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ISSN (Print: 2537-0154, online: 2537-0162)

International Journal on:

The Academic Research Community Publication

DOI: 10.21625/archive.v2i3.361

A Tool for Comparative Disaster Risk Analysis and Evaluation in Urban Areas (Draes)

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Abstract

The issue of examining the earthquake safety for existing constructions, which form the basis of urban mitigation strategies, requires new methods and tools according to each city's and society's specific conditions. The common goal in all methods is to yield correct results in a timely manner. However, due to the multiplicity and complexity of the parameters used in the examination, auxiliary tools are needed. This is not only because of difficulties in collecting data, but also in order to obtain reliable results. Thus, collected data must be analyzed in computerized environment.

In this study, an evaluation tool (software) called "Disaster Risk Analysis and Evaluation System (DRAES)" is developed. This software has been implemented and tested in Antalya; one of the metropolitan cities of Turkey within an area of 8800 hectares at 26610 buildings. The obtained results were evaluated comparatively which determined, consequently, the priority areas for planning as an important input for the city of Antalya. In this study, the general structure and working principle of the developed software are given. The source codes and data base of the program have been registered in accordance with the regulation on Registration of the Intellectual and Artistic Works of the Ministry of Culture and Tourism.

Keywords

Loss estimation; Seismic hazard; Seismic vulnerability; Urban areas; Comperative Assesment; DRAES

1. Introduction

Cities behavior during earthquakes depends on the structures in the city, characteristics of the local ground, earthquake source and the interrelationships among all these factors. Therefore, in urban risk analyzes a large number of variables should be evaluated at the same time.

Urban habitats with a structure mass that has undergone inadequate engineering service have been formed in Turkey in the mid-20th century as a consequence of population increase and migration to the city, using geologically inadequate areas for construction. This current situation, coupled with unplanned urbanization, has made our cities vulnerable to disasters. With the earthquakes, the problem of the safety of existing structural areas has come to mind. In the face of this problem, it has become a necessity to conduct a rapid and reliable screening of building stock expressed in hundreds of thousands of buildings in order to create a sense of structural confidence. However, the excess of building stock, workforce and resource problems have made the implementation phase almost impossible and it has become necessary to carry out alternative work on the subject.

In this study, a software was developed to create a new evaluation approach by using the first degree evaluation algorithm which is among the methods to be used in determining the risky buildings within the scope of the "Law on the Conversion of Areas Under Disaster Risk" law no: 6306, currently used in Turkey and the results obtained were transferred from the building scale to the urban scale. Although the method of construction examination is the same, for different cities; past earthquakes, structural characteristics, construction-methods and habits will be different. The underlying principle in developed approach and software is that these subjective conditions of cities differ from each other.

2. Development of the Methodology

To say that disasters are purely natural phenomena is the biggest mistake made conceptually. Disasters are a result of the coincidence of natural hazards and human vulnerabilities. So a danger does not create a disaster by itself. Disaster is the result of the humanitarian systems and their fragility. Natural disasters occur when these two effects are encountered in the same coordinates in time and space (Alcantara, 2002).

Despite the fact that disasters are happening all over the world, the effects are much greater, especially in the underdeveloped and developing countries. In cities, the most destructive effects occur in the poorest and faulty structured neighborhoods, in other words, the most irregularly structured areas. In short, the formation of disasters is not a work of nature but the result of a system established by man. In reducing this vulnerability, the system should be considered as a whole, legal administrative, social and economic developments should be provided at the same time.

Because of its geological and topographical features, Turkey frequently confronts the earthquake reality and experiences significant loss of life and property each time. Since the beginning of the 1900s there have been 158 damaging earthquakes in Turkey, 97200 people have lost their lives, 175,000 people have been injured and 583371 buildings have been destroyed or damaged in these earthquakes (Taymaz, 2001). As can be understood from the figures, Turkey, despite its dangerous geographical structure, has paid great price for the reason that it is unprepared for disasters. One of the biggest factors in the occurrence of these disasters is inadequate regulations, incomplete implementation decisions and unplanned construction as a result of them.

