

It is a common phenomenon that the next earthquake will test whether lessons from previous disasters became "Lessons-Learned" or they were simply ignored and forgotten. As a dramatic reality, repetition of lessons from earthquake disasters occurs in both time and space. To learn the lessons from two large earthquake disasters in Iran - Rudbar 1990 and Bam 2003 and also lessons from other six large earthquake disasters worldwide - requires a sustainable long-term framework, a culture of earthquake disaster risk reduction and a boost in the resilience of both rural and urban communities at risk. The Japanese model of such culture as an illustrative example and few practical suggestions for implementation are offered for the Iranian seismic space.

1. INTRODUCTION

Earthquakes are geological phenomena which are integral part of the course of nature and life on Earth (Berberian, 2014). However earthquakes are events that dramatically affect our complex societies (Bilham, 2009). In the last decades, within the "disaster risk reduction arena", speaking and writing about "Lessons"

and particularly “Lessons-Learned” became a common phenomenon (Alexander, 2012). Nonetheless, many questions remained unanswered and among them a persistent question: Are the lessons from earthquake disasters really “Lessons-Learned” and if not, what may give a boost in order the lessons to become “learned”? In this regard, Iran and two of the numerous earthquake disasters during the time (Berberian, 2014; Ambraseys and Melville, 1982) were chosen as case studies of this work; Rudbar earthquake disaster in 1990 and Bam in 2003. Non-exhaustive insights of their lessons are presented within the following section. Moreover, in order to offer a broader international perspective, various insights into lessons from other six worldwide earthquake disasters are presented; Spitak-1988, in Armenia; Kobe-1995, in Japan; Marmara-1999, in Turkey; Gujarat-2001, in India; Kashmir-2005, in Pakistan and Wenchuan-2008, in China.

2. LESSONS FROM TWO LARGE EARTHQUAKE DISASTERS IN IRAN

2.1. LESSONS FROM RUDBAR EARTHQUAKE, 1990

Rudbar earthquake with M_w (moment magnitude) of 7.3 occurred on 20 June 1990, in Western Alborz Mountains in northern Iran, southwest of Caspian Sea. The death toll was about 40,000 people, 60,000 people were injured and more than 500,000 homeless. Both rural and urban areas were affected - the cities and towns of Rudbar, Manjil, Lowshan and Harzevil were entirely demolished, Rasht city affected, 700 villages were destroyed and other 300 suffered damages (Berberian, 2014). Liquefaction had its contribution for causing great damages to the earthquake area (Astaneh and Ghafory-Ashtiany, 1990). Between 76 and 140 landslides occurred and especially two landslides, Rudbar and Fatalak were very destructive as entire villages completely disappeared (Shahrivar and Nadim, 2005). Such landslides and many heavy rock falls considerably delayed the action of search, rescue and relief teams (IIEES Report, 1990). An essential lesson was that a comprehensive assessment of earthquake hazard needs to include the hazard associated with earthquake-landslides (Rodriguez et al., 1999). The poor seismic performance of adobe, stone and unreinforced masonry buildings added to the lessons of Rudbar earthquake. Severe damages of oil and gas pipelines for a distance of several kilometres were added to the lessons of earthquake. Moreover, it strongly recommended for the necessary improvements in other cities of Iran (IIEES, 1990).

2.2. LESSONS FROM BAM EARTHQUAKE, 2003

The 26 December 2003 Bam urban earthquake had a magnitude of moment M_w 6.6, but in terms of the death toll, had almost the same fatalities as Rudbar earthquake, see Fig. 1. In addition, Bam earthquake was between 26 and 36 times more destructive and fatal comparative with other previous seismic events of M_w 6.6 in Iran (Berberian, 2014). The performance of adobe residential buildings in Bam was disastrous and the necessity to implement the vital lesson of seismic rehabilitation of adobe buildings was once more emphasized. It was found that the application of wood, steel, and reinforced concrete beams and other connective elements impedes walls and roofs from collapse. In addition, a good quality of work, compliance with buildings codes and good quality of building materials were recommended (Maheri et al., 2005; Nadim et al., 2004). The most serious “geotechnical effect” identified after the earthquake was collapse of qanats - traditional underground water channels. As Bam is situated in an arid area of Iran, where the water main sources are represented by the underground water resources, an important lesson highlighted the connection among the sources of water, existence of qanats and resilience of communities (Ibrion et al., 2014; Ibrion et al., 2015). In addition, De Ville de Goyet (2007) highlighted that in order to control the outbreak of various diseases after the disasters, one of the first priorities is to ensure the access to clean water and the function of sanitation services.

