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This paper was submitted to Anglia Ruskin University's Institutional Repository by the author.

Citation: Please cite the published version.

Achour N, Pascale F, Price, AFD, Polverino F, Aciksari K, Miyajima M, Özüçelik N, and Yoshida M (2016), Learning lessons from the 2011 Van Earthquake to enhance healthcare surge capacity in Turkey, *Environmental Hazards*, 15 (1), 74-94. DOI: <http://dx.doi.org/10.1080/17477891.2016.1139539>.

Version: Accepted for publication

Publisher: Taylor & Francis

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Learning lessons from the 2011 Van Earthquake to enhance healthcare surge capacity in Turkey

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Abstract

Historically, Turkey has adopted a reactive approach to natural hazards which resulted in significant losses. However, following the 1999 Kocaeli Earthquake, a more proactive approach has been adopted. This study aims to explore the way this new approach operates on the ground. A multi-national and multi-disciplinary team conducted a field investigation following the 2011 Van Earthquake to identify lessons to inform healthcare emergency planning in Turkey and elsewhere. The team interviewed selected stakeholders including, healthcare emergency responders, search and rescue services, ambulance services, and health authority representatives, in addition to conducting a focus group. Data were analysed according to an open coding process and SWOT analysis. The findings suggest that the approach succeeded in developing a single vision by consolidating official efforts in a more structured way, mobilising many governmental and non-governmental organisations, securing significant amounts of resources including physical and human, and increasing the resilience and flexibility of infrastructure to expand its capacity. However, more attention is required to the development of stronger management procedures and acquisition of further resources.

1. Introduction

Turkey is a tectonically active country, located across 326 faults with approximately 66% of its area laid on active faults subjecting 70% of the population to a high risk of earthquakes. Within the last century, the country was hit by many earthquakes, the greatest of which were the 1939 Erzincan (magnitude $M7.9$) and the 1999 Kocaeli ($M7.4$) earthquakes with a mortality toll of 50,000 people. The latest of this series took place on 23rd October 2011 at 13:41 local time measuring a moment magnitude of $M_w7.1$. The epicentre was located between Van and Erciş cities as shown in Figure 1. The event was followed by over 6,200 aftershocks with North-East and South-West spread (see Figure 2). One of these aftershocks took place on 9 November 2011 in the south of Van measuring $M_w5.6$ (see Figure 3), as a result of the stress that was building up during the aftershocks (Aydan et al., 2012). The main- and after-shocks caused wide spread damage that was estimated at €1.2 billion.

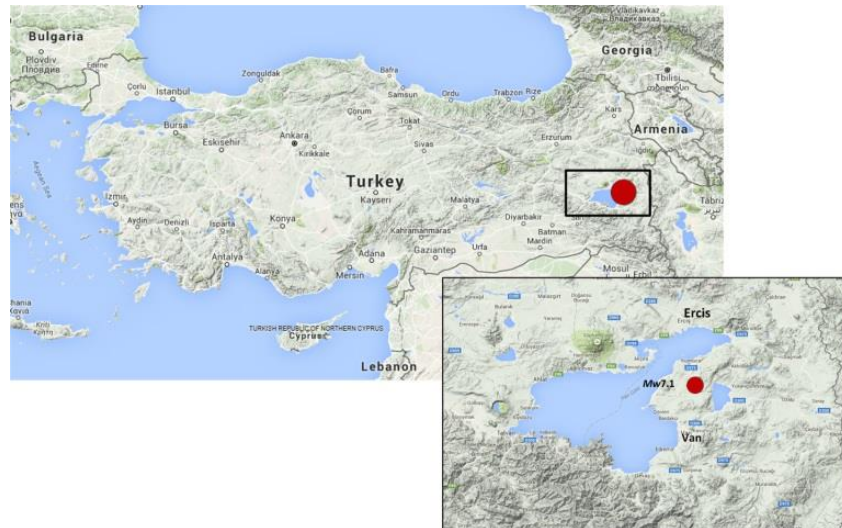


Figure 1 – Epicentre of Van Earthquake of 23 October 2011 (Source: KOERI)

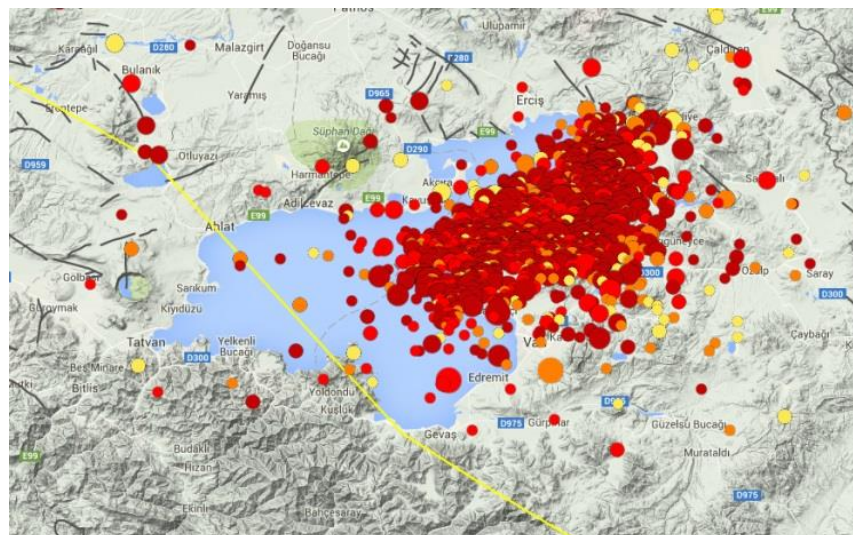


Figure 2 – Aftershock epicentres magnitude $M_w 3$ and above (Source: KOERI)



Figure 3 – Epicentre of main aftershock of 9 November 2011 (Source: KOERI)

1.1 Van earthquake

Van and Erciş cities are located in the province of Van, population of approximately 1.023 million people representing 1.4% of the total Turkish population. The cities' combined populations count for almost half of the population of the province.

The Van Earthquake was characterised by “*a smooth and bilateral rupture*” (Irmak et al., 2012), causing widespread damage, 604 fatalities and 2,608 injuries. The aftershock of 9 November caused much more structural damage (Güney, 2012) in addition to causing a further 40 deaths due to the collapse of Bayram Hotel (Erdik et al., 2012). Approximately 4,000 buildings collapsed or were severely damaged (Güney, 2012) despite the fact that the peak ground acceleration was as low as 150-200cm/sec² (Çelebi et al., 2013). Erdik et al. (2012) reported that hospital and school buildings performed better than in previous experience due to changes in their design requirements. This statement most probably refers to newly built schools and hospitals, as most of the old facilities were damaged resulting in the authorities' decision to demolish and reconstruct these. As a consequence of the main shock, 200,000 people were forced to reside in 3,800 prefabricated Mevlana houses, 2,700 container houses and 14 tent cities. This is in addition to 40,000 who migrated to other regions due to anxiety, distress and lack of trust in the resilience of their buildings.

