AN INTEGRATED PUBLIC POLICY TOWARD NATURAL HAZARD MITIGATION: CAN URBAN PLANNING AND CONSTRUCTION SUPERVISION FIX ECONOMIC LOSSES?

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SUMMARY

Natural hazards such as earthquakes can inflict intolerable losses on urban environments. The differences of public policy for mitigation of these losses reflect the institutional fabric of a given country, and the nature of its democratic preferences. Turkey's long history of earthquakes led to the establishment of a ministry in 1958 charged with the duty of studying and administering the natural hazards problem with the aim of reducing future losses. This ministry was made responsible for enforcing both the Development Law and the Disasters Law. One of the first missions undertaken by the Ministry of Reconstruction and Settlement was the preparation of a building code for natural disaster protection, and a seismic zones map. The ministry was also responsible for regional and urban planning. In 1984, this ministry and the Ministry of Public Works were combined to form a single ministerial entity, and all planning responsibility was entrusted to city governments. This move was in the correct direction because elected local governments should be the primary cradles where urban environments are created, and permits for most construction are issued.

The Development Law and the Disasters Law are linked to other legislative pieces in a complex way. Among related legislation are civil law, contracts law, municipal law, law on engineering and architecture services, insurance, obligations, and statutes governing their execution. We examine the tools at the disposal of the urban planner for reducing the impact of disasters. This discussion is in a generic format, and the broad outline of the tools at the disposal of the regional and city planner for mitigation of natural hazards is examined. Conversion of the outcomes of effective planning and construction supervisory activity to economic benefits is not straightforward. We provide figures based on experience derived from large-scale rehabilitation programs implemented in three different cities in Turkey affected by earthquakes within the last seven years. The transportability of these numbers to other circumstances would be debatable, but they serve to underscore the economy of preventive versus post-earthquake healing measures.

INTRODUCTION

A study for the reduction of natural hazard losses through planning and building quality assurance is currently being carried out at Middle East Technical University. The Turkish Government Housing Agency supports this investigation. Its scope and unique feature of being perhaps the first comprehensive policy-recommendation platform for an enduring improvement for disaster-related legislation in Turkey makes it a valuable source for formulation of public policies in disaster mitigation. There exists an abundantly rich body of legislation and policy documents in Turkey in relation to urban development and planning. What lacks is a consensus among the many parties (central and local governments and their agencies, engineers, planners, academics, professional societies, NGOs, and the society at large) as to the steps toward the objective of creating livable, clean, well designed urban environments with the desired disaster resistance. Building construction supervision is under consideration in this context.

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REDUCTION OF DISASTER LOSSES

Turkey's long history of disasters, most frequently earthquakes, led in 1958 to the establishment of a Ministry of Reconstruction and Resettlement. The ministry had the unique feature of being responsible for the implementation of the Development Law and the Disasters Law. The primary objective in setting up the ministry and its agencies was to reduce the risk of death and injury to the population, and as a second but equally important priority to reduce the scale of the economic risks involved. The Ministry was made responsible for updating and promulgating both the seismic building code and the earthquake-zoning map. The latest revision of the code became effective as of 1998, and the map, shown in Figure 1, in 1996.