3. LESSONS FROM OTHER SIX LARGE WORLWIDE EARTHQUAKE DISASTERS

3.1. LESSONS FROM SPITAK EARTHQUAKE, 1988, ARMENIA

On 7 December 1988, an earthquake with M_w 6.7 took place in the northern part of Armenia. The earthquake destroyed two cities, Spitak and Leninakan (nowadays Gyumri) and more than 100 villages. The

official number of death was 25,000 people, 140,000 injured and more than half a million became homeless (Berberian, 1997).

Necessity of implementation of a mental health recovery program was seen as one of the lessons of this earthquake (Goenjian, 1993). Occurrence of massive landslides highlighted the lesson for a sound preparedness towards this matter (Rodriguez et al., 1999).

Based on the tragic experiences offered by Armenia earthquake regarding the crush syndrome, and role of nephrologists, necessity of the international preparedness was seen as mandatory; 600 registered cases were victims of the crush syndrome after earthquake. In order to mitigate survivors of earthquakes to become victims of "renal disasters" international logistics and support were seen as necessary (Sukru Sever et al., 2009). In this regard, International Society of Nephrology organized a logistic organization named Renal Disaster Relief Task Force. Its intervention and logistic support were appreciated as positive during earthquakes in Turkey 1999, Bam 2003 and Kashmir 2005. However, both external interventions and local resources need to closely collaborate (Fukagawa, 2007; Sukru Sever et al., 2009). In addition, the vulnerability of reinforced concrete buildings highlighted the lesson for the improvement of buildings' seismic performance, their design and construction (Spence 2007).

3.2. LESSONS FROM KOBE EARTHQUAKE, 1995, JAPAN

Hanshin-Awaji or Great Hanshin earthquake, more known as Kobe earthquake, with M_w 6.9 occurred on 17 January 1995. Its death toll was 6,610 people (Fukagawa, 2007). Atsumi and Okano (2004) emphasized that the society's focus and concern on the Kobe survivors was not kept for long time, but faded away within few years after the earthquake. The identified lesson was to keep alive the memory of the earthquake disaster and its survivors for long term in order to learn from them. Another lesson concerned the necessity of sharing Kobe earthquake's lessons to other parts of the world. This initiative was put in practice after earthquake disaster of Bam. One of the shared lessons by the Japanese delegations in Bam was that international non-governmental organizations (NGO) leave the affected area within few months after earthquake. Therefore, the local NGO and local organizations together with governmental organizations have an important role in relief and reconstruction processes. Another lesson from Kobe earthquake was the interdisciplinary work and the necessary collaboration of researchers and practitioners from various fields. This lesson was identified as one of the biggest lesson-learned from Kobe, as highlighted by Hiroyuki Aoyama, the founding president of Japan Association for Earthquake Engineering (JAEE) which was established in 2001. This lesson is part of the aim of JAAE towards earthquake disaster preparedness. Another lesson from Kobe earthquake was referred by Fukagawa (2007) as the experiences and lessons from crush syndrome, the role of nephrology and dialysis units. Blockage of roads after the earthquake pointed to the lesson of a better preparedness for the transportation of injured survivors.

3.3. LESSONS FROM MARMARA EARTHQUAKE, 1999, TURKEY

Kocaeli or Marmara earthquake occurred on 17 August 1999, with M_w of 7.4 and a death toll of 17,127 and 43,953 injured people (Ozerdem and Barakat, 2000). According to Sukru Sever et al. (2009) the crush syndrome was one of the major causes of mortality after earthquake. The "Renal disaster" took its toll after this earthquake with 639 registered victims' cases with crush syndrome. Regarding other lessons from Marmara earthquake, Ozerdem and Barakat (2000) highlighted the necessity of increasing earthquake public awareness and education for both urban and rural communities. Moreover the civil society needs to play a more active role in earthquake disaster preparedness. Interdisciplinary collaboration was recommended among academia, engineers and other professionals and governmental organizations. The massive collapse of the reinforced concrete buildings highlighted the lesson for necessity of the implementation of seismic codes, improving quality of workmanship, construction materials, sound urban planning law and insurance schemes (Spence, 2007; Arslan and Korkmaz, 2006; Ozerdem and Barakat, 2000).