There was limited damage to critical city lifelines (e.g. water, power, gas, and roads). The majority of these were restored within several hours, but some took up to a week. This situation enabled the efforts of the emergency teams as they were able to search and transfer injuries to medical centres. There were 476 search and rescue (SAR) teams who succeeded in saving the lives of 230 people buried under the rubble (Erdik et al., 2012).

1.2 Emergency response

For many years Turkey followed a reactive approach to disasters (Unlu et al., 2010). Significant resources were allocated to respond to emergencies with the view that this would reduce the impact of disasters. The approach was mainly driven by ‘*fate, reaction and recovery, wait and see, ex-post, crisis management, ad-hoc efforts, and development at risk*’ (Tufekci, 2012). However, following the 1999 Kocaeli (İzmit) Earthquake the Turkish authorities realised that planning is also a key element for disaster risk reduction as many buildings, municipalities, industry, emergency and response agencies were not ready for disasters despite the number of ambulances sent to the stricken areas. The main lessons learnt were the need to; (1) increase the resilience of telecommunication systems (landline and mobile), (2) save capital through minimising resource losses, (3) improve organisation and coordination (in search and rescue, reduce bureaucracy, enhancement of logistical support, and train and organise voluntary efforts), and (4) integrate resilience in the development (building resilient infrastructure and public buildings, enforcing codes, improving inspection during construction). This led to a new approach that is driven by: “*choice, proactivity, mitigation, anticipation and prevention, ex-ante, risk management, comprehensive approach, and sustainable development*” (Tufekci 2012). This study aims to collect information on the way this new approach has been implemented in order to identify key lessons.

Table 1 - Earthquake occurred in Turkey in the last 20 years sorted by numbers of killed (Source: EM-DAT, www.emdat.be)

Earthquake	Date	No Killed	Affected	Injured	Damage (\$US million)
İzmit Körfezi	17/08/1999	17,127	1,358,953	43,953	20,000
Düzce	12/11/1999	845	224,948	4,948	1,000
Erzincan	13/03/1992	653	250,000	3,850	750
Erciş-Van	23/10/2011	604	6,786	2,608	1,500
Bingöl	01/05/2003	177	290,520	520	135
Ceyhan-Adana	28/06/1998	145	1,589,600	16,000	550
Dinar	01/10/1995	94	160,240	240	206
Afyon-Sultandağı	03/02/2002	42	222,000	327	96
Corum-Amasya	14/08/1996	0	17,000	6	30

2. Methodology

This study adopted a qualitative research methodology to “provide rich descriptions of phenomena” and “enhance understanding of the context of events as well as the events themselves” (Sofaer, 1999). Two months after the earthquakes an international team, comprising researchers from England, Italy, Japan and Turkey, conducted field investigations (10-15 December 2011). Data were collected both in the stricken areas of Erciş, Van and Istanbul and involved unstructured interviews and a focus group. Twelve unstructured interviews were conducted with emergency responders representing healthcare providers, search and rescue services, voluntary organisations, ambulance services and health authority representatives. Interviewees represented most of emergency planning and response levels (from transport and treatment of casualties to developing and implementing strategic decisions). Fifteen people involved in the rescue and relief activities in Van (psychologists, emergency physicians, nurses, public health officers, midwives, paramedics) participated in the focus group. The interviews and the focus group were conducted in Turkish, with the support of a professional translator, and recorded. Collected data were supplemented with information distilled from literature, including: research papers, reports, government and non-governmental codes, guidelines and databases. The research was guided with a set of research questions (see Table 2).

Data were organised in an open coding process, in which interviews were analysed and sorted under different subthemes allocated under two main themes: (1) surge capacity (resources); and (2) processes in mass casualty event (MCE) management (Ryan and Bernard, 2003, Hsieh and Shannon, 2005, Elo and Kyngäs, 2008).

A strength, weakness, opportunity and threat (SWOT) analysis was also conducted to deduct the major lessons and recommendations. The findings were classified based on the following criteria:

- **Strengths:** Characteristics (approach/actions) that have led or will potentially lead to an advantageous position (i.e. resilience).
- **Weaknesses:** Characteristics that have led, or will potentially lead to a disadvantageous position (i.e. vulnerability)
- **Opportunities:** Elements that could be exploited to enhance resilience.
- **Threats:** Elements that could lead to major failure of the entire resilience approach.

Table 2 - Research questions and source of information

Question	Source of information
1- What are the major criteria for effective management of mass casualty events?	Literature
2- What is the Turkish approach in building capacity to manage mass casualty events?	Investigations
a. What approach has been adopted to save capitals?	Investigations
b. What improvements have been made to the coordination and organisation of mass casualty events?	Investigations
c. How has resilience been integrated within development?	Investigations
3- What are the major lessons to be learned from the Turkish experience?	Analysis and literature

3. Literature review: Effective management of mass casualty events

3.1 Requirements of surge capacity

Sudden-impact disasters often lead to a sudden increase in demand for healthcare services due to injuries, worsening of chronically ill people and outbreaks (Stratton and Tyler, 2006). Disasters, therefore, may evolve into what internationally is defined as a *mass casualty event*, a situation in which the healthcare services lose their capability to manage the influx of patients (WHO, 2007a). In this situation the provision of uninterrupted healthcare services is a matter of life and death (PAHO, 2008). A healthcare service must have a suitable surge capacity defined as “*a measurable representation of ability to manage a sudden influx of patients. It is dependent on a well-functioning incident management system and the variables of space, supplies, staff and any special considerations (contaminated or contagious patients, for example)*” (ACEP, 2012). In practice, this has resulted in increasing healthcare resources following empirical approaches that are not based on evidence and thus have been viewed as “*obscure*” (Schultz and Koenig, 2006). For example, the United States National Preparedness Guidelines (DHS, 2007) indicate that surge capacity is one of 37 fundamental *capabilities* that the nation must implement in order to be ready to face a disaster.

Surge capacity has been empirically estimated as extra bed capacity in healthcare facilities of 500 beds per million population for patients with symptoms of acute infectious disease, and 50 beds per million population for non-communicable diseases and injuries, such as trauma or burns (HRSA, 2006). In reality, the problem of surge capacity is much more complex and includes at least three essential elements; continuous supplies, sufficient number of healthcare professionals, and infrastructure with appropriate medical equipment (Hammond, 2005, Barbisch and Koenig, 2006, Kaji et al., 2006, Christian et al., 2008).

Researchers have been actively studying surge capacity each from their own point of view. For example, Achour (2007), Zhong et al. (2014) and Jacques et al. (2014) developed comprehensive approaches to evaluate the resilience of hospital buildings. In addition to these academic studies, experts recently revised the WHO Hospital Safety Index (WHO, 2015) which also provides a good combination of structural and non-structural safety and emergency and disaster management. Researchers also looked in detail at the different aspects of hospital resilience such as design perspective Pascale et al. (2014), post-earthquake structural and non-structural performance Achour et al. (2011), and post-earthquake utilities performance (Achour et al., 2014, Myrtle et al., 2005). Others investigated the resources supporting the emergency response process such as estimating number of casualties (Trendafiloski et al., 2008, Turkan and Özel, 2014), and mapping damage to identify potential injuries (Wegscheider et al., 2013).