After Marmara Earthquake of 1999, it is once again understood that Turkey is inadequate and unprepared against natural disasters. After this date, it is not only legal but also project-oriented. In this context, many projects such as Istanbul earthquake master plan, RADIUS project, Zeytinburnu project, Marmara earthquake emergency reconstruction project, disaster prevention and mitigation project including seismic microzonation in Istanbul province have been carried out and many evaluation methods have been developed within these projects and "Law No. 6306 on the Conversion of Areas Under Disaster Relief" was issued. The methods to be used in determining the buildings defined within the scope of this law are similar to IDPM. The purpose of these studies is to make a rational evaluation with minimal data to be collected in a limited time by building observation from outside, thus making a performance order for the detailed examination of the buildings in Istanbul (İDMP, 2003). Arranged order does not include any unit of measurement or the buildings are not classified according to their risky status. The review is carried out in a comparative way, with priorities for the next assessment being determined. In order to determine the regional risk distribution in the method, a series of parameters for the evaluation of 1 to 7 storeys reinforced concrete buildings are investigated by observation and evaluated by their weights. In order to apply the method specified in the law, the following parameters must be specified. These parameters are; type of structural system, floor type, current state and apparent quality, soft floor / weak floor, vertical irregularity, heavy outcrops, planar irregularity / torsion effect, short column effect, structure / collision effect, peak / slope effect, earthquake hazard and ground (ÇŞB, 2012).

3. General Structure of Developed Software

The general structure of the software consists of 3 parts: Android application, Java Desktop application and Php Web application.

3.1. Java Desktop Application

Draes is a software developed in OOP (Object-Oriented Programming) standards using the Java SE software language. The MySQL database management system, which is flexible and fast enough to store building information and regional risk data and to display records whenever necessary, is integrated into the software. Draes completed the development process using the Waterfall model, coded in the "Composite" design pattern. The use of a "composite" design pattern allows the resulting objects to be combined together in a piece-whole relationship with a tree structure, and this composition can be accessed from a single interface. Because the Java programming language is used, the platform can run independently. Draes can run on any operating system that has a JVM (Java Virtual Machine). The initial login screen of the software is as shown in Figure 1.

Figure 1. Splash Screen

The software has user characteristics defined for 3 different user scenarios. These users can be classified as "observer, analyst and manager". Once the user has logged in, the observer can enter and edit the data, the analyst can access and analyze the data, and the administrator can identify the new user. The user diagram is as shown in Figure 2.

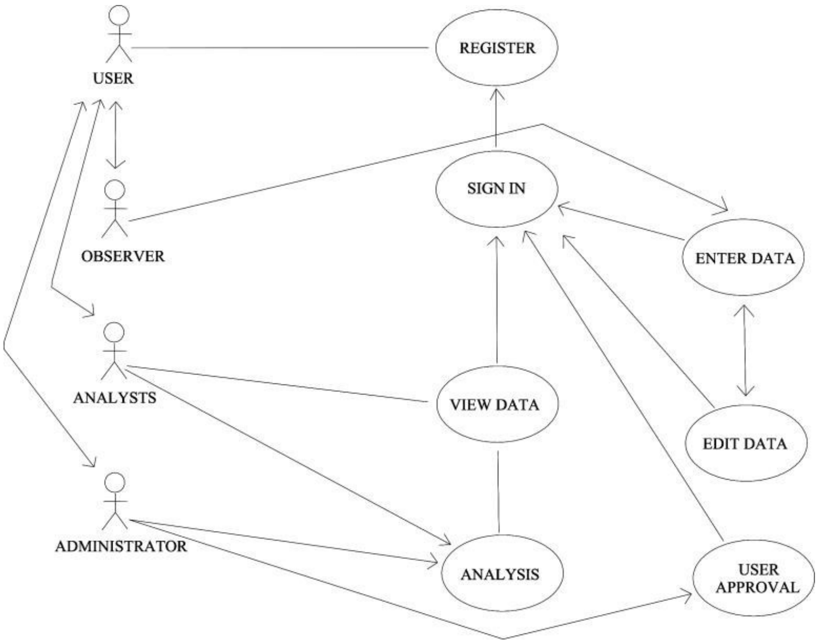

Figure 2. DRAES Usage Status Diagram

Draes offers 8 different interfaces to the user in terms of usage. Under the new data entry tab, there are the building identity, the technical information interfaces, the site map service interface under the display of the building data interface, the general, regional analysis, neighborhood analysis interfaces and finally the user profile interface under the data analysis tab. Since the recent earthquakes and Arc GIS commands direct windows to different software, they have not been defined as an interface.

