Multi-Hazard Mitigation during Post-Disaster Recovery following an Earthquake

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Post-disaster recovery and reconstruction following major natural or man-made disasters such as earthquakes, floods, catastrophic fires, acts of war etc. is a multidimensional phenomenon that must address short term response issues as well as medium and long term recovery and reconstruction issues. This is typically best accomplished through post-disaster recovery plans made before the disaster hits. Theories, policies and procedures in this area are fairly well developed and disseminated in research literature[1,2] and by Federal agencies such as FEMA (Federal Emergency Management Agency). On the other hand, because each case is unique, a good amount of effort and planning must go into any post-disaster recovery planning for it to be forward looking and long term. A major disaster can be and must be seen as an opportunity to make a fresh start with better planning for multi-disaster mitigation, especially in those cases where a plan did not exist to begin with.

This paper aims to look at issues related to fire protection during post disaster recovery and reconstruction in areas where major disruptions to the economic and social infrastructure require major planning efforts. The reconstruction process following the 7.4 strength earthquake that killed over 18,000 people on August 17, 1999 in Izmit, a province in northwestern Turkey, only 90 miles from Istanbul, provides a good opportunity to discuss multi-hazard mitigation issues, in this case specifically addressing fire safety within the context of earthquake mitigation.

MULTI-DISASTER PLANNING

In general, among the most effective methods used in advancing the public's concerns for health, welfare, and safety are land-use regulations, building codes and master plans. These are also some of the best mechanisms for controlling reconstruction efforts following a disaster. While there are additional organizational and financial issues such as tax incentives, risk distribution, etc. that must be addressed in such plans, due to its focus on multi-hazard mitigation, this study will only address issues related to the creation of disaster resilient built environments.

Concerns related to post-disaster recovery and reconstruction planning for multi-disaster mitigation can be grouped as follows:

1. Activities that are related to the design and construction of buildings, such as the type of construction technology used, building codes, occupancy classifications, certifications, and occupancy re-certifications after reconstruction. Enforcement activities, such as the inspection of the occupancies, legislative actions that help to enforce codes, and the development of new codes and their enforcement process are also included in this category.

2. Land use planning that take multi-hazard mitigation into account. Identification of soil conditions, the location of hazardous facilities and their inspection, transportation routes that consider multi-hazard mitigation as a factor, building the necessary infrastructure for hazard mitigation, and the protection of critical facilities that are essential for the economic viability of a region are among the issues that must be considered. The concept of "safety element" developed by the State of California following the 1971 Sylmar earthquake made a considerable difference in the way cities approach land use and master planning efforts in that state. Municipalities who are developing land-use and master plans must similarly consider "safety element" as a key issue.

3. Data collection activities. Information that will be very critical during an actual disaster and during post-disaster recovery must be collected and managed routinely so that such information is available when disaster hits. Policy and procedures for data collection must be carefully established.

4. Public education and training issues. The literature indicates that public's perception of risk is a big factor not only in taking appropriate protective actions during a disaster, but also in providing support to the often hard decisions the officials must make during post-disaster recovery and reconstruction. The better the public understands the issues related to multi-hazard mitigation, the better they and the officials can make informed decisions.

These issues will in turn be addressed within the context of the reconstruction efforts that are currently underway in Izmit, Turkey. Because Izmit region is the industrial heart of the country, it is among the most populated regions of Turkey. The population is comprised of professionals such as engineers, architects, doctors, teachers, etc.; rural population engaged in agricultural production; as well as workers who work in the industry. The per capita income of the region is considerably higher than many other parts of the country. Furthermore, the existence of an oil refinery and a major naval base increases the importance of the region for Turkey.

For this study, data for assessing the multi-hazard mitigation issues in the region were primarily collected from newspaper accounts and official WEB sites of government organizations. Building codes that are in effect in the region and in Turkey were also referenced. A local developer/ builder who has been working in the area for over 25 years was phone-interviewed as part of the data collection effort.