Literature thus indicates that an effective healthcare surge capacity must have at least the physical ability to extend its space capacity as well as sufficiently available resources, and managerial capability. This concurs very well with recent findings of Kearns et al. (2014) who reviewed the development and progress of surge capacity since the 1900s concluding that the current understanding of surge capacity involves staff, space, supplies and the standard of care.

3.2 Principles of mass casualties management

The successful healthcare response to mass casualty event depends on the effective coordination of the three major response phases pre-hospital care, casualty distribution, and hospital care (CDC, 2010). Effective medical management is an essential element of the pre-hospital care in mass casualty events, and it depends on the appropriate use of resources for timely treatment. Triage is usually used to dispatch patients to the most suitable healthcare providers with the aim to efficiently allocate limited healthcare resources (Jenkins et al., 2008). Consequently, triage officers are expected to be fully aware of the geographical location of healthcare facilities, emergency departments and specific care centres (e.g. trauma and burns) (Kennedy et al., 1996). The evacuation of mass casualties needs to be designed to provide specialized care to specific individuals, such as those with burns and crush injuries, and to move critical, and high resource consumers, injuries, to resource-rich areas (Born et al., 2007). Critical patients, as suggested by Pre-hospital Trauma Life Support (PHTLS) guidelines, should be transferred promptly after primary triage and resuscitation preferably to a Level I trauma centre. Non-urgent patients should be dispatched to further emergency departments in order to reserve the nearer facilities for treating urgent and self-evacuated patients. On arrival at the hospital area, casualties receive a secondary triage, classify as either *critical*, *severe* or *moderate*. For this reason, it is important to organise a triage area outside the emergency department entrance to minimise the re-triage procedures inside the emergency department (Hammond, 2005). In summary, an effective mass casualty management depends at least on: effective coordination of the three response phases, competent triage staff with adequate resources and information, and management processes that take into consideration vulnerable people (e.g. chronically ill people).

4. Turkish experience in mass casualty events

4.1 Reforming the approach of resilience

Resilience has been defined as “*the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of the hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions*” (UNISDR, 2009, WHO, 2015). This definition indicates that resilience has to take into consideration a holistic view of the system and all its components, which can be physical, technical, social and/or psychological, as suggested in Alexander (2013)’s recent concept. The holistic resilience concept is essential for the healthcare service due to its complexity and intertwined components, any damage to any of these components could result in partial or total failure of the service (see Figure 4). Resilient healthcare does not imply only meeting the business continuity obligations, but also addressing the social, moral and ethical necessity, and enhancing the public confidence (UNISDR, 2008). In order for the healthcare service to save lives, it has to be physically and functionally resilient (WHO, 2007b). This denotes that resilience needs to go beyond strengthening the infrastructure (Achour et al., 2011) to include other aspects that are essential for maintaining the continuity of the service. These aspects could be finding ways to reduce the impact of other infrastructures’ failures (Achour et al., 2014), empowering people to interact more with other emergency agencies

(Achour et al., 2015), and developing strategies to improve response to major hazards (Achour and Price, 2010). The findings of this study suggest that the Turkish authorities are implementing a more resilient approach due to lessons gained from previous experience.

Many projects have been launched in Turkey to improve the structural capacity of infrastructure. Amongst these projects is the €1,129 million Istanbul Seismic Risk Mitigation and Emergency Preparedness (ISMEP) project, started in 2006 and expected to end in 2017. This project sought to strengthen emergency capacity, along with seismic risk mitigation for priority public buildings and enforcement of building codes. To target needs for emergency capacity and provide a single approach for emergency response, the *General Directorate of Emergency Management*, the *General Directorate of Civil Defence* and the *General Directorate of Disaster Affairs* have been replaced with the *Disaster and Emergency Presidency (AFAD)* in 2009. Within this approach, the Ministry of Health's *Disaster and Emergency Coordination Centre (SAKOM)* is in charge of the overall coordination in the disaster area, including provincial disaster centres. Provincial disaster centres are in charge of mobilising search and rescue services such as the police, fire brigade, civil defence and other rescue organisations. Different organisations work in partnership when responding to emergency calls to rescue injuries and provide medical care. For example, the *Search and Rescue Division of the Civil Defence* is responsible rescuing people from collapsed buildings, the *National Medical Rescue Teams (UMKE)* provides primary care immediately after rescue, non-governmental search and rescue associations (e.g. AKUT) play a major role in relief following earthquakes and mining organisations support search and rescue efforts because of their specific resources and equipment.

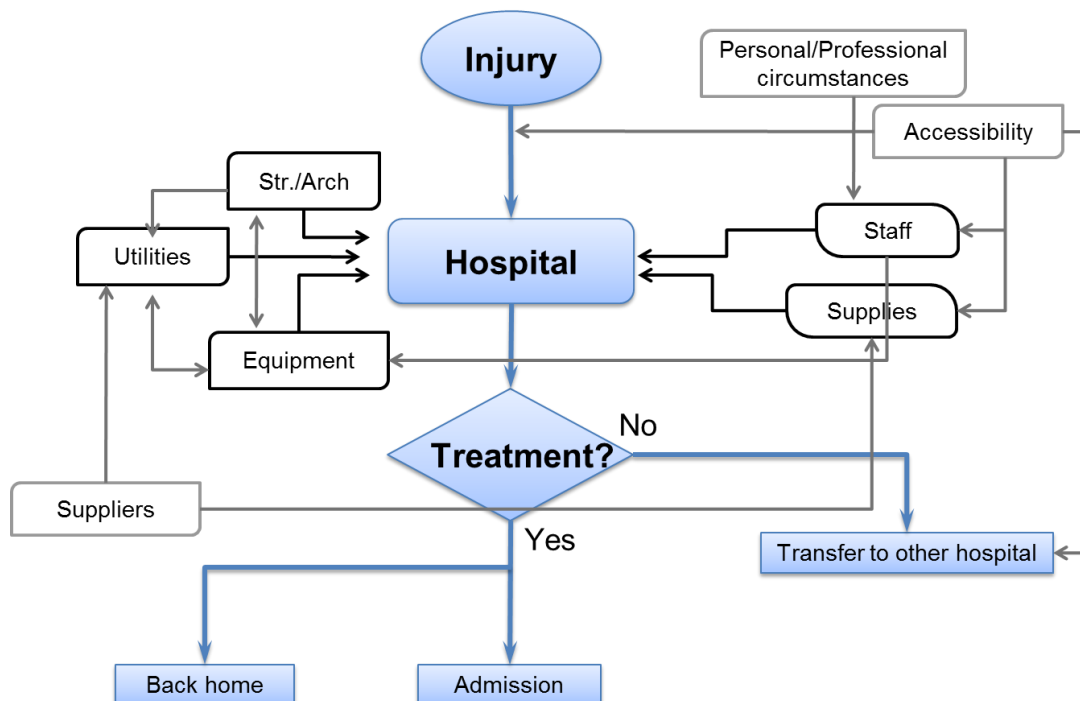


Figure 4: A simplified model for hospital dependencies (internal and external systems).
Source: (Achour 2007, 2015)

4.2 Surge capacity improvements: resources

In the likelihood of an earthquake in Istanbul and as part of the ISMEP project, enormous resources have been allocated to building surge capacity. Significant reform work for healthcare infrastructure renovation has been undertaken, including the construction of new healthcare facilities, retrofitting and renovating existing facilities and increasing bed capacity. Healthcare facilities have been designed to have, single and double patient rooms, each being equipped with enough connections to double their capacity, and underground parking space, allowing green areas to be used for evacuation when needed.