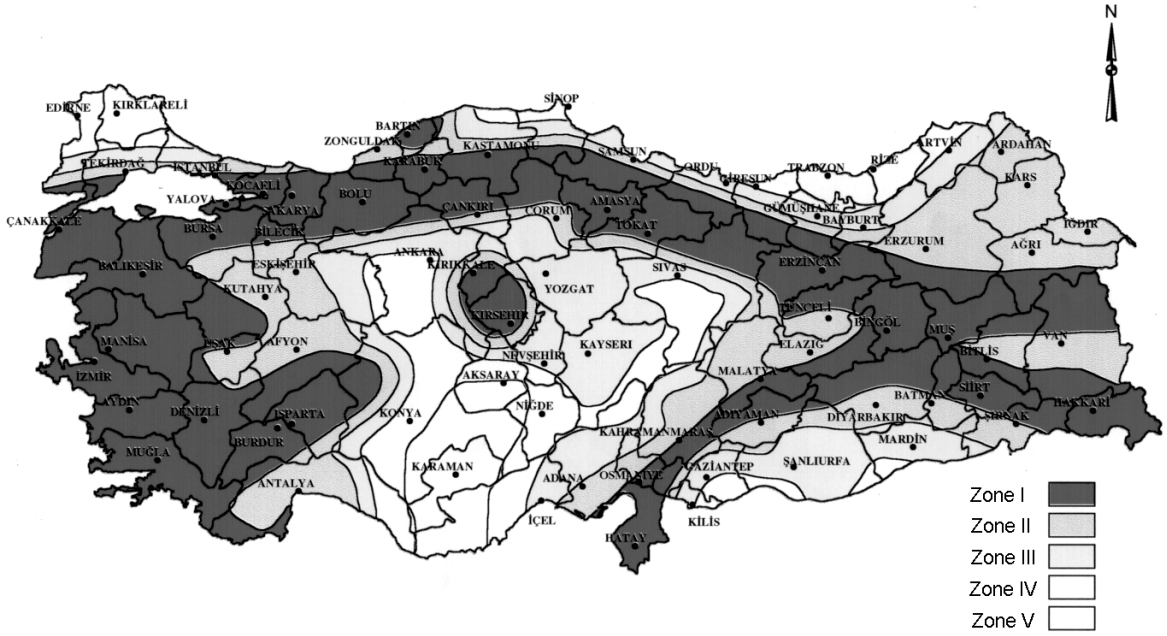

Figure 1. Earthquake Zones Map

Until 1985, when the current Development Law was enacted, urban planning departments in Turkey were part of government offices representing the Ministry of Reconstruction and Resettlement. The role of the authorities included land use designation (the preparation of a land use master plan), control and compliance with zoning ordinances, licensing new developments by private owners, and locating public facilities. From 1985, these privileges were transferred to the local governments. The Development Law has the declared intention of controlling the appropriate formation of settlements and buildings. The mission of controlling only the construction phase is narrow, because it excludes organization of investments and entrepreneurship, provision of land and other infrastructure, technical means of oversight during the construction. Property management approaches and the protection of the various kinds of the environment are also not included in the scope of the law. Powers of plan making and ratification have been delegated to the local governments, irrespective of size and manpower resources. To compound the difficulties, other ministerial bodies have also been entrusted with plan making powers and in-house approval rights [Gülkan, et al., 1999].

Control over enforcement of building codes in privately owned buildings is possible within municipal bounds, defined loosely as townships with more than 2000 population (there are at present some 3100 municipalities in Turkey) where municipal engineers theoretically have powers to enforce compliance with regulations. Building plans are submitted to the municipal authorities with the signature of a design engineer who is responsible for code compliance. In practice, municipal engineers are not able to check thoroughly all of the design calculations because of their heavy workload.

URBAN POPULATIONS AT RISK

In a country such as Turkey with many diverse climate zones, building traditions and available materials for construction, there exists a wide variation between the earthquake performance of buildings. This difference is

much greater in the case of owner-built rural buildings because in general dwellings in the eastern provinces have thick rubble masonry walls and heavy, earthen roofs that collapse easily and bury occupants. Much of the engineered construction is reinforced concrete. The number of provinces arranged on the basis of the highest hazard zone within boundaries is shown in Figure 2.

