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ScienceDirect

Procedia - Social and Behavioral Sciences 216 (2016) 452 – 459

Procedia
Social and Behavioral Sciences

Urban Planning and Architecture Design for Sustainable Development, UPADSD 14- 16 October 2015

How can be disaster resilience built with using sustainable development?

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Abstract

Cities in the developing world are facing increased risk of disasters and the potential of economic and human losses from natural hazards is being exacerbated by the rate of unplanned urban expansion and influenced by the quality of urban management. The use of information and communication technologies (ICTs) by citizens after a disaster increases resilience against disasters. In this context, this paper's research question is "How to build disaster resilience via sustainable development?". Therefore, the aim of this study is to increase pre and post disaster resilience by using ICTs to ensure citizens play an active role in disaster management.

Peer-review under responsibility of IEREK, International experts for Research Enrichment and Knowledge Exchange

Keywords: Urban planning; disaster resilience; sustainable development

1. Introduction

The Report of United Nations Development Programme (UNDP) Bureau for Crises Prevention and Recovery (2004) pointed out that 75 % of the World's population lives in an area affected at least once by natural disasters between 1980 and 2000. Furthermore, at least one hazard periodically affects billions of people in more than one hundred countries. 158,551 people died related to earthquakes and its indirect hazards in the world between the years of 1980-2000. Approximately 12 % of these deaths are constituted in Turkey at the same period.

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Peer-review under responsibility of IEREK, International experts for Research Enrichment and Knowledge Exchange
doi:10.1016/j.sbspro.2015.12.059

Urbanization and the overgrowth of the cities are the major global changes since the beginning of the Industrialization period. According to Uitto (1998) at the start of the 20th century, there were only eleven metropolitan areas with more than million inhabitants. However, at the end of the century it is estimated that 400 cities in the world have over one million inhabitants each. Furthermore, twenty-eight cities have over eight million people two-thirds of which are in developing countries. The complexity and the large scale of people that crowd around large and mega cities create a new intensity of risk factors.

The Report of UNDP for Crises Prevention and Recovery (UNDP, 2004) shows the destructive effect of natural hazards at the beginning of the 21th century. Particularly, developing countries face great risk from disasters because of the rapid and uncontrolled growth of cities. For example, Turkey experienced some major earthquakes at the end of the 20th century, which caused the death of at least 110.000 people, about 250.000 injuries, and 600.000 building damages.

Controlling rapid growth and rearrangement of the social, economic and physical conditions of cities are important urban planning problems especially for developing countries. Unfortunately, lack of sufficient qualifications of administrative constitution causes a defect for urban planning which the administrators direct the planning process. While these deficiencies affect preparation of disasters negatively, inhabitants and administrations are not sufficiently aware of the consequences of possible natural hazards.

There have been some struggles to form a hazard resistant society, especially in developing countries; however, there is not a certain achievement for many countries to prove a hazard-resistant society yet. Lack of sensibility of citizens and institutions for natural hazards and its consequences obstruct an efficient intervention in hazard-prone areas.

Cities in the developing world are facing increased risk of disasters and the potential of economic and human losses from natural hazards is being exacerbated by the rate of unplanned urban expansion and influenced by the quality of urban management. In developing nations, as well as in Turkey, a number of factors, such as uncontrolled growth of cities, poor design and building techniques, inadequate supervision of the construction process and lack of enforcement of land use regulations, increase the amount of damage caused by earthquakes. Major hazards and sustainable development figure prominently today in both the language and fields of action of public policies. Identifying and managing risks, resilience levels, and associated economic stakes on the one hand, and planning for the environmental, economic and social future of an area and its population on the other, appear to be two closely related concerns. It would thus seem appropriate to define and examine the possible link between major hazards and sustainable development. Today information and communication technologies (ICTs) are used in many areas to facilitate and accelerate our lives as a part of sustainable development. Public, private and civil society sectors already use existing ICTs, offering the potential to reach broad populations, and engaging them directly in processes of decentralized decision-making. This engagement provides reducing vulnerability to risk and improve disaster resilience. The use of ICTs by citizens after a disaster increases resilience against disasters. In this context, this paper's research question is "How to build disaster resilience via sustainable development?". Therefore, the aim of this study is to increase pre and post disaster resilience by using ICTs to ensure citizens play an active role in disaster management. The case area is Izmir, in Turkey.

