The Relations of Earthquakes with Cadastre and Real-Estate System[1]

Prof. Dr. Erol KÖKTÜRK [1], *Dr. Erdal KÖKTÜRK*[2],

[1]Kocaeli University Karamürsel MYO, İzmit-Turkey; erolkokturk@superonline.com
[2]Beykoz Municipality, İstanbul -Turkey; erdalkokturk@yahoo.com

ABSTRACT

Horizontal and vertical deformations occur due to earthquakes. Movements at the earth crust cause modifications in property boundaries. Consequently, earthquakes affect cadastre and real estate system. The modifications caused due to earthquakes on cartography, cadastral system and ownership must be observed and the associated problems must be resolved. Furthermore, experience and information exchange between the countries having earthquake risk must be established.

It is known that 92 percent of the land of Turkey has a risky characteristic in terms of seismology. Probability of an earthquake stronger than 7.0 occurring in İstanbul during the next 30 years is 62 percent. Strategic action plans have to be implemented to minimize the life loss and property destruction. As a matter of fact, the achievement of such activities aiming to reduce the destruction effect of earthquakes depends on determination and evaluation of the relationship between earthquakes and cadastre and real-estate systems..

The relationship and the interaction of earthquakes with cadastre and real-estate system is examined in this article. Furthermore, the capability and the possibility of performing joint-action plans with countries which face similar problems are researched.

Keywords
Earthquake, Cadastre And Land Register, Urban Planning, Property, Reducing Earthquake Damages.

1. INTRODUCTION

As stated above 92 percent of Turkey's total land (769 604 km^2), %95 of the population (67 803 927 in year 2000),74 percent of industrial foundations and %44 of the dams are in threat of earthquakes. In Turkey, 130 earthquakes stronger than 5.0 in Richter scale occurred in the past 100 years. Due to these earthquakes 80 000 people died, 150 000 people were injured and 600 000 buildings were damaged.

1500 km long North Anatolia Fault crossing Turkey from east to west, was broken in two different points (100 and 200 respective km's east of İstanbul) with 2 consequent Earthquakes stronger than 7, in 1999 August and November . In these earthquakes named as "East- Marmara Earthquake" and "the Düzce Earthquake"; over 20 000 people died, 90 000 house were demolished and 15 billions USD economic lost occurred. A probable fault crack under the Marmara Sea part of the North Anatolian Fault threatens the Marmara Region with a population of 17 365 027 people and city of İstanbul with a population of 10 018 735 people. According to the researches of many Turkish and foreign scientists, the probability of an Earthquake occurring with a scale stronger than 7.0 in İstanbul during the coming 30 years (2002-2032) is %62 (BARKA and ER 2002, İDMP 2003). The impact of such an

[1] Written in 2005, but has not been published.

earthquake, will cause 223 000 people to die, to be lost or injured, buildings hosting 3 700 000 people to be damaged and approximately 50 billions USD economical lost to be occurred (İDMP 2003: 130-133).

An inevitable earthquake in İstanbul necessitates determining the emergency procedures and preparing the disaster management studies for reducing the possible lost and damages.

During 17 August 1999 East-Marmara Earthquake and 12 November 1999 Düzce Earthquake, maximum of 4.40 m Earth crust movement was observed. (Picture 1, 2, 3, 4; İTÜ 1999,HERECE, ŞAHİN 2003).

Picture 1: Railway in Sapanca Region

Picture 2: Lateral Shift in Road

Picture 3: Düzce City Center

Picture 4: Demolished Building

The slides and deformations due to the earthquakes changed the boundaries of natural and artificial foundations and also parcel lines. Destruction and damage of buildings modify the parcel lines in the horizontal plane (x, y), and vertical (z) displacements occur in places where land settles down. All these deformations and physical changes require renewing and updating the cadastral maps and the register of title deeds.

When the relationship of earthquakes with cadastre and real estate system in Turkey is examined, it is observed that establishment of joint action plans with the countries facing similar problems become crucial.