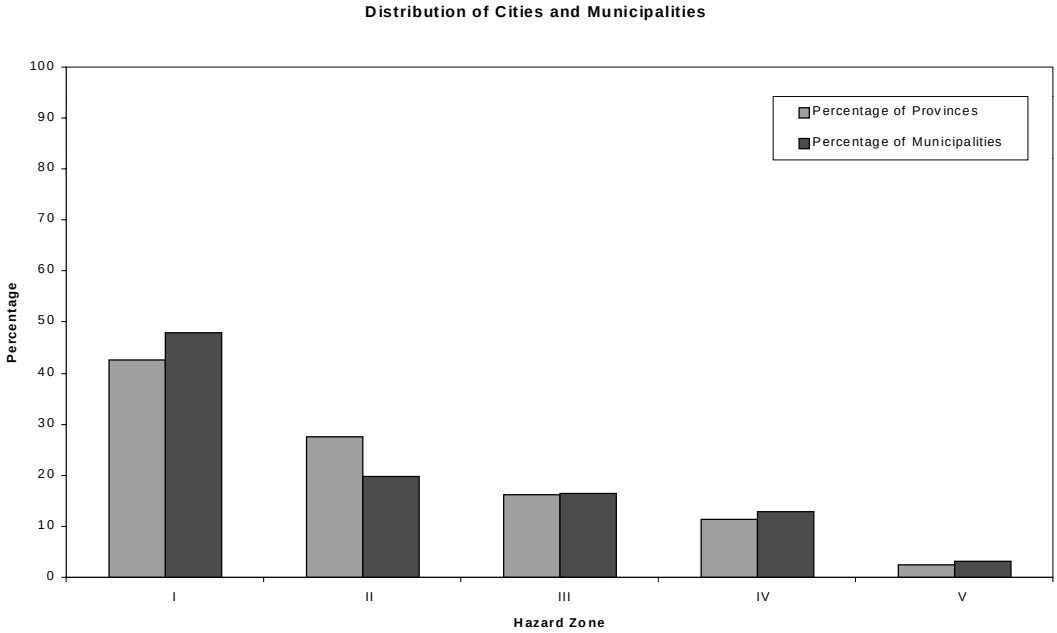

Figure 2. Distribution of Municipalities among Earthquake Hazard Zones

DICHOTOMY OF THE DEVELOPMENT LAW AND THE DISASTERS LAW

The layout and development of cities, location of the infrastructure, key buildings and utilities, and the physical development of the built environment can all affect the impact of an earthquake. The town planner, the regional planner, the engineer designing the layout of the utility networks, transportation routes or key installations, and anyone whose job is to locate facilities within a town or whose decisions affect the use of the land, all have a role to play in reducing the potential impact of, say, an earthquake [Coburn, 1995].

Effective management of urban development in a city depends on understanding the processes that shape it. The trends in land prices, location preferences for different types of industrial facilities, community development patterns, population growth are the complicated dynamics that shape a given city. Urban planning attempts to regulate these processes using the powers of legislation and economy. The principal concerns of town planning are directed toward the creation of a safe, clean and pleasant environment. Disaster management concerns follow a parallel course: limiting the densities of population and development, provision of critical services at times of emergencies, and ensuring the continued operation of economic activities. Urban planning is a long-term process, therefore disaster management and protection are also long-term [Mader, 1997]. Traditionally, the disaster-worthiness of the building stock has not been a concern for the urban planner, but of the engineer.

In many Turkish municipalities, particularly in those where rapid economic growth has been registered within the last twenty years or so, the zoning ordinances and master plans prepared by the town planning departments have been overtaken by the dynamics of urban growth. Changing circumstances occur faster than planning responses can be put into action. This in effect has resulted in a planning environment that follows, rather than directs, patterns of urban development. Zones defined in master plans can not be maintained as their intended categories, with many zones being transformed into ill-defined mixed-use areas. Even further removed from the formal planning process are the informal settlements where almost no building quality measures can be enacted. In many metropolitan areas the most dangerous sites, steep and unstable hills, stream gullies, riverbeds and environmentally hazardous areas have been covered with runaway settlements. The human and material losses of a severe hazard affecting these areas are likely to be very high.

Plan making at only regional and urban levels represents an incomplete hierarchy. The Ministry intervenes as an intermediate authority if conflicts arise between local authorities or in cases when national concerns are involved. Land preparation, sub-divisioning, and rearranging property rights in areas where rural to urban conversions occur are the basic operational tools of the law. Building permits are obligatory, designs being submitted to the local governments to meet the requirements of both building and disaster regulations. The actual construction activity can not be supervised too well because of inadequate personnel and financial resources. Yet, local governments are responsible for this supervision and the issuance of occupancy permits.

The scope of the Disasters Law dating from 1959 is to provide a public intervention capacity and improvement in the efficiency of relief operations after disasters. These operations are entrusted to provincial governors who are granted wide powers in the aftermath of disasters. Plans of disaster-affected settlements are immediately revised and construction permits are granted. Settlements that have been destroyed substantially may be relocated by decree of the Council of Ministers.

Apart from its restriction to post-disaster operations, and its independence from the Development Law, the Disasters Law falls short of being a contemporary disaster management blueprint. One of its most counter-productive requirements is that every homeowner will have a dwelling built with public funds if his former property is unusable after the disaster. This stipulation does not differentiate between authorized and unauthorized construction. Building owners who abide with the legal requirements, and those who insure their property are effectively penalized by the system because they are excluded from the handsome subsidies meted indiscriminately to other "entitlement holders" from taxpayers' funds. It is acknowledged that this not only becomes a source of injustice, but contributes also to a culture of fatalism, leading to the creation of a society in expectation of disasters. With the above review the components of a strategy to transform the system to a model where a prepared, rather than a fatalistic, society can be recognized as a priority [Balamir, 1999].