ISSUES RELATED TO BUILDING CONSTRUCTION AND RECONSTRUCTION IN THE AFTERMATH OF IZMIT EARTHQUAKE

An essential purpose of any post disaster recovery plan is to provide a vision for the recovery process that can serve to guide the decision makers following a disaster. Lack of post-disaster recovery plans can lead to a reconstruction effort that might already be plagued with potential problems in disaster resiliency. Multi-disaster resiliency is not necessarily one of the highest priorities of short-term recovery efforts. The tendency to focus on the most recent disaster can lead to the overemphasis of this aspect of safety at the peril of other safety concerns. For example, preliminary data indicate that in Izmit, the focus is primarily shifted towards earthquake mitigation, and long-term issues in fire protection are not sufficiently addressed during post-disaster reconstruction efforts. Some of the multi-disaster mitigation problems and fire safety concerns emerging in Izmit can be summarized as follows:

a. The *speed* with which new construction must be completed and its *scope* are obviously important problems in the post disaster reconstruction period. According to a newspaper account of a press conference held by the prime minister of Turkey on August 24, 2000, 7123 permanent housing units were completed approximately a year after the 1999 earthquake, although roughly 40,000 permanent units were needed to house those who were left homeless.[3] On the other hand, most of those who are in need of shelter were already housed in over 26,000 prefabricated temporary structures completed within 3 months of the earthquake. The public's impatience for speedy permanent housing in the face of such immense construction effort is clearly a sign of unrealistic short-term expectations and pressures put on the politicians and the government. Obviously such pressures have the potential to lead to haphazard post disaster reconstruction efforts. Careful pre-disaster planning and systematically collected data might have helped to counteract these kinds of public pressures.

b. Technology shift in the building industry since the 1999 earthquake. With the shift to the free market economy in Turkey in the mid 80's, an influx of imported construction technologies was already taking place. For example, at the upper end of the housing market, imported wood and wood finishes have been quite trendy. Post-earthquake reconstruction efforts when combined with the public's demand for earthquake-resistant structures have served to speed up the shift to imported construction technologies in the area.

Since the earthquake, market forces have created a larger demand for one to two story houses and a shift towards non-traditional construction technologies such as wood frame or lightweight metal frame construction. This technology is also being encouraged by the municipality of Izmit as evidenced by the prototypical housing projects posted at their Web site.[4] Such construction technology obviously comes with a much different set of requirements for fire protection and it is not clear whether fire protection is being incorporated into these structures. The increase in the use of materials such as vinyl siding, asphalt shingles, wood or light metal frame construction, dry wall construction etc., is of concern, since these materials have not been traditionally used in Turkey and neither building codes nor builders, architects, engineers and tradesman are ready to comprehensively address fire protection concerns in such technology. Building codes, including the Istanbul building code primarily recognize emergency exit requirements as part of fire safety precautions, but do not necessarily address building materials and construction technology as part of fire precautions.

This shift in the building technology is also being advocated by the academics and building professionals who primarily focus on earthquake-resistance. For example, Hacettepe University, Dept. of Engineering has recently announced the design of a single story prototypical home that is made out of lightweight building materials as an earthquake resistant design.[5] This design is intended for rural Turkey, replacing the rubble stone traditional housing. Although this is a commendable effort for earthquake mitigation, its resistance to fire must also be equally considered, especially if it is to be adopted as a prototypical earthquake resistant design for rural Turkey. Fire safety problems were an important concern in the fires and fatalities observed during the months following the earthquake in Izmit, especially in tents where portable heating devices were used. Lightweight permanent or temporary structures are equally vulnerable to fires if necessary fire safety precautions are not taken during construction.

Currently, many people in the countryside are rebuilding their homes themselves, using brick wall and wood truss construction, eliminating ceiling slabs with the intention to avoid any heavy roofing or ceiling materials. While this is probably a good decision for earthquake mitigation (not necessarily resistance, i.e. brick walls can still collapse if they are not braced properly), it has the potential for fire spread from any chimney fires that normally would not have spread into the building if concrete ceiling slab were provided.

On the other hand, projects funded by government and by international agencies such as the World Bank are mostly built as 3-4 story high reinforced concrete structures. Obviously, the compartmentation afforded by such construction technology is very desirable from fire safety point of view.