2. OUTLINE OF RELATION WITH EARTHQUAKE

First of all, the quality of buildings must be enhanced and settlement system must be improved to reduce the destructive effect of a probable earthquake. To achieve this, it is required to conduct geological / geophysical and geotechnical researches before planning, to define population and socio-economic development tendency and to predetermine possible developments both in town centers and countrysides. Therefore, strategic planning for fundamentals of urbanization and settlement politicy is crucial.

Earthquake damages can be reduced by sustainable land planning and by improving settlement of people in disaster risky regions. All long term problems and requirements should be addressed in risky seismic zones. Otherwise, huge destructive effects of Earthquakes cannot be prevented .

Earthquake loses heavily depend on, driving factors caused by the economical, social or legal system of countries. Especially, the regulations for urban planning and construction management are inadequate in developing countries. Comprehensive regulations should be introduced to the current legal system to decrease the disaster risk and to minimize the casualties and damages from earthquakes.

There are lots of reasons causing human, social, economical and physical damages in an earthquake. More important reasons are;

1. Inadequate planning and land usage decisions in urbanization and municipal settling systems .
2. Lack of insufficient control in construction process and during project phase.
3. Unstable economic system.
4. The tendency of people building illegal construction due to unemployment, unbalanced income distribution, slow bureaucracy, political pressures and self-interest initiatives and other similar reasons.

Required revisions in"*1) urbanization, 2) land politics 3) residence planning 4) control"* subjects must be done to decrease the destructive effects of earthquakes. Legally correct execution of construction period and settlement system should be ensured. Technical rules and standards should be carefully and thoroughly followed in construction.

In Turkey relevant measures for a safe, sound and healthy planning measures has not yet been introduced. Moreover most cities are located over an active fault. Insufficient land and planning politics have been applied in Turkey over the past 30 years. As a result, industrial plants and urban areas are concentrated on riverbeds, active seismic lines, river deltas, agricultural lands and marine filling areas. Constructing industry, residences, trade centers, tunnels, viaducts, bridges, power plants and similar foundations in high risky seismic regions threaten the environment and human security. Since 1970, **regional planning** policy has been left in planning stage and environmental order plans done and approved by Ministry of Public Affairs are insufficient and not in compliance with the general investment and environment policy of the Government. Therefore, construction without any criteria including those on the coast lines in İstanbul -İzmit –Sapanca metropolitan region resulted in a chaotic and dangerously settled environment. (ŞPO 1999).

Furthermore, illegal buildings are not demolished and continuously protected against laws and regulations by introducing new exclusive articles. . , Since 1948, a total of 17 such kind of regulations which pulled illegal properties into legal frame without any penalties has been practiced. (1948-2000). Consequently all illegal buildings benefited from all infrastructure facilities (electricity, water, sewage system, natural gas, etc.). 85% of demolished buildings in 1999 earthquakes were among this kind of illegal buildings (YILMAZ 2002).

"Disaster Management" must be established to decrease the earthquake damages. Disaster management facilities should not be limited to intervention and improvement, but they should also include preparation and damage decreasing stages (İDMP 2003). This includes;

1. Taking inventory of existing buildings and examining their seismic safety,
2. Strengthening the weak buildings,
3. Gathering the ownership information of buildings and citizen parcels and people living there,
4. Establishing the earthquake information system for determining the building and life loss after an earthquake and keeping public real-estate stocks in reserve for temporary or permanent settlement,

Pre-seismic preparation facilities include the establishment of a "Geographic Information System (GIS)" including cadastre and land registry information. Also, when refurbishing the demolished buildings and harmed urban structure during earthquake, socio-economic and physical conditions should also be considered. Cadastral and land registration information play an important part in forming "**Urban Transformation"** and GIS that supply legal reproduction of cities. For this reason, it is necessary to deal with these subjects and the effects of deformations on earth crust after earthquakes on cadastre and real-estate system must be examined and eliminated.