2. Current Problems of the Urban Areas - Resilience and Sustainable Development

Rapid urbanization and overgrowth of cities is an important obstacle of healthy development in developing countries. The city authorities should make some effort to solve this problem. Enlargement of urban settlements cause over concentrated areas in terms of population and economy and create a potential risk due to natural hazards. This risk is changing rapidly with time, location, exposure, vulnerability and resilience (Bademli, 2001; Balamir, 2001; Sengezer, 2005).

Despite of the all-serious efforts to mitigate natural hazards, success is limited due to the seriousness of the problems and deficiencies in implementation especially in developing countries. In Turkey, these problems cause inadequate conditions to produce and manage the hazard mitigation strategies and implementations of the projects. This process decreases the resilience of Turkish cities. Therefore, this paper takes into consideration these problems and their consequences for settlements.

The current problems of the urban areas can be categorized as physical, economical, cultural, social and technological problems (URL1, 2015; URL2, 2015; Denhardt and Glaser, 1999; Ferguson and Dickens, 1999; Gans, 1993; Dodson & Gleeson, 2009). This study is concerned only with the technological problems. Developing technologies provide multi-variety analyses for complex urban planning problems. Especially, computer techniques allow specialists' to perform data analyses. However, data is inadequate and unreliable in the developing countries to make meaningful analysis. For example, information about census, building stock, hazard risk area, resources, number of manufactures, etc., could not be collected appropriately for most sample areas. Moreover, lack of enough specialists, such as geographical information system (GIS) analysts, urban planners, civil engineers, and architects using appropriate technologies in order to develop a hazard-resistant building construction, causes the ineffective and unsuccessful results for different sectors.

Rio+20 recognized the importance of early warning systems as part of effective disaster-risk reduction at all levels in order to lessen economic and social damage, including the loss of human life. It further recognized the importance of comprehensive hazard and risk assessments and knowledge and information sharing, including reliable geospatial information. Clearly, ICT play a crucial role in sharing climate and weather information and in forecasting and early warning systems (URL3, 2015). In the Montreal Declaration, they recognized the enormous scope of ICT, focusing on seven key areas: environmental protection; smart metering; adaptation and response to natural disasters; mitigation of climate change; awareness-raising and capacity building; intelligent waste management and recycling; and partnerships for environmental sustainability.

Disaster management includes four steps to reduce the consequences of hazards. These phases are mentioned by Montoya (2003) as below:

- "Hazard mitigation is the pre-disaster activities aim to eliminate the effects of a disaster. These activities necessitate the risk assessment and determination of potential effects of disasters.
- Preparedness is planning of the emergency facilities and increase resources available to respond effectively.
- Response is activities to organize the emergency assistance to reduce the victims occurs possible secondary damage.
- Recovery is the final step of the disaster management continues until the system return to normal conditions."

According to this classification, this research emphasizes the importance of both the pre and post-disaster activities and building resilience. Resilience is defined as the ability of a system and its component parts to anticipate, absorb, accommodate or recover from the effects of a major shock in a timely and efficient manner (URL4, 2015; Walker & Salt, 2006; Folke et al., 2010; Folke et al., 2002). Capacity for resilience should be developed in institutions at all levels and sectors of society. In many cases, strengthened resilience has multiple benefits: helping to mitigate immediate deaths, injuries, and economic losses from relatively frequent emergencies, while building resilience to future disasters. Elements of building resilience include:

- Systematic assessment and monitoring of disaster risks, continued research to improve understanding of the underlying causes, improved warning systems, and awareness of risks by the public and all levels of governments.
- Establishment of a culture and incentives that lead to the acceptance of responsibility by communities, including private sector and civil organizations, for planning and cooperation in preparation, response, and recovery.
- Long-term planning, investment, and enforcement of mitigating or preventive measures, such as land-use and other zoning and building codes.
- International cooperation in advanced planning and rapid response, as well as research and evaluation on risk factors.