A shortage of critical building materials and also a tendency to overcompensate in retrofitting are also observed. For example, the builder who was phone-interviewed for this study indicated that it is typical for him to have a 2:00 am appointment for the pouring of ready-made concrete at his construction sites, since the demand was far exceeding the supply. There is also demand for concrete mixes with much higher strength than previously used with almost a two fold increase in the specified strength of the concrete used in the area. Another observation was that retrofitting was overdone, in many cases by providing huge number of additional supports, since the owners were not sure how much was enough.

c. Shortage of trained and licensed trades people knowledgeable in the imported building technologies. Although Turkey has very good universities and programs in engineering and architecture, Tezcan[6] indicates that none of these programs require courses on earthquake resistant design. He continues to point out there are no professional organizations that self control and license builders. Therefore, it is quite difficult for the public to know the competency level of any builder.

To further elaborate Tezcan's point about university education, architectural or engineering curricula do not address fire safety issues in a systematic way either. Unlike the United States, there are no fire protection engineering programs in Turkey, therefore the only potential watchdog group for fire safety can be architects and civil engineers. Furthermore, there is no mechanism for training and licensing skilled trades people such as masons, plumbers, roofers, framers, etc. Mostly, builders themselves assemble a group of trades people they work with

and provide on the job training. Therefore, some of the very fundamental fire safe construction principles can go unattended very easily.

This point is further exasperated by the introduction of imported construction technologies. Other than the importers themselves or the manufacturers, there is no other quality control mechanism for skilled labor. For example, Oran Mimarlik who represents HolzBau wood products in Turkey also provides wood construction services.[7] Senkron imports wood treatment products, and provides services in this area.[8] Unfortunately, their products do not include fire protection treatment, obviously since this issue is not addressed in the building codes and there is no demand for it. Local municipalities mostly see fire safety as a matter of effective fire fighting and search-and-rescue problem, thus are diverting funding to the building of the necessary technical infrastructure for this. While these are very important aspects of fire safety, attention should also be paid to fire protection and fire prevention in buildings through proper code development and enforcement.

d. Poor remodeling or repair practices can not only affect the integrity of building structures in resisting future earthquakes but also in resisting potential fires. For example, Vendome Hotel in Boston collapsed during fire fighting operations in 1972 killing 9 fire fighters. The main reason for this collapse was that an air duct opening was cut through a wall directly below a cast iron column that supported a brick wall at the upper floors.[9] Similarly, in Izmit wide spread devastation and collapse of buildings were observed due to the removal of columns or walls at the ground floor of high rise apartment buildings with the intention to make more room for retail space.[10] Similar concerns exist during reconstruction practices, where conditions that are created as a remedy for earthquake retrofitting can cause collapse during a potential fire if the reconstruction process does not take into account multiple hazards. For example, additional steel supports might be introduced to a damaged building during reconstruction, which require proper fire protection. Mixed brick construction and wooden beam retrofitting can also be dangerous during fires. Istanbul building code does not address the issue of fire protection practices during earthquake retrofitting or reconstruction.[11] The model code developed and revised in 1998 by the Ministry of Public Works and Settlements does not sufficiently consider multi-hazard conditions either.[12] For example, the section on fire safety is only half a page long, and is included only to address fire safety concerns until more complete fire safety codes are developed by the Turkish Institute of Standards.[13]

e. Difficulty to control the quality of construction and code compliance checking. Although developers and builders are under incredible scrutiny by the public for earthquake resistant construction, lack of skilled labor and the difficulty to perform quality control due to the sheer number of buildings being built can undermine even the best intentions for quality control.

Following the earthquake in Izmit, a lot of focus has been rightfully diverted to construction practices for earthquake resistant structures and to the problems with code enforcement. Another problem that exasperates this issue is the lack of control in the areas that are outside the city limits of Izmit at a time where very extensive reconstruction is happening due to the public's desire to flee the apartment living in the city (which is deemed to be disaster prone by the public) to the surrounding rural areas (one to two story buildings deemed safer by the public).