3. THE EFFECTS OF EARTHQUAKES ON CADASTRE AND OWNERSHIP SYSTEM

3.1. Geodetic Networks and Modifications in Parcel Lines

Due to the earth crust movements during earthquakes, geodetic networks suffer damage. Earthquakes change the cadastral structure and the coordinates of geographic objects in the region of broken seismic line in three dimensions (x, y, z). The modifications occur in location of triangulation and polygon points and affect the cadastral maps, public works plans and topographic maps produced by leaning on these points.

Therefore deformation size and direction must be determined first in the seismic regions that have earth crust movements. As a result of this, triangulation and leveling networks need to be re-evaluated. Establishment and continuation of geodetic network must be modeled according to the obtained data's. Therefore, the triangulation points on moving layers must be examined by leaning on the points that are unaffected from earthquakes and have no motion.

The basis for a correct and reliable location data is geodetic reference systems that have been defined precisely (precisionally). The geodetic networks should be based on these systems. Also, time wise location changes on these network must be monitored.

In Turkey, after the East Marmara and Düzce Earthquakes which occurred in 1999, "**Marmara Earthquake Emergency Reconstruction (MEER) Project" was** activated which is supported by International Improvement And Development Bank. As a sub-component of this project **"Marmara Earthquake Region Land Information System (MERLIS)"** was initiated for reconfiguration and improvement of earthquake region (ERCAN 2003). Furthermore, including the dedicated projects, correcting and updating the locations of "**Turkey National Base GPS Network (TUTGA)"** points in earthquake region formed by Register and Cadastre General Directorship has been conducted. The coordinates of these points were corrected as a result of new measurements in 2002. In addition, as a result of examinations done related to the mentioned MEER project in earthquake regions, cadastral applications were completed in 3 cities, 863 villages and quarters, including 1 000 000 parcel and 11 500 cadastral map. In these studies it was observed that;

1. Alterations in parcel geometry due to earth crust movements after earthquake, took place
2. Whole earthquake region has a pre-made graphical cadastre,
3. Many cadastral maps and documents used to produce these maps are insufficient (measurement sketch, measurement values, use sketch, etc.)

4. Different surveying techniques, coordinate systems, scales, legends and legend - keys has been used, in cadastral studies.
5. That the current cadastral system is far from being eligible to meet todays demands and is technically insufficient ,

Thus, the project subtitles has been forseen to be conducted with the following subtitles:

1. Digitizing the graphical cadastre,
2. Integration of cadastre and land register information to system by establishing a data base,
3. Constructing service buildings and forming computer aided working conditions,
4. Education,

But, the scope of the studies that was supported by World Bank till 2004 have then been are reduced to two purposes;

1. Producing 1/1000 scaled digital photographic maps,
2. Renewing the cadastral system in 100 villages.

Project area is planned for 9351 km^2 versus the area affected by earthquake 36 000 km^2. Furthermore, producing topographic maps used for improvement plans and public services were excluded from the project scope thus cadastre and urban planning integrity is spoiled. On the other hand, expected results were not attained due to unprepared applicable action plans and due to coordination deficiencies between associations.

3.2. Cadastral Works in Earthquake Regions

In Turkey, general principles of cadastre and real-estate ownership system are defined in Turkish Civil code dated 1926. According to this law, if a parcel's boundaries on cadastral map do not match with boundaries on land, the boundaries on cadastral map are accepted as the essential boundaries. By an amendment made to Turkish civil code in 2001 (Paragraph: 719), it is specified that this rule is not applied in "landslide regions". Despite this, the word "earthquake" is not mentioned. Moreover, earthquake is not mentioned in Cadastre Law either. This situation is a great deficiency for a country that 92 percent of its land is at earthquake risk.

On the other hand, in case of an earthquake, the procedure according to the cadastre and ownership system is regulated in Disaster Law dated 1959 number 7269. Disaster Law counts earthquake among the other natural events like fire, flood, landslide, avalanche and name all these events with the general name "Disaster". The articles about cadastre in Disaster Law were changed in1968 and some exceptional articles were set up different from Turkish Civil Law and Cadastre Law (Table 1).