3.1.1. User Profiles

The number of buildings to be examined in urban areas is expressed in thousands. In such highly comprehensive projects, the hierarchy of employees needs to be applied. Furthermore, in such studies conducted with expert personnel, it is possible that the error rate may be found in the data to be evaluated on the grounds that not all of the personnel on the study team are at the same information level. For this reason, there should be a tracking system for the personnel. The control of the data to be evaluated with this system can be controlled by another expert through the photographs taken, new levels of success and lack of personnel can be determined and new training programs can be prepared.

Each user must have a record and an ”id” in order to login to the system. In addition to general information such as name, surname, e-mail address, and password, the users who come to the registration screen should also choose the area in which they want to use the program. These areas consist of 3 options; observer, analyst and manager. The areas that users can choose from these areas are different. In addition to the recording area, there is an area where the user can leave messages to the manager. Due to this field being filled on demand, the administrator has supervised the system security. Users approved by the administrator can use the system in the user group they belong to.

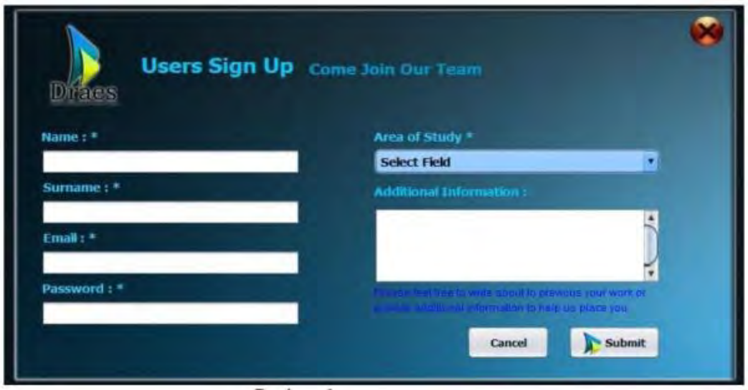

Figure 3. User Registration Screen

On the DRAES home page, users can use their user group attributes when they log in with their e-mail addresses and passwords, and their assigned IDs are processed on the data they enter (Figure 3). In addition, when the date of entry of each of the data is recorded, the next work to be performed on this area is made visible.

After the login screen, the application continues with a login screen as shown in Figure 4. System users get their e-mail addresses and passwords with help. Users who want to register with the system, forget their password or visit our website can access the relevant page from the bottom line commands.

Users who do not remember their passwords can ask the system to send them a new password by entering their e- mail addresses with the help of the screen shown in Figure 5 after the password forget command. Passwords consist of randomly generated letters and numbers. These passwords are both sent to your e-mail address and automatically changed in the database.

After login with the current user name and password, the DRAES main interface comes up (Figure 6). This interface can be accessed in submenus by selecting English and Turkish language options. There is also a brief description of what each of the commands on the bottom of the screen does when the command is on the bottom of the screen.

Figure 4. DRAES User Login Screen

Figure 5. Password Renewal Screen

Figure 6. DRAES Main Interface

3.1.2. Addition of New Building Data

The first menu in the software is the Add Building Data menu. When the corresponding command at the top is clicked, the menu shown in Figure 7, opens.

The layout of the building to be evaluated is determined without fault and the layout, island and parcel numbers are used so that the information is not confused with the information of the other building. The map, island and parcel numbers that are taken from the municipality where Yapi belongs are written in the related field in the software. When entering the map, island, parcel information manually, the coordinate data can be taken automatically on the android devices, unlike on the desktop. As you can see in Figure 7, you can enter the name of the district, street, street, building id, building name, estimated age of the building, place of the building (concrete-masonry) to enter the data obtained with the help of forms during both the application and the field work intermediate percent.

Figure 7. New Building Data - Identity Information

In the Add New Building Data interface, there is a page where the technical information will be entered next to the identification information command. This window contains the area where the variables to be used are entered when calculating the performance score.

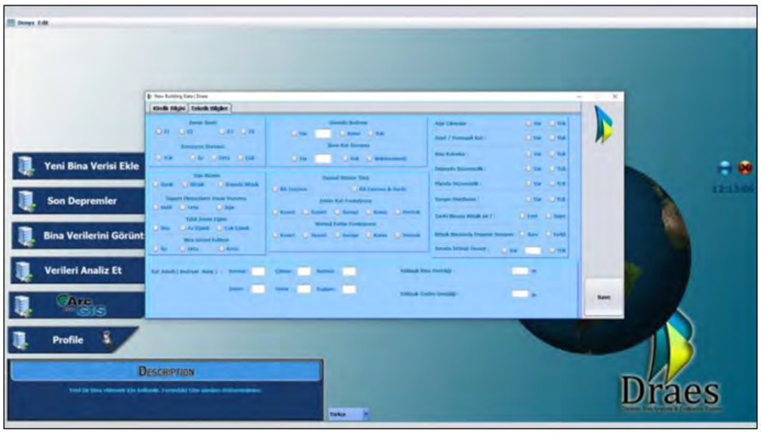

Figure 8. YeniBina Verisi – Teknik Bilgileri

If the user wants to enter data from a form that is in his / her hand rather than through the Android device, he can log in from the page shown in Figure 8.