In dealing with seismic hazards, historically building codes have played a much greater role in mitigation than land use regulations. Therefore, although the current efforts by the Izmit municipality for tighter land-use regulations (soil testing, extensive data collection etc.) are commendable, effective building code enforcement is primary in reducing the likelihood of foundation failure and in heightening structural stability against lateral forces. For example, a rough estimate in another type of disaster indicated that 1/4th of the $16 billion losses incurred in Hurricane Andrew in Florida were attributed to code violations.[14] There is plenty of anecdotal evidence that a very large portion of the losses incurred last year in Izmit were due to code violations, although this author was not able to come across specific data in terms of the percentage of this. Looking at the damage in earthquakes of similar magnitude in other parts of the world such as San Francisco, Ca., one clearly observes a big difference in the scale and scope of the damage. Since current building codes in the area are an adaptation from California seismic codes, code violations is the only explanation for such an incredible difference in loss of life and property in these two earthquakes. Therefore, a very extensive enforcement policy and control must be established. In the April of 2000, the Turkish government has issued a decree in the effect of law outlining the mechanisms for plan review and code enforcement.[15]

LAND USE ISSUES

The city of Izmit is currently focusing on land use regulations in order to identify the areas with soil conditions that are suitable for earthquake mitigation. While, this is a very necessary component of reconstruction activity, this also has the potential to overshadow other hazard mitigation problems that can be created inadvertently. Among the most important ones is urban-wildfire interaction possibility in wooded areas that are currently being explored as safer locations for settlement. The planning of the necessary infrastructure for multi-hazard mitigation is another important consideration. Some of the multi-hazard issues that are emerging in the area are as follows:

a. The rate of urban sprawl into the countryside that started long before the earthquake has only increased after the earthquake due to "reverse migration" (in reference to the migration to the urban centers which is historically more typical in Turkey), i.e. fleeing of the affluent from the cities to the countryside. This has already created inadequate vehicular access and traffic congestion wide spread in the region.

The Izmit municipality is strongly advocating the inclusion of the whole province into the greater metropolitan municipality of Izmit.[16] While the desire to expand the tax base of the municipality by bringing the industrial facilities into the jurisdiction of the municipal administration is one of the concerns here, another intent is to provide better coordination of the infrastructure within the light of the urban sprawl that is already happening.

A much wider spread of the (sub)urban area into the countryside is a concern in a country that is not known for its good infrastructure such as roads with proper surface conditions and acceptable width for fire fighting, rescue and emergency vehicles, for its good water pressure for fire fighting, and for acceptable fire response rates with sufficient fire department services throughout the area. Recognizing this problem, the city of Izmit is currently establishing over 110 centers for emergency response. At a time when the environmental and infrastructure costs of such sprawl is questioned in other countries such as the United States, it is important for Izmit to incorporate plans for controlled growth in its post-disaster

planning efforts. This should also include limits on the further expansion of the industrial base of the region. This also makes strategic sense for Turkey, since by doing so the country would not put all of its proverbial eggs in this seismically active basket.

Lack of proper infrastructure for fire department operations, especially access by fire fighting vehicles is a real concern. For example, the author has observed in a housing complex near Lake Sapanca where not only the village roads that lead to this upscale housing were too narrow for any fire trucks, the access ways within the bounds of the housing area were so tight that a small car could barely navigate the access roads. While a swimming pool was designed to double as a reservoir for fire fighting purposes, its location at the lowest end of the housing complex with quite steep stairs leading to the pool made it almost impossible for any fire vehicles to access the pool for fire fighting purposes.

b. Wildland/urban interface for wildfires. An additional issue that is emerging as a result of this sprawl is the danger for wildfires affecting human settlements. The recent census held in Turkey indicates that population in the surrounding villages and towns of Izmit has in some cases doubled in the last 3 years, such as the population of the village of Balaban went from 856 to 1330 in 3 years, Cakirkoy from 385 in 1997 to 702 in the October of 2000 (October 2000 census). Many of these villages are in the surrounding hills and mountains with lush vegetation and greenery. This is clearly increasing the danger of urban/wildfire possibilities not unlike the Oakland, Ca. fires in the early 1990's. Any fire in such an environment will create a much bigger challenge for fire fighters for the reasons cited above. This also indicates the need for better coordination between multi-agencies such as the Ministry of Forestry and the local municipalities for fire fighting purposes.