It is observed that, Disaster Law mainly concentrates in facilities that will be built past the disasters partially including the pre-earthquake facilities. The cadastral works of earthquake regions are specified in the cadastral law dated 1987 and numbered 3402 In addition to this, articles in Disaster Law is not updated and associated with Turkish Civil, Cadastral and Improvement Code, which totally changed after the ratification of the Disaster Law. Therefore, problems and confusions are common and contradictory applications are observed.

3.3. The Effects of Damaged Buildings on Cadastre and Ownership System

The idea that "Buildings that become useless after earthquakes are assumed to be land," is stated in Disaster Law dated 1959 (Paragraph 24).This law also brings the condition of being holder of right to the residents of the razed buildings who will receive a new house or a loan (Paragraph 29). "Builders of unlicensed buildings on locations defined as restricted in zoning plan and Builders buildings on reel

estates not belonging to themselves and not having the construction license are not accepted as holder of right" is stated in the amendment of the Disaster Law with the Council of Ministers Decision KHK/574 validated in 1999. Furthermore, the clause "house and building loan will not be given to families who have another undamaged building in earthquake region" is also present in the law. (Paragraph 29).

It is known that buildings mainly constructed with no or limited control cause high risk for earthquake damages. The percentage of buildings, constructed without a building license or with a license but constructed not in compliance with its original project plan, in Turkey is about 70 percent. By the amended clause in Disaster Law stating *"buildings constructed contrary to the law can not get Governmental aid in case of destruction during an earthquake"* pushes people to behave legally. Despite this, illegal construction processes rapidly keep going on, even though people are now more conscious of future human and property casualties.

In contradiction to this, illegal housing construction is still going on with no interruption all its speed although the cost to strengthening such buildings or to those built not in compliance with the development plan is extremely high.

Such buildings not in compliance with the cadastral and condominium system is a major issue of the Turkish Development system and is yet to find a solution.

Condominium on buildings is ending automatically according to Condominium Law dated 1965 and numbered 634 if *"whole building is ruined on the cadastral parcel"*. *"Unusable due to being wrecked"* must be comprehended from the expression *"whole building ruined",* not *"demolished*". It's comprehended that, Condominium Law arranges different conditions from Disaster law and does not have clauses concerning with earthquake. When a consensus between the apartment owners is required for re-construction of a building demolished by outer effects depends on the Condominium Law. Also, Condominium Law does not authorize owners on taking obligatory decisions by themselves in taking protective precautions about buildings against earthquake. Therefore decisions by a large majority is advised instead of whole apartment owners about renewing or strengthening the building.

4. CADASTRAL UPDATE REQUIREMENT AND LEGAL STUATION

Parcel corner points precision in Turkey's cadastre is ±10 cm. When the movement of plates up to 4.40 m occurred during earthquakes in 1999 is taken into consideration, re-coordination necessity is appearing in cadastral system of earthquake regions.

Turkey's cadastre is a lawful cadastre and cadastre is defined as *"registering title deeds by determining the geometric and legal status of real-estates"* in the law. Information registered to title deeds by land survey, are taken into account of gained fundamental rights of real estate owners, due to forming by public guaranty. Therefore, it is impossible to annihilate real-estates once registered to the title deeds by deleting after even a number of years passed. Therefore registration of title deeds based on cadastre can not be erased or changed unless getting parcel owner's approval or judgment in countries having cadastre system.

Furthermore, it is not possible to raise an objection or bring a law - suit against real-estates registered to title deeds after ten years from cadastral definiteness. Consequently, public confidence in register of title deeds is obtained and public order is protected.

When reforming and updating the cadastre system damaged due to earthquake, the basis of land register information is preferred instead of complete erasing. These facilities are also subject to legal regulations as cadastral renewal. Developing countries can obtain the capability of digitizing the linear

(graphical) cadastre system by cadastral renewing with the condition of keeping the vested ownership information of people and public.