On a daily basis, emergency departments in Istanbul treat an average of 1,000 patients. This indicates that the current facilities are constantly crowded, but also that clinical and non-clinical staff have developed a strong capability and process to deal with large numbers of patients. Plans are to increase the capacity of these departments. The departments have a floor area of between 10,000 and 14,000 square metres, higher than the maximum values proposed by international guidelines such as the UK Health Building Notes – HBN 22 – (DH, 2005) and the Australasian College for Emergency Medicine (ACEP, 2005). However, the location of healthcare facilities is still under debate. Whilst some interviewees view it critical to have the facilities within the city in order to shorten injuries travel distances, others saw this as challenging in terms of injuries, patient transfer and continuity of supplies (e.g. medication and food).

Concerns were expressed by the interviewees regarding continuous hospital utility supplies stating that *‘most of the government hospitals in Istanbul have all the emergency power generators, all the medical supplies and communication system at the bottom of the hospital’* (interviewee). This is a sensible solution for a hospital located in an earthquake prone area because equipment tend to destabilise in upper levels (Achour, 2007). However, because Istanbul is also exposed to floods, generators and fuel supply should ideally be in adjacent locations above flood levels (Achour et al., 2009, Stover, 2009). An effective solution to improve the resilience of the hospitals’ utilities would be provided by equipping ground floors with an anti-flooding system such as gates, which have been adopted in many hospitals around the world such as the Kaohsiung Municipal Hospital in Taiwan (Achour et al., 2009).

In addition, *‘most hospitals in Istanbul are equipped with emergency generator fuel tanks of 200 litres capacity, which is sufficient for approximately 4 hours’* (interviewee), whilst the World Health Organization (WHO) recommends sufficient fuel tank capacity for at least five days (PAHO, 2008). With regard to the number of healthcare professionals, interviewees reported that it is mandatory for Turkish emergency departments to have mass casualty event emergency plans. These plans must have clear procedures to recruit human resources in disaster situations and local healthcare authorities are willing to establish medical rescue teams in each city hospital.

Interviewees expressed concerns over the lack of a clear vision with regard to major emergency response in Istanbul. They noted that the city hosts many thousands of old and vulnerable buildings. The occurrence of a major earthquake could lead to their collapse and thus inaccessibility for the rescue operations. The impact could expand to isolate the entire city. Ataturk Airport is located in an earthquake prone area and *‘maybe we cannot use this airport after an earthquake’* (interviewee). Sabiha Gökçen International Airport is far from the city and is linked to the city through a very-traffic-congested urban motorway and *‘in the rush hour, with the traffic problems, you can’t use those motorways’*, stated an interviewee. The two urban

motorways, linking the European and the Asian sides, could be made unusable by damage, traffic or accidents. Access by ships is challenging because of potential damage to harbours. For all these reasons, it will be difficult to take patients out of the disaster area, but *‘it will also be difficult to receive external assistance within the first 24 or 48 hours’* (interviewee). This situation is aggravated by the lack of potential support from close cities due to Istanbul’s peculiar geographic location: *‘we don’t have closer cities to support us. Istanbul is not a city if you look at how far it is from its neighbouring cities resulting in it being viewed as a small country’* (interviewee).

4.3 Mass casualty management: experience of Van earthquakes

Whilst current surge capacity in Istanbul relies on healthcare infrastructures located in the disaster area, in Erciş and Van it relied on facilities located outside the disaster zones. An interviewee explained the rationale behind the difference of both approaches by stating that building capacity based on infrastructure located outside the disaster area *‘is not the solution for big places like Istanbul, or highly dense cities. The approach adopted in Van was easy to use in this region because the population is not high and the number of injured people was small. In Istanbul you cannot do that’*. Transporting all patients to hospitals outside the disaster area was feasible during Van earthquakes because of the substantial resources allocated (see Table 3), the relatively low volume of population and recent mobile telecommunication system improvements. However, the investigation highlighted several concerns that need to be addressed.

Table 3 - Allocated resources

Resources	Quantities
Search and Rescue	5,267 search and rescue personnel
	34 search dogs
Shelter	72,597 tents
	480 communal tents
	200 tarpaulins
	260 pre-fabricated houses
	2,711 containers
	3,794 Mevlana Houses
	151 toilet/shower containers
Health	2,976 medical personnel
	11 mobile hospitals
	183 ambulances
	18 air ambulances
Equipment	1 mobile oven
	732 construction machinery
	79 projectors
	146 generators

a. **Site information:** The management of the disaster zone was overseen by the *Civil Defence*. Search and rescue operations were led by the *Search and Rescue Division* of the Civil Defence, with the support of non-governmental search and rescue associations and organisations (e.g. AKUT). Approximately 20 minutes after Van Earthquake, the *Disaster and Emergency Coordination Centre* (SAKOM) provided access to, and started searching for survivors within the disaster area. Initially, medical rescue was secured by local medical teams before the arrival of organisations such as the *National Medical Rescue Team* (UMKE) a few hours after the

main shock. The initial challenge faced by the rescue teams was the estimation of the amount of available resources (e.g. medical rescue teams, ambulances, equipment) and managing them based on the limited available information, one interviewee noted that *'it was difficult to find maps of the area'* to locate collapsed buildings, and gather information about the number of victims. Collapsed buildings and casualties were identified through onsite inspections and information provided from local people, because immediately after the shock many people escaped from the disaster area without communicating their destination. Once the situation was assessed, a medical rescue team, an ambulance and a rescue vehicle were sent to each collapsed building.

b. Coordination and collaboration: All 604 casualties caused by the 23rd October shock were transported to hospitals outside the disaster area. On 30th November, 102 patients (36 of them in critical condition) were transferred by planes to hospitals located in cities far away from the disaster area such as Ankara. Vulnerable individuals, such as the chronically ill, mentally disabled and those on dialysis were the most affected by these transfers due to the unclear coordination strategy. Coordinators were assigned by other cities and changed on a weekly basis: *'we had a real problem of coordination because we did not have enough people with experience in earthquake and disaster management and the coordinators arriving from other cities change weekly'* (interviewee). This staffing change indicates a lost opportunity to gain knowledge that supports effective emergency activities and to develop coordination skills that could be used for future events. There were significant material and human resources that were not exploited to their full potential. Most of the volunteers worked as part of national and international emergency teams making them invaluable resources. Yet, *'they didn't know what to do; there was nobody taking control and making decisions; this was a big problem – that of coordination'* (interviewee). An interviewee confirmed by saying: *'now we have more professional teams, more mobile equipment, more vehicles, which is a good development sign for our country; however, effectiveness is still to be targeted'* (interviewee). *'By using less human resources and working in a much more coordinated manner we would have done more effective rescues'* (interviewee). Interviewees also highlighted that collaboration between emergency teams was also a challenge. An interviewee stated *'we worked well with other teams, but we had problems with coordination and logistics'*, and another added *'we worked well with our team but not with other UMKE teams'*. The reason behind this is that, even if each agency had developed its own plans and training, there were no common plans for coping with major disasters. An interviewee stated that *'the crisis centre is creating contingency plans with rehearsals and simulations, but there are individual procedures which are not communicated to other agencies. We are conducting our own contingency plans in our hospitals, as is the national medical rescue team, the fire department, the police department, and there is no sharing of strategies'*. In summary, the constant change in coordination meant a constant lack of clarity combined with absence of leadership and collaboration between teams led to less effective use of resources and difficult environment for emergency operations.