Major revisions must be made in the Development Law. Firstly, the Disasters Law should be stripped of its pretensions of disaster preparedness, and these functions should be embedded in the Development Law itself. The former law needs to have its post-disaster procedures revised, with particular reference to re-defining the terms and conditions of entitlement rights. No individual should be entitled to public subsidies without proof of full compliance with the ordinary development constraints. Such entitlement could be based on a registered qualification of property, leading to differentiated property markets at the early stages of property valuation. Further improvement will be the encouragement of individuals for buying out building insurance, and the transfer of a part of property taxes collected by the municipalities to the Disasters Fund. Differential property taxes could be levied by local governments to penalize unauthorized development.

Amendments in the Development Law must include the following headings: a general upgrading of planning supervision, and unification of powers for planning with a comprehensive hierarchy of interrelated plans. Incorporation of participation, community protection, urban renewal and design and property management will not only complement the existing planning functions, but also improve the background for disaster management operations.

THE BUILDING PROCESS IN TURKEY

The principal instrument governing how buildings are created is the Development Law. This document has a few articles in Part 4 that regulate the supervision of building construction. The law holds municipalities (or governorates for buildings outside of urban areas) responsible for project supervision. Construction supervision is entrusted to the so-called engineers of record.

Holders of deeds or parcel assignment certificates submit petitions to either the relevant municipality or the governorate to acquire building permits. In addition to the certificate of land ownership the applicant must submit architectural, structural, and mechanical designs as well as a schematic drawing of the buildings location. Some municipalities have transferred this duty to the local branches of the Chambers of Civil Engineers or Architects through informal agreements, but this is a very dangerous practice because the law clearly holds the local government liable for ensuring the life and property safety of the people it serves. The customary procedure is that the technical offices of municipalities function as rubber stamps in their approval work. The Development Law does not specify what measures are to apply if erroneous designs are approved. Legal precedent appears to hold the design engineer responsible in this regard.

The Development Law requires the engineer of record to report to the municipality or governorate any contraventions by the contractor of the design he supervises. When such a violation occurs it is incumbent upon the local government to seal the construction site, and to order the owner to take corrective action. If within one month this action is taken, the order for work stoppage is rescinded. If the owner does not comply with the order, then his permit is revoked, and the building demolished at his expense. This process is largely illusory.

EFFECTIVENESS OF LAND USE PLANNING

Limitations exist in how effectively the land-use planning instrument can be used as a tool for disaster mitigation. Land-use planning is an opportunistic activity because it can be exercised only in the case of an expanding city where there are choices between alternative areas. Land-use planning must be controllable, and this is where the greatest difficulty exists within the Turkish system. Without major changes in the planning control mechanisms currently in use according to the Development Law, detailed control over private urban development will remain illusory because the administrative framework for planning controls is overwhelmed by their bureaucratic volume. A less tangible factor in shaping cities is the price of land. Hazards can influence the price of land, and change the shape of a city. For example, riparian land where ground motions are more severe than on firm ground can potentially suppress land prices there in spite of scenic advantages it may offer. Theoretically, an educated real estate market in a rich economy can make proper decisions to protect itself against hazards [Johnson, 1998]. This is not yet within reach in Turkey, so strict enforcement via newly crafted means is necessary. For these measures to have any success there must be a social agreement for the communal benefits they will engender, and a willingness to pay the corresponding price.

MITIGATION MEASURES

It is not clear what quantifiable reductions in disaster potential will accrue if changes in land use are enacted. This could be attempted on a theoretical basis by determining the optimum location of facilities where location affects seismic vulnerability. The change in damage potential is connected to changes in subsoil or distance from active faults. It is then possible to calculate the added benefit of either relocating facilities or of strengthening them taking into account the special requirements these conditions may impose on the cost of building. The effectiveness of different schemes for beyond-code strength measures for strength could then be compared with the returns they provide. The most sensitive item in such assessments would be the quantification of the lives, and the economic value saved, a notoriously inaccurate effort [Housner, 1999].

Any policy recommendations following from mitigation needs must carefully balance costs and the accruing benefits. It would be very useful if a quantitative framework could be drawn for defining risks, vulnerabilities, and mitigation actions and their costs. To our knowledge such work has only been done to date only on a theoretical basis, with no physical calibration because the answers to these questions depend on many social and economic considerations where formal decision making techniques can not be applied directly. Even with uncertainties, the quantification of costs and the corresponding benefits for earthquake protection measures can illuminate the decision making process. Loss estimates should be of much interest to those who do physical or economic planning because planning decisions can have an effect on future losses. We will refrain from entering the subject of loss estimation, but an attempt will be made in the next section for quantifying costs and benefits on the basis of experience gathered from three large-scale rehabilitation projects in which we have been involved during the past six years.