3.4. LESSONS FROM GUJARAT EARTHQUAKE, 2001, INDIA

Gujarat or Bhuj earthquake of M_w 7.6 occurred on 26 January 2001 in western Gujarat of India. Both urban and rural areas were affected, and 18 towns and 7,940 villages suffered severe damages. More than 20,000 people died and almost the same number severely injured, as reported officially. Among the Bhuj earthquake disaster's lessons, these are highlighted: to launch a national earthquake mitigation programme for implementation of building codes and land use regulations, improvement of search and rescue capacities (Sharma 2001) and necessity of implementation of disaster relief policies (Bremer 2003). Moreover, more than 17 earthen dams were affected by earthquake, but because water reservoirs behind dams were empty, due to prolonged drought in the area, only 4 dams suffered severe damages. Their seismic performance recommended as a lesson, the necessary advancement of earthquake engineering to consider the disastrous consequences of dams failure (Krinitzsky and Hynes, 2002).

3.5. LESSONS FROM KASHMIR EARTHQUAKE, 2005, PAKISTAN

Earthquake in Kashmir, Pakistan, occurred on 8 October 2005 with M_w of 7.6. The death toll was 86,000 people, more than 69,000 were injured and approximately 4 million were left homeless (Owen et al., 2008). As per De Ville de Goyet (2007) an identified lesson of this earthquake disaster was the necessity for disaster preparedness of the health governmental institutions. Health authorities needed to be more involved in the improvement of the seismic performance of health facilities and to enhance their capacities to meet the needs of injured in case of disasters. Transportation of injured people, education and preparedness of local health staff needed further attention. The creation of a disaster center within national health organization was seen as necessary by the authorities in Pakistan. The improvement of coping capacity of local communities was also required. This earthquake occurred within remote mountainous areas with only few roads of access. Earthquake-induced landslides affected further the access (Owen et al., 2008). Rescue and relief could not be provided in time and even some of the remote places took months in order to be accessed. This situation had a high impact on the number of death.

3.6. LESSONS FROM WENCHUAN EARTHQUAKE, 2008, CHINA

Wenchuan earthquake with M_w of 8.0 occurred on 12 May 2008 in Sichuan province and affected 237 counties in Sichuan, Gansu and Shanxi provinces. From the time of Tanghshan earthquake in 1976, Wenchuan earthquake was the most catastrophic earthquake in China. As per official reports issued after 137 days from the earthquake, 69,227 people were confirmed dead, 374,643 injured, 17,923 people missing, approximately 46,240,000 people affected by the earthquake and 15,100,000 people displaced since they had to leave their houses and to search for safer places and shelters (Zhang et al., 2012). More than 60,000 landslides after the earthquake caused about one-third of the death toll (Huang and Fan 2013). Among the Wenchuan earthquake lessons, Zhang et al. (2012) highlighted the followings: effects on survivors' mental health, prevention for the outbreaks of various infectious diseases, evacuation of people and the role of aviation within the transportation of injured people, as well as better health preparedness for earthquake disasters. Moreover, after Wenchuan earthquake disaster, the communication about earthquake preparedness, emergency rescue and other vital information in case of earthquake were offered abundantly by the media. The accessibility of information by the society was incomparably much higher than before, in comparison, for instance, with the situation after Tanghshan earthquake disaster in 1976 (Zhang et al., 2012).

4. DISCUSSION: LESSONS, "LESSONS-LEARNED" AND LEARNING FROM EARTHQUAKE DISASTERS

The landscape of lessons from eight earthquake disasters - two in Iran and six around the world as presented in Sections 3 and 4- does not offer an exhaustive overview of lessons, as the scope of paper is limited to offer just a glimpse of them. Definitely, each of these 8 earthquake disasters brought many essential lessons for the country where they occurred. All of these earthquake disasters can be truly

considered as "wake-up calls" in their countries and for others, in terms of actions, preparedness and strategies towards earthquake disaster reduction. In a time span, these earthquake disasters occurred quite near each other, in a 20 years' time interval, see Figure 1.