c. Casualties distribution and hospital care: The triage protocol used during Erciş and Van earthquakes was a four level process: *Ambulatory, Delayed, Immediate* and *Deceased*. This is part of procedure used by medical rescue teams, in which all members are aware of their roles. However, this protocol was not always used during the evacuation and dispatch process. An interviewee stated that *'everybody knows what triage is but they don't use it'*. Failing to follow a triage process will potentially led to inappropriate distribution, overwhelming receiving centres that would not be in position to care for patients (Zoraster et al., 2007). Patients were transferred from the impact zone to the Advanced Medical Posts (AMPs). These acted as triage and stabilisation points for patients before transporting them to the most appropriate hospital.

In Erciş, immediately after the earthquake, an AMP was set up in a sports complex for 5 days before a tent hospital was erected in the adjacent car park. The choice of this location was made based on the availability of sufficient parking space for the large number of ambulances and helicopters and situation outside of the city, i.e. more convenient for moving patients to other cities. The dispatch process involved multiple receiving facilities. The Crisis Centre was thus in continuous communication with hospitals via the 112 Command Centre, seeking information regarding their capacity to receive patients. Patient transfer was provided through a number of different organisations with SAKOM coordinating the health response and providing both ground ambulances and helicopter/plane ambulances. Turkish military also provided helicopters and planes at night and in difficult weather conditions.

‘Emergency departments in Turkey operate normally above their capacity’ (interviewee) and it took them two hours on average to be ready to accept patients from the disaster area. According to PHTLS guidelines, critical casualties are to be transferred after primary triage and resuscitation to Level 3 Hospitals. Dynamic solutions were set in place to reach the appropriate surge capacity; the main approach was to rapidly discharge patients already in hospital. Once in hospital, patients were admitted through their emergency department, where they received a second triage and from here sent to the hospital final destination. Figure 5 has been developed to provide a visual illustration of the process followed in Erciş and Van earthquakes.

d. Care in the recovery phase: After the earthquakes, approximately 40,000 people, including local healthcare staff, left the region fearing more earthquakes. Many of the healthcare staff who remained in the area were traumatised and refused to enter healthcare facilities. For example, in Van Regional Training and Research Hospital (VRT&R Hospital), staff members were unable to perform their duties. One interviewee reported that *‘there are operating theatres and intensive care units here, but they didn’t want to use them; it was regrettable to transport patients, who could easily be treated in their current location, out of the area’*. All medical functions, apart from emergency services, were provided in tents located in the parking area in spite of the weather condition and the good state of the hospital building. The three month-old-hospital was designed according to the most recent seismic code, and successfully resisted the tremors. It was designed with the intention to not only hold large meetings and conferences but also to expand its capacity to accommodate the need of mass casualty events (see Figure 6).

The healthcare system relied on the support of medical rescue teams, which with the support of mobile teams, provided on-going care in rural areas for individuals who are incapable of reaching hospitals or local medical centres. In Erciş field hospital, 195 volunteers, of whom 40 were doctors, provided a large range of services such as emergency care, obstetrics and X-rays despite the temperature being several degrees below zero. As a result, interviewees expressed concerns with regard to the load of work. Another interviewee reported that *‘the work is very hard and we are very tired’* expressing the need to improve *‘work and health conditions, by providing better resting areas for rescue teams’*.

Two months after the earthquake, the Ambulance Service call centre was receiving an average of 8,000 calls per day. Once telephonic triage was performed by qualified staff, ambulances were dispatched. However, the damage caused by the quakes, the delays in the post-earthquake building safety evaluation and the shortage of healthcare staff meant that medical care was limited and thus a decision was needed on whether to transfer the patient to a different city or deal with the situation locally.