RECENT REHABILITATION PROGRAMS

It is acknowledged that a revision of Turkey's disaster management capacity is necessary if unreasonable losses are to be avoided in the future, Within a cost-sharing arrangement with the UN Development Programme, the Ministry of Public Works and Settlement is currently executing a program entitled "Improvement of Turkey's Disaster Management System." This program aims at institutional strengthening with carefully designed seed projects, each addressing a specific area for which a given agency is responsible. Additionally, a more ambitious and comprehensive program (code-named TEFER: Turkey Emergency Flood and Earthquake Rehabilitation) is

underway to meet this objective. TEFER is funded by a loan from the World Bank. These programs have the objective of reducing Turkey's potential risk burden from natural disasters.

Reducing the vulnerability of existing buildings is an important aspect of any earthquake hazard mitigation program. Maintaining the existing stock is necessary not only for economic but also social and cultural reasons. In many areas the older, weaker buildings where poorer people live are the sources of expected future losses. Nearly all options for strengthening are expensive when compared with the incorporation of capacity building elements into a new design, so the costs and benefits must be carefully analyzed in deciding whether to strengthen or to demolish. In areas of higher seismic risk, upgrading is more likely to be more cost-effective because the cost per life saved, or per saved time of economic disruption is lower [Coburn, 1995]. Unfortunately, such rational analyses have not been performed prior to decisions leading to the rehabilitation schemes in Turkey because appeasement of public suffering has always been accorded higher priority.

Over the last twenty-five years, faculty members at METU have conducted extensive field investigations in damage assessment and disaster evaluation following major earthquakes. Until 1992, these field studies were limited to making immediate reconnaissance reports, followed by sporadic involvement in rehabilitation projects, and long-term scientific investigations. The 13 March 1992, M = 6.8 earthquake in Erzincan (640 fatalities) marked a threshold because in its aftermath first institutional and then privately owned buildings were rehabilitated on a large scale. Three national universities, including METU, have served as the principal consulting agencies for the repair and strengthening programs. This practice seems now to have become a matter of government policy because following the 1 October 1995, M = 5.9 earthquake in Dinar (92 deaths), and the 27 June 1998, M = 5.9 event in Ceyhan-Adana (145 losses of life), similar large-scale and costly rehabilitation programs have been undertaken.

Upgrading the lateral load-resisting capacity of an existing, but damaged, building is an arduous task. Precise quantification of the degree of loss of capacity is not possible because of the high degree of indeterminacy. Often, material and workmanship quality is variable (and invariably poor), as-built drawings not available, and foundations inaccessible. In such cases the best policy seems to be to devise simple rules for identification of vulnerable buildings on the basis of readily identified indexes, and to conduct in-depth assessments for those that have been prioritized [Gülkan, et al., 1994]. By law, only moderately or slightly damaged buildings may be repaired in Turkey. This process is understood to imply the incorporation of structural walls in the case of reinforced concrete buildings or the encasement of masonry buildings within a shotcreted outer shell so that the lateral force capacity meets the requirements of the code. When the damage degree of heavy (including partial or even total collapse) has been accorded to a given building, it is demolished. Fatalities occur almost exclusively in these buildings.

A CASE STUDY OF DİNAR

An understanding of the cost effectiveness of repairs in terms of saving lives and preventing injuries can be derived from the data for Dinar. The local magnitude 5.9 earthquake on 1 October 1995 caused 92 deaths and about 200 injuries, mostly within the town with a population of 35,000 itself. Sporadic damage and injuries were reported from the villages in the vicinity. The total number of affected people was 100,000, and the number of households 24,000 [Sucuoğlu et al., 1997]. A building may consist of anywhere from one to several households. For reasons of entitlement canvassing, the Turkish system records only the household information, so building damage must be derived separately. The breakdown of the damage distribution is illustrated in Figure 3. The number of buildings that suffered collapse was 201. Their classification is summarized in Table 1.

For purposes of this discussion we can confine our attention to the distribution of building types within Dinar. The recorded peak ground acceleration of 0.29 g in the city is compatible with a return period of about 100 years, so the levels of moderate damage, implying structural distress and collapse (causing death and injury) correspond to unacceptable response. Ideally, had a pre-earthquake assessment been made, these building would have been indicated as requiring structural intervention for upgrading purposes. Multistory reinforced concrete buildings were hit harder, although they constituted only 15 percent of the building stock. These buildings contributed more household units, and larger total area than their share of the building types. In a simplistic approximation, we may assume that one-third of all buildings, and two-thirds of households needed prior upgrading so that no injuries and deaths would occur. (As stated earlier, upgrading is costlier than full enforcement of code requirements and building quality assurance during construction. This has been calculated to amount to about 10 percent extra cost.)