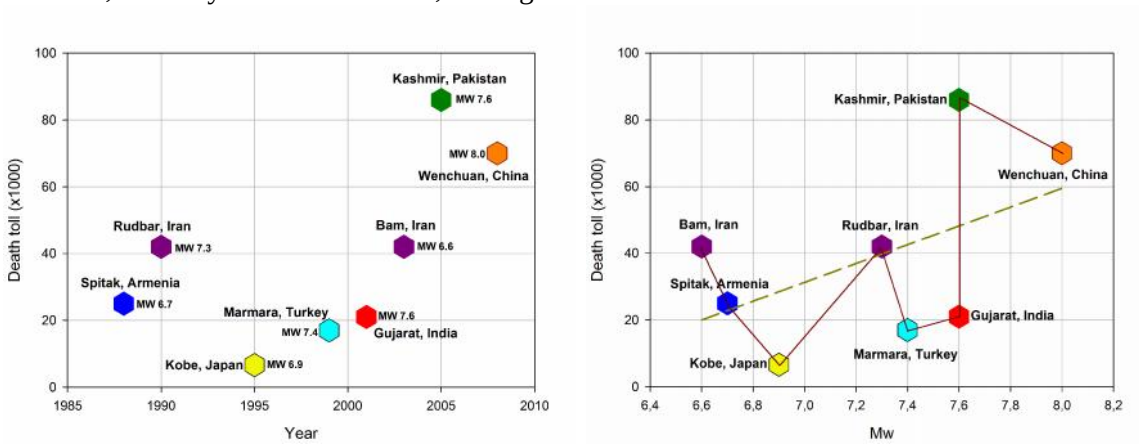

Figure 1. Large earthquake disasters in Iran and around the world in a 20 years' time interval (1988-2008), left: death toll versus year, right: death toll versus M_w

Despite various geographical spaces and that each earthquake disaster brought specific lessons for its place of occurrence, many of the lessons are common between all of these earthquake disasters. The need to improve the seismic performance of buildings, better preparedness for the earthquake-induced landslides, improvement of infrastructure, especially in mountainous areas, national and international preparedness about crush syndrome and role of nephrologists and dialysis units, mental health recovery programs, necessity of interdisciplinary work, and the need to raise earthquake awareness and education, just to name few of the common lessons among the eight analysed earthquake disasters. A particular lesson from Kobe 1995 was to share the earthquake disaster's lessons at international level. This lesson was put in practice and become a "Lesson-Learned" after the earthquake disaster in 2003, Bam, Iran. Another particular lesson from 1995 Kobe earthquake disaster was the necessity to keep alive the memory of earthquake disasters and its survivors. The importance of this lesson emerged also after Bam earthquake. Almost ten years after Bam earthquake, the voices of its survivors were heard through their dramatic narratives:

"Earthquake of Bam left a very rich experience for all other parts of Iran and other countries in the world which have earthquakes. But to get this experience, people of Bam paid a very high price by losing their loved ones. And such suffering, sadness and very heavy burden can only be reduced, if people of Bam see that other people in Iran make use of this experience very well and not letting other earthquake disasters to happen again."

Bam survivors' narratives highlight the necessity to learn from lessons of the earthquake disasters, to make use of survivors' tragic experiences and to dedicate efforts to build and enhance resilience of communities in both urban and rural areas in Iran. The high death toll of both Rudbar 1990 and Bam 2003, and also the high death number from other earthquake disasters in the world, except Kobe, Japan – see Fig. 1. – draw attention that earthquake risk is still far from being reduced to an acceptable or tolerable level by the communities and societies (Lacasse et al., 2012). Moreover, such human losses cannot be acceptable taking in account the survivors' experiences, the multitude of lessons from previous disasters in the same country or around the world, the high number and a large range of scientists, engineers, specialists, abundant technical and scientific literature and numerous national and international events dedicated to reduction of disasters such as IDNDR (United Nations International Decade of Natural Disaster Reduction) between 1990-2000, UNISDR created in 1999 and WCDR (World Conference on Disaster Reduction) in 2005. The knowledge about earthquake disasters needs to be put in practice in a responsible way by the national institutions, organizations, policy makers and with adequate planning and long-term financial budgets (Berberian 2014; Alexander 2011). Furthermore, implementation of lessons and learning from earthquake disasters is a complex and dynamic process which requires responsible involvement, a serious degree of accountability and participation of everybody starting from individual level, families, communities, society, to the international level. Definitely, the degree of accountability varies from one level to another.