Moreover, repeated risk surveillance and capacity building for regular assessment and applications of advanced ICTs are two basic components of disaster resilience. It is hard to prepare for disasters that have not been imagined. Individual regions, nations, and the international community must develop strategies to regularly identify and assess the disaster risks they face and reduce their exposure. Continued monitoring is critical. Information technologies, including geospatial, are important, both to monitor, identify and warn of pending disasters, and to assess the location, nature and extent of damage, deaths and injuries and dispatch, coordinate and allocate relief efforts. Nations should assess the potential advantages of dedicated ICT systems for emergency response versus shared systems that serve multiple roles. Either way, systematic practice (emergency response gaming) with all key players, as well as active programs of public involvement and education, are critical to the effective use of these systems (URL4, 2015).

3. Earthquakes in Turkey

Turkey is surrounded by three main plates, the African, Eurasian and Arabian ones, characterized by relevant tectonic activity. Other two minor plates are also present in this region, the Aegean and the Anatolian ones (see in Fig.1) (Moro et al., 2014). The red lines represent the main active faults in the area and the white and the black arrows indicate the plate motion versus. B part shows the tectonic setting of the Eastern Mediterranean region. The notable earthquakes of Turkey from the 20^{th} century to today is listed in Table 1.

Izmir Province, the case area, west of the Anatolian Peninsula, is located in the middle of the Aegean coasts. City lands, $37^{o}45^{'}$ and $39^{o}15^{'}$ north latitude and $26^{o}15^{'}$ and $28^{o}20^{'}$ east longitude, is torn between. Izmir is the third biggest city in Turkey in terms of population and socio-economic situation. There are 4.2 million people living in Izmir (URL6, 2015). Izmir survived as a big city throughout its history of 5000 years and has been frequently renovated under geological influences. Izmir has been greatly affected by earthquakes, fires and flood in its history.

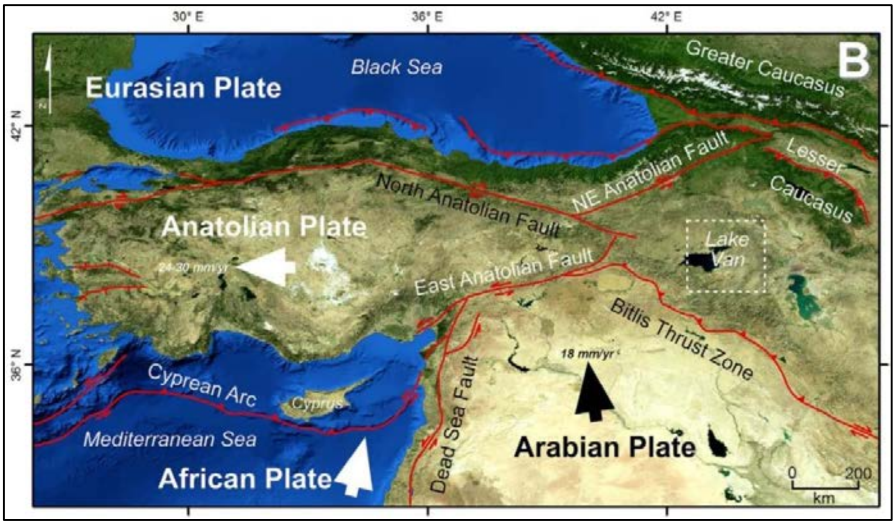

Fig. 1. Main plates of Turkey

Table 1. Notable earthquakes of Turkey (URL5, 2015)