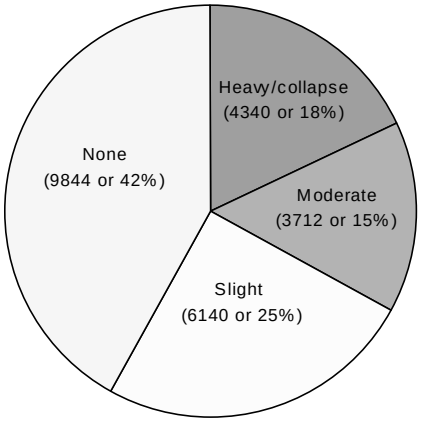

Figure 3. Damage Distribution

Table 1. Classification of Collapsed Buildings in Dinar

Structural System	Number of Stories	Collapsed Buildings	
		Single-Story	Full
R/C Frame	≥ 4	33	28
R/C Frame	3	29	18
Brick Masonry	4	32	41
Brick Masonry	3	10	4
Composite Masonry	2	6	-
TOTAL		201	

The METU inventory contained 35 reinforced concrete buildings with a combined floor area of 24,200 sq. m and about 300 household units. The average floor area for a building was 700 sq. m. The repair expenditure varied between buildings, and ranged from $15/sq. m to $63/sq. m, with an average figure of $45/sq. m. The total floor area of reinforced concrete buildings examined also by other teams and requiring structural intervention was about 70,000 sq. m. Many owners decided not to repair their homes, and refused to enter into long-term indebtment arrangements with the Ministry, choosing instead to continue living in sub-capacity buildings. About 100,000 sq. m of such housing existed in Dinar prior to the earthquake. Under the category of masonry buildings, including hybrid construction, the METU team decided to repair 79 of the 152 structures for which detailed assessments were made, and the remainder was condemned to demolishment. The total floor area of the 152 buildings amounted to 20,500 sq. m, for an average figure of 135 sq. m for each. The total number of buildings in the masonry classification was 430, with a combined floor area of 60,000 sq. m. Again, there was great asymmetry among the estimated repair expenditures, with an average figure of $30/sq. m. As a guiding figure, it may be assumed that of those eligible only about half were included in the rehabilitation program.

These figures state that, if a pre-emptive structural intervention program had been initiated in Dinar prior to the occurrence of the earthquake, the cost would have amounted to $8,100,000. This figure corresponds to $90,000 per life saved, or about $30,000 per injury avoided. These figures require qualification. In Dinar, precursors had occurred so that most people were already alerted to the possibility of an earthquake. The time of the main shock was about 6 pm, so that most people were still outdoors. In comparison with Ceyhan where on 27 June 1998, 12 buildings collapsed killing 89 people, the number of deaths per collapsed building was lower in Dinar.

The current average cost for reinforced concrete construction in Turkey is $250/sq. m, and for masonry $200/sq. m. If strict quality assurance is assumed to increase these amounts by 10 percent, then a total of $4,900,000 would have been needed prevent the deaths in Dinar, for an average of $53,000. These figures may be compared with the total of $250 million, estimated as the total loss bill for the Dinar earthquake.

CONCLUSIONS

The principal theme chosen for this World Conference has been mitigation of earthquake damage in the developing countries. This is timely and appropriate. The continuing process of rural to urban conversion

occurring in many areas in Turkey poses a major risk. Reducing the vulnerability of urban settlements would greatly diminish potential losses. A wide range of policies and techniques exists toward this end. The government and local planners can not unilaterally make cities safe for everyone. It requires communal awareness, motivation and self-protective action by a range of groups including local governments, construction industry, private businesses, insurance companies, professional societies and NGOs. Everyone needs to be educated in converting the built environment to one with enhanced disaster resistance. Planning activities in Turkey should focus on proven techniques for hazard reduction. These include hazard maps, deconcentration and decentralization of key facilities, protective land-use maps and street safety measures. The control of building quality is essential for urban disaster mitigation, and should be adressed as an overall urban protection strategy. This should best be entrusted to private design and construction supervision companies working in collaboration with insurance interests. The hindsight figures derived from the rehabilitation program in Dinar demonstrate the cost effectiveness of planning and engineering preventive measures.

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