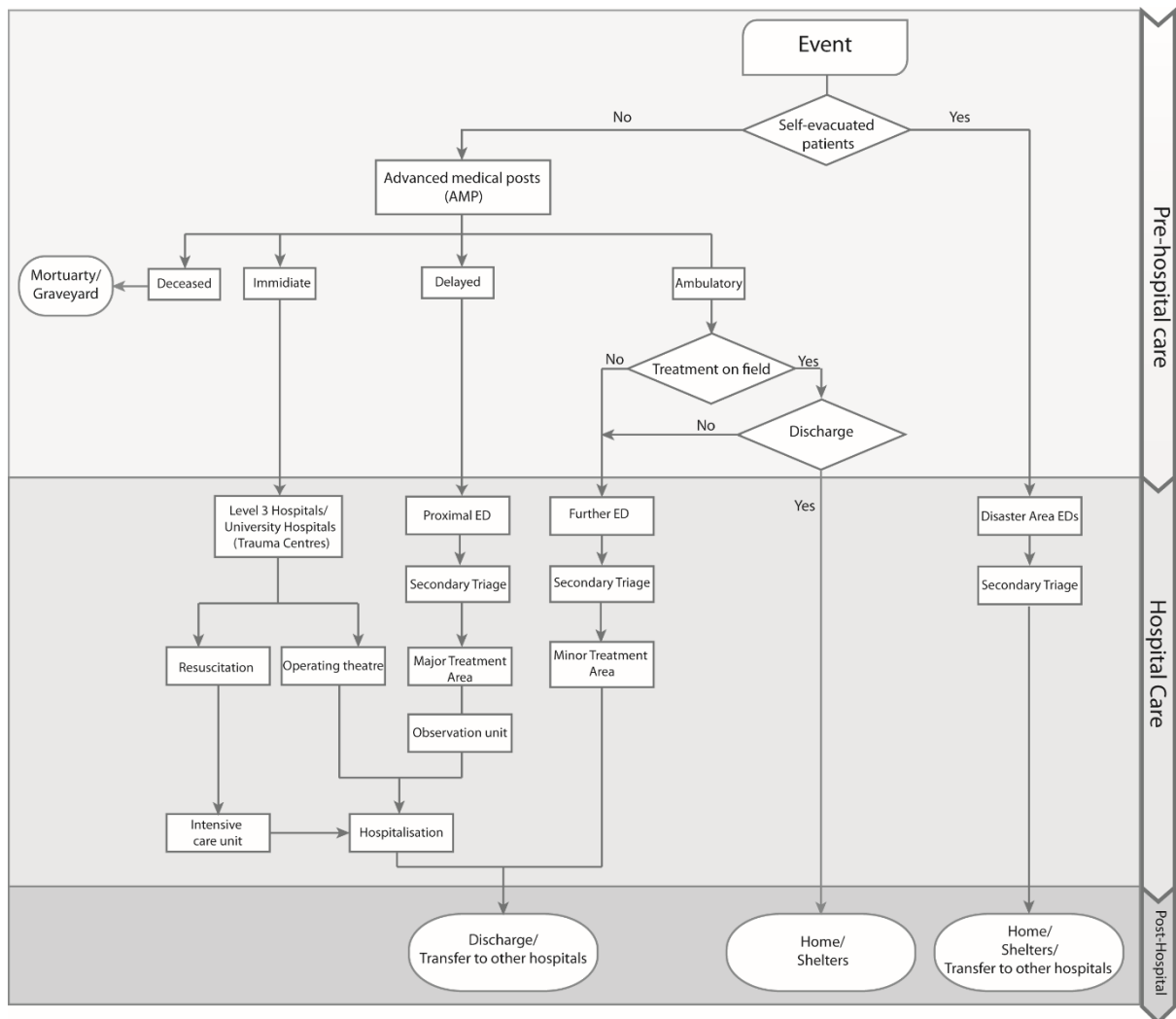


Figure 5 - Patient flow management in Van earthquakes



Figure 6a - Ground floor



Figure 6b - First floor

Figure 6- VRT&R Hospital flexible space

5. Discussion

Despite the vagueness and complexity associated with surge capacity, there are criteria for measurement that could provide information about the ability to manage mass casualty events. These include sound infrastructure and continuous supply and capability to accommodate sudden and progressive influx of patients. They also require sufficient material and competent human resources; and adequate processes for coordination, triage and evacuation. These have been reflected in the major lessons that Turkey learned from its previous experience specifically in terms of saving capital through minimising resource losses, improving organisation and coordination in search and rescue, reducing bureaucracy, enhancing logistical support, training and organising voluntary efforts, and integrating resilience in the development (building resilient infrastructure and public buildings, enforcing codes, improving inspection during construction). Many of these targets have met the criteria for mass casualty events management. However, more work is needed in order to ensure that there is sufficient capacity to cope with major hazards such as that expected in Istanbul. These strengths and weaknesses, in addition to opportunities and threats have been summarised in Figure 6 and detailed in the following sections.

Strength

- Strong and renewed healthcare infrastructure
- Bed capacity
- Evacuation and triage space
- Highly competent human resources
- Substantial transportation resources
- Triage protocols and processes
- Political involvement (e.g. resilience promotion and involvement of army)

Weakness

- No site and resources information
- No clear process to deal with vulnerable people (e.g. chronically ill, staff with PTSD)
- Lack of restoration processes
- Management procedures (e.g. coordination, collaboration)

Opportunities

- Development of a comprehensive emergency model
- More effective and efficient working environment

Threats

- Inadequate risk assessment and failure to adopt a multi-hazards approach
- Change in government priorities/direction
- Resistance of agencies to collaborate and cooperate with each other
- Occurrence of a major hazard before an acceptable preparedness level is achieved

Figure 7 –Strengths, Weaknesses, Opportunities and Threats

5.1 Saving capitals

A major work has been conducted to improve the resilience of infrastructure in terms of building new facilities and retrofitting existing to meet the requirements of the new seismic code, in addition to enforcing building codes. More research needs to be conducted on the geographic location of strategic infrastructure, such as hospitals, in disaster prone areas. This will potentially lead not only to a reduction in the death toll, but also to saving costs associated with healthcare buildings damage. It would also save many hospitals from being damaged and thus lead to extra capacity to deal with sudden and progressive influx of injuries. Some of these hospitals are exposed to more than one risk. These require the adoption of a multiple hazard approach. Failing to do so could lead facilities to an inoperable state such as happened with the

Taiwanese Kaohsiung Municipal Hospital, which lost records of 500,000 patients records stored in the underground floor (Achour and Price, 2010).

5.2 Improvements to organisation and coordination

Successful healthcare response to mass casualty events depends on the effective coordination of the three major response phases: pre-hospital care, casualty distribution, and hospital care (CDC, 2010). The integration of the governmental directorates in 2009 was expected to reduce much of the fragmentation, provide a clearer vision and produce stronger processes. However, this is expected to be a lengthy process. On the ground, the investigations demonstrated that there are several concerns related to the coordination of the emergency operations. These have potentially led to ineffective use of resources and exposed seriously injured and critically ill people to higher risks through transferring them to other cities. Challenges with coordination are not unique to Turkey. However, each country has its own set dictated by its environment as demonstrated by Achour et al. (2015) for UK healthcare emergency planning. The availability of site information (such as details of local population and fragilities of buildings and infrastructures) could have provided opportunities to save capital in terms of allocating resources efficiently and effectively. Recent publications demonstrate that this issue has been the focus of Turkish researchers such as Turkan and Özel (2014) who developed a model to estimate the number of casualties of destructive earthquakes. This could be a good start to support emergency response and planning in Turkey if it is further elaborated. Coordination also requires strong collaboration from people on the ground such as hospital staff in order to ensure that processes are followed carefully. The stress and behaviour of some staff members (e.g. in VRT&R Hospital) could have aggravated the situation and challenged the emergency response. This anxiety was also recently discovered in the education sector (Menteşe, 2014), indicating the need to develop the leadership and skills of professionals as part of emergency planning. Despite this difficult situation, there are many positive signs (such as considerable resources and competent and enthusiastic staff) indicating that the country is well able to develop an exemplary healthcare emergency model. The findings suggest that the effectiveness of this model depends on: (1) the ability to collect information from sites immediately after a disaster; (2) enhancement of the effective use of resources; (3) ability of healthcare staff members to perform their critical role in the rescue chain; (4) addressing the need of healthcare and rescue teams (e.g. welfare, PTSD, relevant trainings); and (5) enhancing the communication between the teams and agencies pre- and post-disasters.

5.3 Integration of resilience within development

In many countries such as Turkey, resilience has often been thought of as the ‘robustness of infrastructure’ or the ‘management of disasters’ and rarely from a holistic point of view, where infrastructure robustness, planning and management are well integrated and thought through. Prior to 1999, the Turkish authorities thought that resilience is the ability to manage disasters. However, the 1999 Kocaeli Earthquake demonstrated that this is ineffective and thus adopted a *disaster prevention* approach. For instance, the retrofitting of existing and construction of new facilities incorporated the new construction code (law enforcement), need for mass casualty scenarios (bed capacity), and healthcare processes (evacuation and triage processes). However, the investigations demonstrate that there are concerns about inadequate risk assessment, failure to adopt a multiple-hazard approach for hospitals, and lack of clear vision for the redevelopment of Istanbul. The City is in urgent need of a clear strategy to drive the redevelopment. This strategy could be developed based on the findings of this, and other research work (e.g. Mitchell (1999), Trice (2006), Izadkhah and Hosseini (2010) and Hochrainer and Mechler (2011)), loss estimation tools (e.g. Trendafiloski et al. (2008) and

Turkan and Özel (2014)), and advanced use of simulation. Recent governments have been very active in addressing resilience, dealing with it as a 'top priority' and driving it through.