SYSTEMATIC DATA COLLECTION

The lack of information and the disruptions in communication were major problems encountered during the earthquake in the region in 1999. The development of standard procedures and forms for data collection, identification of the agencies that are responsible for data collection and their maintenance, and the availability of an electronic management system such as a geographic information management system that is kept up-to-date and is readily available during a disaster are very important.

Multi-disaster preparedness reinforces the need to collect information regarding the quality of the building stock of an area. Information regarding the location and the nature of hazardous substances, potential environmental hazards, etc. must be available in such a database. In many cases, disasters such as earthquakes or floods can lead to fires, multiplying the effect of the initial disaster. Therefore, multi-hazard preparedness plans and data collection efforts must always include fire-protection and fire fighting components. Furthermore, information regarding the substances stored in large quantities in the industrial facilities in the area that can lead to environmental pollution and/or fires during an earthquake must also be collected and stored in electronic databases.

PUBLIC EDUCATION AND TRAINING

While, in the literature, public education is usually seen as an issue related to the immediate response patterns of the individuals following a disaster (e.g. drop-and-roll principle during a fire or seeking shelter under heavy furniture for protection during an earthquake), public education in third world countries must also include general awareness of pre-disaster planning principles with the intention to get the public to act as watch-dogs for inconsistencies in code enforcement. Currently in Turkey, many of the current public education activities are related to emergency response issues.[17]

A big portion of education also involves changing the public's perception of risk. For example, the public's perception of risk up until the recent earthquake in Turkey was minimal, with little to no market pressure for earthquake resistant structures. Following the earthquake, the risk perception sharply increased with people demanding answers to the wide spread devastation.

As witnessed in the earthquake, it was not the lack of good building codes (California seismic codes were in force in the disaster area), but the lack of effective enforcement that gave way to large-scale building collapses. Therefore, public acting as a watchdog, and changing the market dynamics of the construction industry are essential public education challenges. Maintaining the memory of the disaster in the psyche of the public through continuous media campaigns, school curriculums that include disaster awareness (not unlike the tornado drills in the Mid-west), and the training of government bureaucrats in disaster awareness are some methods of creating and maintaining the public awareness needed for effective enforcement. Similar training and education of the public is needed in the area of fire safety. Since K-11 curriculum is coordinated centrally through the Ministry of Education, the Ministry must develop curricula for disaster awareness and management education.

As the public was quite outraged by the shoddy construction practices in the area, the attitude of the public that undervalues the services of the professionals in the building industry along with the attitude of expecting miraculous solutions from the government and the public officials while assuming little personal responsibility is beginning to change. While, the popular media is full of stories that always blame the other (whether it is the officials or the builder/developers), there are also stories of self-reflection and self-criticism.

EMERGENCY RESPONSE AND PLANNING

The greater metropolitan area of Istanbul, who is expecting a major earthquake within the next 30 years with 62% probability, has developed an "emergency action plan" since the 1999 earthquake.[18] This plan also includes some multi-hazard mitigation issues by addressing earthquake mitigation as well as fire safety precautions. For example, better automatic shut off systems for natural gas systems and expanding fire fighting capability by allocating 10 trillion liras (14.5 million US$) for the purchase of fire fighting and rescue equipment and for the hiring of additional personnel are currently foreseen. It also includes emergency transportation and field hospital plans. As mentioned earlier, the city of Izmit has also built over 110 fire and emergency response centers around the area since then. Clearly, following such a major disaster, heightened public awareness and public pressure help to undertake such additional long overdue precautions. On the other hand, emergency response plans alone are not sufficient and such efforts must also be accompanied by post-disaster recovery and reconstruction plans.

SUMMARY

Post-disaster recovery and reconstruction is a long, arduous and expensive process which, when planned properly, can contribute to the creation of healthier and safer environments considerably. In this article, a preliminary assessment of this process in the aftermath of the 1999 earthquake in Izmit Turkey was done from the point of view of multi-hazard mitigation. Clearly, 15 months after the earthquake, it is time to take stock and undertake an extensive study with the intention to collect data regarding multi-hazard issues during reconstruction. The

need to protect the public as well as the need to protect the investment that is currently made in the area renders the time and effort needed for such a systematic assessment worthwhile.

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