3.1.3. Displaying Building Data

In the DRAES software, there is the View Building Data section where the observer group can input and edit (Figure 9). The Analyser user group is not allowed to make any changes to this page. In the interface, the entered building data can be displayed and modified on the system identification and technical information. With the help of GPS data, the location of the building can be determined by clicking on the region map service command, and the accuracy of the data can be done on this side (Figure 10). In addition, the district and neighbourhood options on the interface can be labeled by marking the areas where only the change is required. This grouping is displayed on the right side of the interface. The average of all the buildings where the performance score is calculated is compared with the neighbourhood and district buildings on the right side of the interface and the number of buildings below the average is displayed as a percentage.

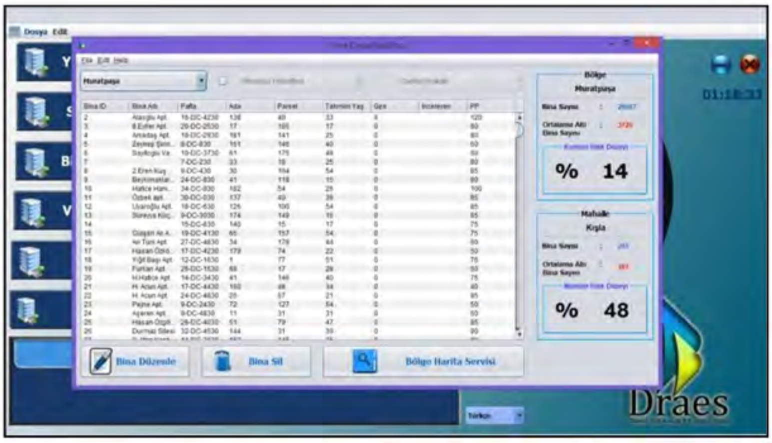

Figure 9. View Building Data Interface

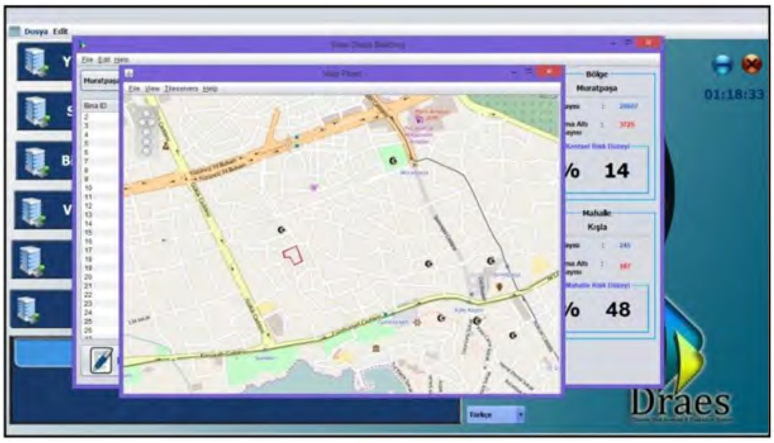

Figure 10. Territory Map Service Interface

3.1.4. Analysis of Data

Another interface within the software is the interfaces of general-data analysis, region analysis, neighborhood analysis and structure analysis, which are opened by the analyze command. These interfaces are defined for display by the analyst user group. When the command to calculate the performance score is pressed on the general data analysis screen coming to the first screen, the performance scores of the buildings are calculated with the help of the algorithm defined in the software (Figure 11). However, before the performance score is calculated, the "List" command needs to be displayed on the right-hand side of the building where no data is entered. It is possible to display the identification information of each building on this screen. Just below the screen is a window with "Building Information". With the help of this window, you can check the performance scores and make the necessary corrections by returning to the building data add menu

The second drop-down menu under the "Analyze data" command is the region analysis menu (Figure 12). The analyzer can be used by the user group to display both a single district data on the interface and two different districts can be compared graphically. The data on the left side of the interface are given as the performance score averages, the total number of buildings and neighborhoods, the number of buildings being evaluated, and the percentage of irregularities determined by the standard deviation. The number of buildings under the average urban average is given as a percentage and is called "Urban Risk Level". This value has been visualized above the menu as a pie chart. In addition, the value entered with the command "enter limit value" and the performance scores of that county are compared with the determined value again.