6. Conclusion

For many years, Turkey dealt with disasters from a reactive point of view. However, after understanding its ineffectiveness, it adopted a proactive approach. This new approach is driven by proactivity, anticipation, mitigation, comprehensiveness and prevention. Major efforts have been made to retrofit existing, and build new infrastructure according to the requirements of the new seismic resistance code, and to have sufficient flexibility to deal with mass casualties. Many of the directorates have also been merged in order to reduce bureaucracy and enhance effectiveness; and significant resources have been accumulated.

This study investigated the impact of this new approach on the resilience of healthcare emergency response following Van earthquakes. The findings suggest that the approach succeeded in:

- developing a single vision by consolidating official efforts in a more structured way (i.e. development of AFAD and SAKOM);
- mobilising many governmental and non-governmental organisations (e.g. Army and volunteering teams);
- securing significant amounts of resources including physical and human; and
- ensuring that infrastructure is resilient and sufficiently flexible to expand its capacity.

This implies that the overall performance of the healthcare emergency response has improved and thus the new resilient approach is progressing. However, more attention is required to the:

- development of stronger management procedures (e.g. coordination, inter-agencies collaboration, vulnerable people, restoration process, and faster building safety evaluation); and
- enhancement of current resources (e.g. site information).

The Turkish authorities have an advantageous opportunity to combine lessons learnt from national and international experience, resources, procedures and computer simulation to develop and run a set of scenarios. These scenarios will help in clarifying the vision and lead to the development of a comprehensive emergency model. This model is expected to reduce risk in major and vulnerable cities such as Istanbul. This study will be developed further to support the development of this model by benchmarking the Turkish approach with international approaches.

The limitations of this study are mainly the inability to get more details about the activities of particular parties such as international aid organisations and their role within the bigger picture, the statics about baseline on the pre-earthquake staff coverage, patients' transfers and outcomes, and ratio of survival. These will be the focus of our future research plans.

References

- ACEP (2005), "Health care system surge capacity recognition, preparedness, and response", *Annals of Emergency Medicine*, 45, No. 2, pp. 239.
- ACEP (2012), "Health care system surge capacity recognition, preparedness, and response", *Annals of Emergency Medicine*, 59, No. 3, pp. 240-241.

- Achour, N. (2007), *Estimation of Malfunction of a Healthcare Facility in Case of Earthquakes*. PhD thesis Thesis, Kanazawa University, Kanazawa, Japan.
- Achour, N., Buxton, D. and Price, A. D. F. (2009), Resilience of Healthcare Facilities, HaCIRIC / Loughborough University, Loughborough, UK.
- Achour, N., Miyajima, M., Kitaura, M. and Price, A. (2011), "Earthquake Induced Structural and Nonstructural Damage in Hospitals", *Earthquake Spectra*, 27, No. 3, pp. 617-634.
- Achour, N., Miyajima, M., Pascale, F. and Price, A. (2014), "Hospital Resilience to Natural Hazards: Classification and Performance of Utilities", *Disaster Prevention and Management*, 23, No. 1, pp. 40-52.
- Achour, N., Pascale, F., Soetanto, R. and Price, A. (2015), "Healthcare emergency planning and management to major hazards in the UK ", *International Journal of Emergency Management* 11, No. 1, pp. 1-19.
- Achour, N. and Price, A. D. F. (2010), "Resilience Strategies of Healthcare Facilities: Present and Future", *International Journal of Disaster Resilience in the Built Environment*, 1, No. 3, pp. 264-276.
- Alexander, D. E. (2013), "Resilience and disaster risk reduction: an etymological journey", *Nat. Hazards Earth Syst. Sci.*, 13, No. 11, pp. 2707-2716.
- Aydan, Ö., Kumsar, H., Ulusay, R., Kose, O. and Çelebi, M. "The characteristics of the triggered 2011 Van-Edremit earthquake and induced damage", International Symposium on Engineering Lessons Learned from the 2011 Great East Japan Earthquake, 1-4 March 2012 Tokyo, Japan. Japan Association for Earthquake Engineering (JAE), pp. 1914-1925.
- Barbisch, D. F. and Koenig, K. L. (2006), "Understanding Surge Capacity: Essential Elements", *Academic Emergency Medicine*, 13, No. 11, pp. 1098-1102.
- Born, C., Briggs, S., Ciraulo, D., Frykberg, E., Hammond, J., Hirshberg, A., Lhowe, D. and O'Neill, P. (2007), "Disasters and mass casualties: I. General principles of response and management", *Journal of the American Academy of Orthopaedic Surgeons*, 15, No. 7, pp. 388-396.
- CDC (2010), Interim planning guidance for Preparedness and Response to a Mass Casualty Event Resulting from Terrorist Use of Explosives, Centre for Disease Control and Prevention Department of Health and Human Services, Atlanta, USA.
- Çelebi, E., Aktas, M., Çağlar, N., Özocak, A., Kutanis, M., Mert, N. and Özcan, Z. (2013), "October 23, 2011 Turkey/Van–Ercis earthquake: structural damages in the residential buildings", *Natural Hazards*, 65, No. 3, pp. 2287-2310.
- Christian, M. D., Devereaux, A. V., Dichter, J. R., Geiling, J. A. and Robinson, L. (2008), "Definitive care for the critically ill during a disaster: Current capabilities and limitations*: from a task force for mass critical care summit meeting, january 26–27, 2007, chicago, il", *Chest*, 133, No. 5_suppl, pp. 8S-17S.
- DH (2005), *HBN 22: Accident and emergency facilities for adults and children*, Department of Health (DH), The Stationery Office, Norwich, UK.
- DHS (2007), *National Preparedness Guidelines*, Department of Home Security (DHS), Federal Emergency Management Agency (FEMA), USA.
- Elo, S. and Kyngäs, H. (2008), "The qualitative content analysis process", *Journal of Advanced Nursing*, 62, No. 1, pp. 107-115.
- Erdik, M., Kamer, Y., Demircioğlu, M. and Şeşetyan, K. (2012), "23 October 2011 Van (Turkey) earthquake", *Natural Hazards*, 64, No. 1, pp. 651-665.
- Güney, D. (2012), "Van earthquakes (23 October 2011 and 9 November 2011) and performance of masonry and adobe structures", *Nat. Hazards Earth Syst. Sci.*, 12, No. 11, pp. 3337-3342.
- Hammond, J. (2005), "Mass Casualty Incidents: Planning Implications for Trauma Care", *Scandinavian Journal of Surgery*, 94, No. 4, pp. 267-271.
- Hochrainer, S. and Mechler, R. (2011), "Natural disaster risk in Asian megacities: A case for risk pooling?", *Cities*, 28, No. 1, pp. 53-61.
- HRSA (2006), "National Bioterrorism Hospital Preparedness Program (NBHPP)", available at: <http://www.hrsa.gov/bioterrorism/> (accessed 19 December 2011).
- Hsieh, H.-F. and Shannon, S. E. (2005), "Three Approaches to Qualitative Content Analysis", *Qualitative Health Research*, 15, No. 9, pp. 1277-1288.