After Rudbar 1990 and Bam 2003 and also after the other 6 earthquake disasters, there is the probability that many of their identified lessons, to be forgotten, even ignored or pending to be "learned" and

applied within disaster risk management. In this case, after a time period, when a new earthquake disaster occurs in other spaces, the "un-learned" lessons which were identified for previous earthquake disasters emerge again together with newly identified lessons. In this way, an unfortunate repetition of lessons occurs in time and space. Much of the lessons from earthquake disasters are just merely "identified" and postponed to be truly "learned". Consequently, next earthquakes have still an important role in testing whether lessons from previous earthquake disasters were "learned" and incorporated within earthquake disaster reduction, or were just ignored, and remained forgotten over the time.

As a viable solution for the earthquake disasters, Berberian (2014) draws attention that is essential to "create a culture of prevention". Moreover, Alexander (2011) advised that it is necessary "to create a culture of resilience against the earthquakes" and Cutter et al. (2013) highlighted that "a culture of resilience" needs to be implemented. Learning from all 8 large earthquake disasters and in order their lessons to become truly "Lessons-Learned" requires a sustainable long-term framework, such as a culture of resilience for communities at risk and earthquake disaster risk reduction. Taking in account the low death toll versus magnitude of Kobe earthquake, and in comparison with other earthquake disasters with lower magnitude, but much higher death toll, see Fig. 1, Japan started long time ago to build and to enhance such culture. Furthermore, Japanese culture of resilience and earthquake disaster risk reduction received a further boost after Kobe earthquake. Definitely, uncertainty needs to be taken in account and one way to reduce the epistemic uncertainty is to continuously incorporate in practice the lessons from past and recent earthquake disasters. Nevertheless, the cascade of disasters which occurred after 2011 Great East Japan earthquake was beyond the lessons and "Lessons-Learned" from previous disasters. This makes so much alive the Japanese aphorism "You can never be too prepared for earthquakes!" (Fukagawa, 2007).

5. CONCLUSIONS

Repetition of lessons from earthquake disasters occurs both in time and spaces. Learning from earthquake disasters in Iran and worldwide is a dynamic and complex process which requires long-term strategies, responsible disaster risk management and a sustainable framework. Otherwise, next earthquakes will be merely the context for a multitude of earthquake disaster lessons –an amalgam of new and old lessons, all of them waiting to be "learned". Lessons from earthquake disasters and learning to live with earthquakes require the necessity of a culture of resilience and earthquake disaster risk reduction. For seismic space of Iran, few practical suggestions are offered as follows:

I. The well-known axiom that buildings, not earthquakes, kill people is very much valid and relevant. Nowadays, even more, the seismic vulnerability of buildings in the world is part of what Bilham and Gaur (2013) metaphorically called as the real "…weapons of mass destruction ". In Iran, buildings have lost much the traditional meaning as *dwellings* and have instead become an important *commodity* with much less or even any consideration of seismic hazard and implementation of building codes. Rigorous and firm policies and adequate planning need to be responsibly and urgently reconsidered.

II. A single model of implementing and promoting a culture of resilience and earthquake disaster risk reduction is far from being universally applicable. However, the most successful such model till now, seems to be the Japanese culture of learning from disasters and mega-disasters. But, aleatory and epistemic uncertainty has to be also considered and especially, the specificity of place. An effective and sustainable adoption of an international model requires an adaptation to the Iranian local context.

III. The potential contribution of survivors towards "Lessons-Learned" from earthquake disasters needs to be valued and integrated within disaster risk management. Survivors need also to communicate regularly through the media their earthquake disaster experiences and to be effectively included in the commemoration events of earthquake disasters and earthquake awareness campaigns.

IV. A massive migration of population to urban areas requires new approaches and strategies for building and increasing seismic resilience in urban areas, versus rural areas. An immense accumulation of seismic urban risk requires urgent and accountable actions in Iran.

V. Living with earthquake hazard in Iran needs to become an integrated and shared responsibility by everybody, people, families, communities, organizations and institutions. Inaction or irresponsibility about earthquake hazard is not anymore an option, and even more, ignoring or forgetting the lessons from earthquake disasters. Earthquake hazard awareness and preparedness in Iran needs to be in place before earthquake disasters become again and again a dramatic reality.

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