The achievement of applications after earthquakes governed by the regulations present in the five different laws about cadastral and ownership system (Table 1).

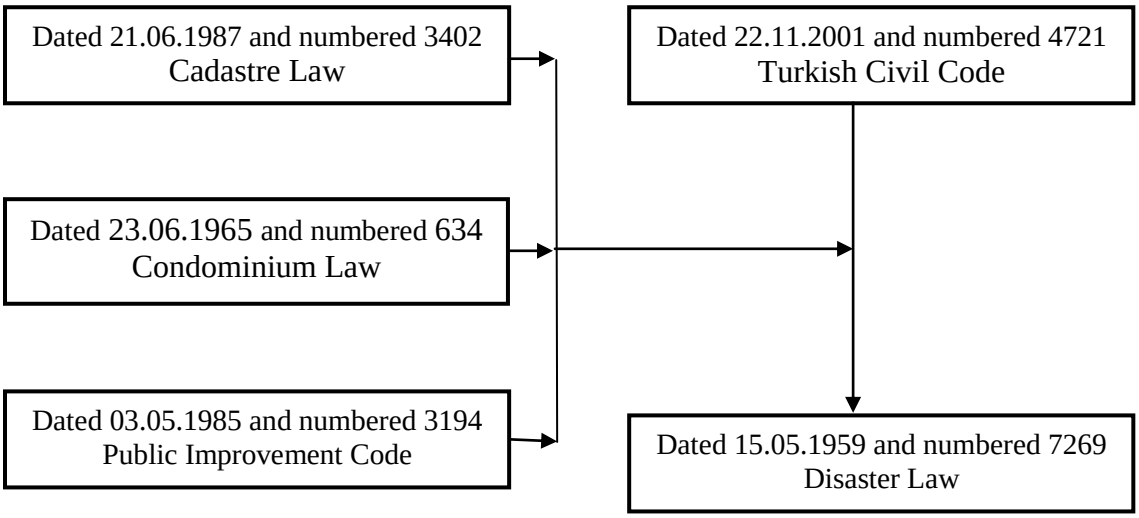

Table 1: Legal Regulations in Relations of Earthquake, Cadastre and Ownership.

5. REQUIREMENTS AND ISTANBUL EARTHQUAKE

The experiences and the findings gained in earthquakes of 1999 make the following actions as the most crucial steps:

1. Evacuating the more risky regions, transferring the improvement rights, transferring these rights to new urban regions, examining the safety of existing buildings against earthquake: URBAN TRANSFORMATION,
2. Digitizing the existing graphical cadastre starting from the more risky earthquake regions, integration of cadastral and ownership system with created database and establishing Geographic Information System based on cadastre: INFORMATION SYSYTEMS,
3. Forming planning system that are open to public participation, that are flexible, that improve urban and environment standards, which improves building and life quality, which cost – effective, more applicable and effectively controllable: STRATEGICAL PLANNING,
4. Defining the application tools and revenue resources: LEGAL REGULATIONS, ADMINISTRATIVE RECOORDINATION AND SOURCE MODELING.

Limitation on the existing resources for decreasing earthquake damages, has an adverse effect on taking the necessary precautions . Furthermore sourcing and financing topics must be modeled during application stated as below.

- Determining the values of damaged buildings and other harms in earthquake regions,
- Determining the eligible individuals that can be incentived by giving a house or a loan.
- Giving construction sites instead of houses and organizing monetary and construction material aid,
- Converting the remaining part, after subtracting damage value from the aids paid to people or families, into debt.

As a result of the 1999 earthquakes in Marmara Region, precautions must be taken from now against a %62 probable earthquake in İstanbul during next 30 years. Considering this fact "**EARTHQUAKE MASTER PLAN FOR İSTANBUL"** prepared by Bosporus University (BU), İstanbul Technical University (ITU), Middle East Technical University (METU) and Yıldız Technical University (YTU) has been presented to İstanbul Metropolitan Municipality (İDMP 2003).