- Irmak, T. S., Doan, B. and Karakaş, A. (2012), "Source mechanism of the 23 October, 2011, Van (Turkey) earthquake ($M_w = 7.1$) and aftershocks with its tectonic implications", *Earth Planets Space*, 64, No. 11, pp. 991-1003.
- Izadkhan, Y. O. and Hosseini, M. (2010), "Sustainable neighbourhood earthquake emergency planning in megacities", *Disaster Prevention and Management: An International Journal*, 19, No. 3, pp. 345-357.
- Jacques, C. C., McIntosh, J., Giovinazzi, S., Kirsch, T. D., Wilson, T. and Mitrani-Reiser, J. (2014), "Resilience of the Canterbury Hospital System to the 2011 Christchurch Earthquake", *Earthquake Spectra*, 30, No. 1, pp. 533-554.
- Jenkins, J., McCarthy, M., Sauer, L., Green, G., Stuart, S., Thomas, T. and Hsu, E. (2008), "Mass-casualty triage: time for an evidence-based approach", *Prehospital and Disaster Medicine*, 23, No. 1, pp. 3-8.
- Kaji, A., Koenig, K. L. and Bey, T. (2006), "Surge Capacity for Healthcare Systems: A Conceptual Framework", *Academic Emergency Medicine*, 13, No. 11, pp. 1157-1159.
- Kearns, R. D., Cairns, B. A. and Cairns, C. B. (2014), "Surge capacity and capability. A review of the history and where the science is today regarding surge capacity during a mass casualty disaster", *Frontiers in Public Health*, 2, No. Article 29, pp. 1-4.
- Kennedy, K., Aghababian, R. V., Gans, L. and Lewis, C. P. (1996), "Triage: Techniques and Applications in Decisionmaking", *Annals of Emergency Medicine*, 28, No. 2, pp. 136-144.
- Menteşe, M. (2014), "A Chaotic Fact: 2011 Van Earthquake-Evaluation of Pedegogs", Banerjee, S. and Erçetin, Ş. Ş. (eds.), *Chaos, Complexity and Leadership 2012*, Springer Netherlands.
- Mitchell, J. K. (1999), "Megacities and natural disasters: a comparative analysis", *Geo Journal*, 49, No. 10, pp. 137-142.
- Myrtle, R. C., F, M. S., Nigbor, R. I. and Caffrey, J. P. (2005), "Classification and prioritization of essential systems in hospitals under extreme events", *Earthquake Spectra*, 21, No. 3, pp. 779-802.
- PAHO (2008), *Hospital Safety Index: Guide for Evaluators*, Pan American Health Organization and World Health Organization, Washington D.C.
- Pascale, F., Achour, N., Price, A. D. F. and Polverino, F. (2014), "Evaluation of factors and approaches affecting emergency department space planning", *Facilities*, 32, No. 13/14, pp. 761-785.
- Ryan, G. W. and Bernard, H. R. (2003), "Techniques to Identify Themes", *Field Methods*, 15, No. 1, pp. 85-109.
- Schultz, C. H. and Koenig, K. L. (2006), "State of Research in High-consequence Hospital Surge Capacity", *Academic Emergency Medicine*, 13, No. 11, pp. 1153-1156.
- Sofaer, S. (1999), "Qualitative methods: what are they and why use them?", *Health Services Research (HSR)*, 34, No. 5, pp. 1101-1118.
- Stover, D. (2009), "Power To Spare: A more robust emergency electrical system", *Health Facilities Management*, 22, No. 1, pp. 21-24.
- Stratton, S. J. and Tyler, R. D. (2006), "Characteristics of Medical Surge Capacity Demand for Sudden-impact Disasters", *Academic Emergency Medicine*, 13, No. 11, pp. 1193-1197.
- Trendafiloski, G., Wyss, M., Rosset, P. and Marmureanu, G. (2008), "Constructing City Models to Estimate Losses due to Earthquakes Worldwide: Application to Bucharest, Romania", *Earthquake Spectra*, 25, No. 3, pp. 665-685.
- Trice, B. (2006), "Urban Management Challenges in Mega-Cities: A Survey of Catastrophic Events in the Developing and Developed World", *Urban Action*.
- Tufekci, N. (2012), Preparing Istanbul for future disasters: Istanbul seismic mitigation and preparedness project (ISMEP), *Global expert consultation on the revision of the Hospital Safety Index*. Istanbul, Turkey.
- Turkan, S. and Özel, G. (2014), "Modeling destructive earthquake casualties based on a comparative study for Turkey", *Natural Hazards*, 72, No. 2, pp. 1093-1110.
- UNISDR (2008), "Hospitals Safe from Disasters", available at: http://www.unisdr.org/eng/public_aware/world_camp/2008-2009/wdrc-2008-2009.html (accessed June 15 2008).

Achour N, Pascale F, Price, AFD, Polverino F, Aciksari K, Miyajima M, Özüçelik N, and Yoshida M (2016), Learning lessons from the 2011 Van Earthquake to enhance healthcare surge capacity in Turkey, *Environmental Hazards*, 15 (1), 74-94. DOI: <http://dx.doi.org/10.1080/17477891.2016.1139539>

- UNISDR (2009), *2009 UNISDR Terminology on Disaster Risk Reduction*, United Nations Office for Disaster Risk Reduction (UNISDR), Geneva, Switzerland.
- Unlu, A., Kapucu, N. and Sahin, B. (2010), "Disaster and crisis management in Turkey: a need for a unified crisis management system", *Disaster Prevention and Management*, 19, No. 2, pp. 155-174.
- Wegscheider, S., Schneiderhan, T., Mager, A., Zwenzner, H., Post, J. and Strunz, G. (2013), "Rapid mapping in support of emergency response after earthquake events", *Natural Hazards*, 68, No. 1, pp. 181-195.
- WHO (2007a), Mass Casualty Management Systems Strategies and guidelines for building health sector capacity, *Health Action in Crises*. World Health Organisation (WHO), Geneva, Switzerland.
- WHO "Risk Reduction in the Health Sector and Status of Progress", Disaster Risk Reduction in the Healthcare Sector- Thematic Workshop, 6 June 2007b Geneva. World Health Organisation (WHO), pp.
- WHO (2015), *Hospital Safety Index: Guide for Evaluators (2nd Edition)*, World Health Organization (WHO) and Pan American Health Organization (PAHO), Geneva, Switzerland.
- Zhong, S., Clark, M., Hou, X.-Y., Zang, Y. and FitzGerald, G. (2014), "Validation of a Framework for Measuring Hospital Disaster Resilience Using Factor Analysis", *International Journal of Environmental Research and Public Health*, 11, No. 6, pp. 6335.
- Zoraster, R., Chidester, C. and Koenig, W. (2007), "Field triage and patient maldistribution in a mass-casualty incident", *Prehospital and Disaster Medicine*, 22, No. 3, pp. 224-229.