Date	Place	Latitude	Longitude	Fatalities (person)	Magnitude
April 29, 1903	Malazgirt	39.14	42.65	600	6.7
August 9, 1912	Murefte	40.75	27.2	216	7.3
October 4, 1914	Burdur	37.82	30.27	300	6.9
March 31, 1928	Izmir	38.5	28.0	50	6.5
April 19, 1938	Kirsehir	39.1	34.0	160	6.6
September 22, 1939	Dikili-Izmir	39.1	26.8	60	6.6
December 26, 1939	Erzincan	39.77	39.53	32,700	7.8

June 20, 1943	Hendek	40.6	30.5	336	6.6
March 18, 1953	Yenice	40.02	27.53	265	7.2
March 28, 1970	Gediz	39.2	29.5	1086	7.2
September 6, 1975	Lice	38.5	40.7	2385	6.6
November 24, 1976	Muradiye	39.12	44.03	3840	7.5
October 30, 1983	Erzurum	40.33	42.19	1155	6.9
August 17, 1999	Izmit	40.77	30	17,127	7.6
November 12, 1999	Duzce	40.75	31.16	894	7.2
October 23, 2011	Van	38.63	43.49	604	7.2

4. Research Methodology

Within this study; web based technologies have been used to increase disaster resilience in context with an effective disaster management. In this context, the web based disaster management system is set on J-query platform. MySQL is used for database design and PHP is used for ensuring the exchange of data between the databases.

"Missing person and resource search and insertion" module is completely based and designed on interactive end-user data entrance and queries. Therefore, based on the concept of social media it is designed two different graphical user interfaces for each module. The first module allows users to enter data about loss person or resource. The second one allows users to make queries of them. The accuracy of the system test is carried out using the rating system in question. For example, when a user enters information into system about a help distribution on the street, the system accepts that information and determines its value as the lowest rating. If multiple users indicate the same distribution for the same area at the same time, this information's rating starts to increase.

This phase will describe how to improve the system after revealing existing system process and define organization performance criteria. In this context, the system should design and manage systematically to develop a more efficient system due to the intended system being an information system. System development life cycle is used to make system development systematical. Waterfall model which was put forward in 1970 by Royce, is used as a process model during software development process due to having understandable phases and at the same time quality requirements are more important according to budget and time constraints (Fig. 2).

5. Web Based Disaster Management System

To reduce risks from disasters, we must mobilize a broad coalition of partners, from village chiefs to government ministers, from family-run shops to international corporations, from school principals to hospital directors. Interviews with experts were performed before the components of the system design process and what kind of tools would be needed before and after the disaster has been determined. In this context, the system is composed of the modules of "location search", "missing person search and report" and also "resource search and report" (see in Fig.3).

In the "location search" part, district and neighborhood based meeting place, tent city, logistic support control center, security control point, police office; hospitals could be searched on the interactive map. Missing person and resources search and report modules aim the information entrance and reporting about missing people after disasters.

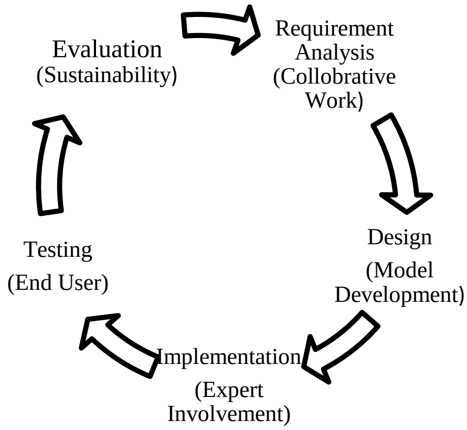

Fig. 2. System development life cycle for disaster management.