In the report, building inventory information is gathered and comparative estimations are presented based on "Japan International Cooperation Agency (JICA)" and Bosporus University-Red Cross Report, Government Statistics Institute 2000 Building Count Data and İstanbul Metropolitan Municipality resources. Existing status, seismic ground movements and ground problems are examined with these data and more risky seismic regions are classified according to its importance and precedence. Also building damages, total casualty, economical loss, emergency sheltering need and closed road proportion are examined in accordance with earthquake scenarios. After these, a sample risk classification is studied and disaster scenes that may occur are visualized by simulations..

The model presented with İstanbul Earthquake Master Plan aims to decrease earthquake effects, improve the natural and urban quality formed by the following components; 1) coordination, 2) event command system, 3) resource management, 4) disaster management education. Suggested model also includes the reasons behind destruction and those week points that needs to tbe identified and enhanced due to economical social and legal system that cause this destruction. Thus, the social and economic structure of the society will be reevaluated and a system whose risk elimination continuously aimed at will be achieved.

İstanbul should get over the effects of the earthquake with the relevant decisions that needs to be taken today. While taking these decisions, cleaning the last fifty years' mistakes should also be considered. "World City Istanbul" should return back to its original identity leaving inadequate and unplanned urbanization.

6. CONCLUSION

There are numerous methods to decrease the destructive effects of earthquakes. From a Survey Engineering perspective. First of all it is necessary to link the geodetic network to reference systems of the cadastral parcels. For those who suffer the most from an earthquake, namely 1-humans, 2-buildings, 3-real-estate, information should continuously be updated and a database should be established since the success of a pre-earthquake study is inversely proportional to the casualties of destruction of an earthquake.

On the other hand ironically such disasters increase the collaboration cooperation and solidarity between countries and professions. In this respects it is expected that FIG's should put more efforts on activating national and international entities.

The results of an earthquake prevail that; migration from rural to urban areas should be stopped; industrial and infrastructural investments should be harmonized; regional inequality should be eliminated; new social, economical, cultural and physical planning policies should be developed and applied; modern multi-purpose cadastral applications and land policies that are of public interests should be dominant. The utilization of space should be based on a strategic plan and an active and effective control should be ensured during the construction phase.

REFERENCES

BARKA, Aykut, ER, Ali, **İSTANBUL, DEPREMİNİ BEKLEYEN ŞEHİR**, İstanbul, 2002.

ERCAN, Orhan, **TKGM'DE JEODEZİ VE ARAZİ BİLGİ SİSTEMİ FAALİYETLERİ,** Coğrafi Bilgi Sistemleri ve Jeodezik Ağlar Çalıştayı, TUJK 2003 Yılı Bilimsel Toplantısı, Konya 24-25-26 Eylül 2003.

HERECE, Erdal, http://www.koeri.boun.edu.tr/jeofizik/duzce21.jpg;

İDMP, **İSTANBUL DEPREM MASTER PLANI (İDMP)**, İstanbul Büyükşehir Belediyesi, İstanbul, 2003.

İTÜ, **17 AĞUSTOS 1999 KOCAELİ DEPREMİ**, İSTANBUL TEKNİK ÜNİVERSİTESİ ÖN DEĞERLENDİRME RAPORU, İ T Ü, 24 AĞUSTOS 1999, http://www.itu.edu.tr/deprem/

ŞAHİN, Hamza,www.hamzasahin.com, 2003.

ŞPO, **TMMOB ŞEHİR PLANCILARI ODASI GÖLCÜK DEPREMİ RAPORU: DEPREM SONRASI BÜYÜK YIKIMIN TARİHSEL SÜREÇ; POLİTİKALAR VE ÜST ÖLÇEKLİ PLANLAMA AÇISINDAN DEĞERLENDİRİLMESİ**, 27 Ekim 1999.

YILMAZ, Mustafa, **İMAR YAPTIRIMLARI VE YARGISAL KORUMA**, Seçkin Yayıncılık, 2002, Ankara, 235s.