If the right side of the pop-up window is inspected, the comparison can be made with another district. The analysis is based on the average performance scores, and the results are given as a graph. Beneath the comparison chart, the result window displays 5 different result texts previously entered in the system.

The next pop-up window of Analyse data is the neighborhood analysis interface. In this menu, the total number of streets and buildings, the number of buildings to be evaluated, the average performance score and the number of buildings below and above the average can be displayed. The average performance score of the neighborhood is evaluated together with the average performance score (OPP) of the province and the result is displayed as "Neighborhood Risk Level" as a percentage. In addition, any value determined by the "Enter Limit Value" command can be compared with the OPP of the examined region. In the analysis of the district, it is possible to classify the streets in the neighborhood by making a comparative evaluation with the average performance score as it is in the neighborhood rank. The same map is also displayed with the "map" command on Google maps.

The last open window of the "Analyze Data" interface is the "Structure Island Analysis" interface. The total number of buildings, the number of buildings, the average performance points, and the evaluation of the buildings below and below average in the examined island are given in pie chart. The average performance score of the structure island is evaluated together with the average performance score of the surrounding region, and the result is displayed as "Structure Island Risk Level". It is also possible to compare any value determined by the "Enter Limit Value" command with the average performance score of the structure being examined. In addition, it is possible to classify the buildings in the island by making a comparative evaluation of the average performance points as well as the street order in the neighborhood analysis (Figure 14). The same map is also displayed via Google maps, which is also examined by the "Map" command.

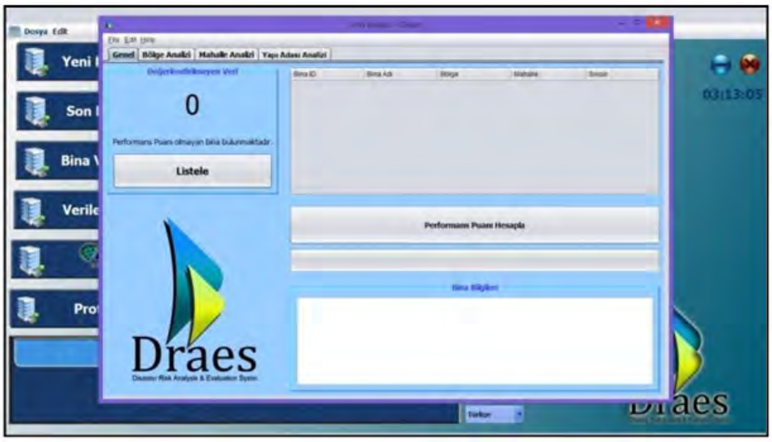

Figure 11. Analysis of Data

Figure 12. Analysis of Data - Comparative Regional Analysis

Figure 13. Analysis of Data - Neighborhood Analysis

Figure 14. Analysis of Data - Structure Island Analysis

4. Conclusion

One of the most important issues in determining the reliability of cities against depression in Turkey is to test the resistance of the building stock against the depression. As a matter of fact, the detailed examination of thousands of buildings in the context of cities can be considered as very difficult and time-consuming when the critical time and costs are considered. For this reason, tools with fast and accurate results are needed with as few parameters as possible. With the introduction of Law No. 6306 in Turkey, rapid assessment methods have partially attained the required level. However, when the size of the cities is considered, tools and raised human subjects continue to be a problem.

Based on the need for the structural risk assessment of Antalya, DRAES computer software has been developed as a tool for the street scanning method in the 6306 numbered law. DRAES software is an infrastructure work on determining regional risks and priorities and can be used to collect building inventory that is needed in disaster management systems.

While providing fast and accurate results for the analysis and analysis of the developed software structures, the programming language used in the software minimizes the time loss in the information input and correction options that can be done by different software. The software not only saves the time lost in transferring survey forms collected in the field to the computer environment but also allows information to be entered on the terrain in all devices with android operating system. Program outputs can be read by software such as ArcGIS, MS Access, Excel, etc. in the ".mdb" format, allowing you to perform different analyzes and mappings on this page.

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