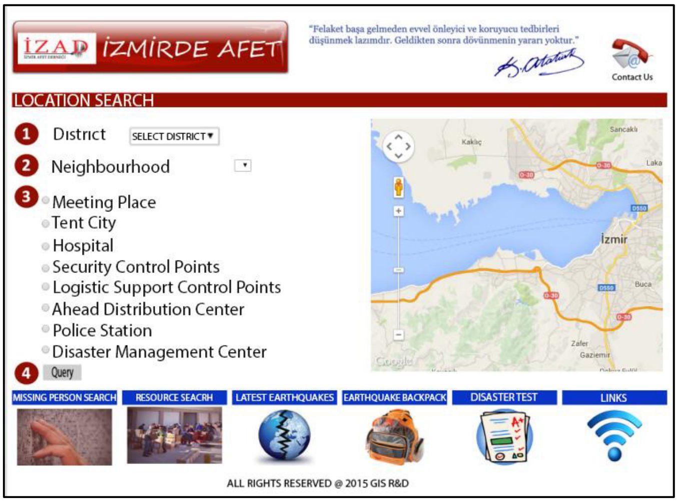

Figure 3. Home page of izmirdeafet.com web site

5.1 Location Search Module

Although many disasters have occurred which led to loss of life and property so far in Turkey, disaster awareness has not yet occurred. Therefore, citizens need to be more awareness and informed. Moreover, there should be studies about what needs to be done after the disaster before the disaster some information about the work to be done. Citizens are directed to the wrong place with the wrong or incomplete information in panic after the disaster. They are unaware of the necessary locations for collecting areas after disasters and to provide the necessary needs. This module provides displaying the search results on the map according to the pre-disaster and post-disaster questioning neighborhoods vital locations. This situation causes waste of time, which is vital for people after the disaster. Using this module, the post-disaster meeting locations can easily be found by citizens and they reach those points without time loosing. Thus, with this module, it is aimed to increase citizen’s disaster resilience (see in Fig.4.).

5.2 Search and Attach Module

In this context, using the missing person search (see in Fig.5) and insertion through social relations, it is aimed to create a social networking environment. In this module, the physical properties information of the missing people, date to be lost and last seen location-based information is intended to reach out to other users. The resource insertion and search module (see in Fig. 5) is performed for cost-effective and post-disaster resource allocation. This also a social networked based optimization tool. It is aimed to share and follow vital things such as food, water or clothing distribution points by citizens.

In “Resource insertion” module, location name, type (water, food, hot meal), lead time (between 01:00- 02:00 pm), resource origin, inserted by and detail information are collected. Using as a base of these information, other citizens who use the application will have access to resources more effectively. On the other hand, this module assists the decision-makers, managers where the resources, coming from different organizations, are distributed. Thus, all assistance from home and abroad will be distributed in a cost-effective manner. Users also benefit from the information sharing to help aid distribution in areas with concentrations of whether people in the optimum ratio can be achieved.

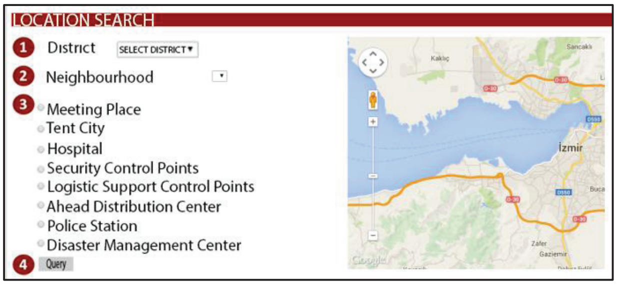

Figure 4. Location Search

Figure 5. Missing Person, Resource Search and Attach Modules

6. Results and Discussion

The relationship between resilience and sustainable development depends on the location of the different equilibria. The use of ICTs increases resilience-building to cope with disasters. Resilience as a planning and managing priority for cities is on a quick rise with governments, planners, architects, social scientists, ecologists, and engineers taking up the resilience agenda. Additionally, resilience needs to be linked to sustainability so that the resilience it is trying to plan and design for actually helps people move towards desired future sustainable systems states, and not undesirable ones. Sustainable city initiatives are maximize efficiency, minimize energy, and reduce redundancy and material use. Yet, redundancy is one of the hallmarks of a resilience system. It is very important that ICT can organize, settle and control any type of mass data. Therefore since disaster management needs and uses big data without ICT. It is not possible to handle all of it. Well-developed ICT system not only manages pre and post disaster, but also set up sustainable disaster resilience for long term.

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