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The Use of Web GIS in The Rapid Evaluation Process of The Post-Earthquake Urban Building Stock

Aşır Yüksel Kaya[1]

Abstract

Map Application Programming Interfaces and Geographical Information Systems have been actively used to manage direct and analyze after-crisis spatial data. The use of GIS and cloud-based technologies has made spatial data analysis easier. Additionally, GIS and its components were increasingly used instead of conventional methods for damage assessment. The main purpose of the research is to exhibit the utility of web GIS software on damage assessments in the city after the 24 January 2020 Elazig Earthquake. The utility of web maps has been exhibited particularly in terms of collection, analysis, and access of end-user. In this particular research, ArcGIS software and web service have been used. The research has three phases: creating a database, uploading to web services, and creating web maps. Additionally, the building attribute data has been collected from onsite measurements to create a database, which is used in a rapid evaluation method for the detection of risky buildings in Elazig. Building attribute data collection and results of rapid evaluation method have been achieved as outcomes of the project called 'The Creation of the information bank framework to Influence Urban Transformation and Earthquake Risk Maps for the Center Neighborhoods of the Elazig City' project. In the last part, Elazig Building Information and Management System (EBİS), based on ArcGIS Online and ArcGIS Enterprise, was created with the base of GIS. As result, the structural condition of the buildings examined and how the buildings will perform under a probable destructive earthquake.

Keywords: Damage Determination, Disaster Management, Geographical Information Systems, Rapid Evaluation, Risk Evaluation, Urban Geography

1. INTRODUCTION

There have been paradigmatic changes in all the aspects of Geographical Information Systems (GIS) due to the increase in internet usage after the 90s (Chow, 2008). The growing number of web map standards (Annen, 2005), Map Application Programming Interfaces (API), and the development of cloud informatic-based GIS Systems (Batty, Hudson-Smith, Milton, and Crooks, 2010; Crampton, 2009; Haklay, Singleton, and Parker, 2008) are the important indicators of this particular change.

GIS technologies tended to change into open-source code data sets and web environments from individual data formats and desktop platforms along with the development of web applications. This ontological change along with the developments in web technologies raised the awareness of GIS users (Chow, 2008) and GIS platforms turned into a data analysis platform for many fields. Since establishment of GIS in 1993, it immensely contributed to governments, the business world, science, and daily life (Fu, 2015).

[1] Dr. Department of Geography, Firat University, Elazığ, Turkey
e-mail: aykaya@firat.edu.tr ORCID No: 0000-0003-0398-7069

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As a matter of fact, GIS software was monolithic at the beginning and caused a lot of expenses (Agrawal and Gupta, 2017). Rather than on an individual basis, it has been used by only a handful of educated personnel in institutions and organizations. It was a system that required a large budget for organizing a large amount of positional data. However, by using the cloud technologies of GIS, web integrations have increased and become an easy-access technology.

Nowadays, the growing nature of positional data requires different approaches to storing and sharing large data (Mete and Yomralıoğlu, 2021). The storing, screening, inquiring, analyzing, and sharing of the positional data became more convenient due to the developments in web GIS technologies. Web GIS technologies which have wider usage currently due to cloud technology provides an opportunity to access and analyze a large amount of positional data simultaneously for many people. In this context, that provides the fastest producing, analysis, and storing of spatial data for institutions and individuals after possible natural disasters such as earthquakes, floods, and landslides.

Web GIS software made it possible to produce user-centred maps. Therefore, it becomes possible for users outside of geographers, geographical information scientists, and land surveyors to create their map contents (Batty et al., 2010). Eisnor and Wilson (2006) refer to this transformation as ''Neogeography''. Instead of this term, Batty (2010), emphasizes the term ''GeoWeb'' as a more correct option. Even though features such as the development of new map creation techniques and conventional easy usage techniques are perceived as a revolution, they are initially basic maps in a professional sense (Batty et al., 2010).

The API (Application Programming Interface) by Google in 2005 paved a way for Web GIS to become popular. As of now, the increasing number of mashups reached 2287. It is impossible to categorize the mashups. Many internet users, create new mashups by collecting data from a variety of sources to create their websites. At this point, the map producers have a crucial position. Especially the institutions such as Google (Maps), Yahoo (Maps), UK Ordnance Survey (Open Space), MapQuest, Virtual Earth, Arc Web, and open-source code map producers such as OpenStreetMap (OSM) and Mapbox are the most known map providers.

The purpose of this research is to evaluate the potential of the utility of web-based GIS software in geographical studies. This research explores the utility and examines functionality of Web GIS tools for processing and screening raster and vectorial data. In this context, the city of Elazig is determined as the research field to identify the current damage to the urban texture after the earthquake. After the earthquake, a prototype has developed to collect attribute information about the structure stock of Elazig. The API of ArcGIS has been utilized to develop this prototype. It has been determined that the web-based system was available to related institutions and individuals on 7/24 for collecting data. The developed maps are intended to be put in service for a variety of institutions and organizations through their APIs. Thus, it is anticipated to contribute to decision mechanisms efficiently in case of possible natural disasters.

1.1. The Development of Internet-Based GIS and its Use in Spatial Studies

Map APIs (ex. Google Maps, API, Yahoo Map Developer API, Mapquest OpenAPI, Control of Microsoft Virtual Earth, ESRI, ArcWEB Services) are source code interfaces that enable web developers to access a program library and request services for creating a map through the web (Chow, 2008). The development and usage of map APIs became an important subfield within geographic information science (Sieber, 2006). Not only do many companies provide API for users, but they also provide map-producing and sharing options for users who do not have geographic information.

Currently, it is possible to see API maps produced for different industries and purposes. Within the maps produced by private and public institutions, some websites share data for different purposes such as public transformation, building information systems, urban planning, cadastre information inquiries, and disaster information system. With the current technology, these maps are now available for smartphones, tablets, smartwatches, and automobile dashboards. These maps are being every day by millions of people over the world (Wagner, 2015).

The emergence of WEB GIS, GIS usage and analysis and the usage of spatial data became easier. Web GIS significantly improved in terms of (I) spatial data access and distribution, (II) spatial data visualization, and (III) spatial data analysis and modelling. Many map API creators emphasize different features. Generally, it is suitable to distinguish them as paid and free versions. Free map APIs (ex. OpenStreetMap) provide an access to general field usage, buildings, roads, and stream data. However, since these data are open-source codes, they were developed depending on the data provided by users and countries. This situation affects the credibility of the data. For this reason, it is possible to acquire incorrect spatial data in research. Furthermore, since the spatial data collected by users, they are mostly not up-to-date. Paid map APIs provides an access to up-to-date raster and vectorial data. The credibility of the data is constantly supervised by API creators. For instance, map creators such as Google Maps, Esri JavaScript API, and Mapbox produce their own base of spatial data with customizing options to create maps fit for the purpose. Paid APIs provide an opportunity to create 3B visuals and 2B web maps for big data sets, map editors Geoprocessing widgets, and basic map visuals.

From the first map API's usage to this day, it became common to use applications that are developed and supported by different users. There are many reasons for the rapid spread of map APIs such as being easy to use, including detailed data sets, being an open-source code, and improving easy analysis and inquiring features day by day. API maps paved the way for the emergence of many internet applications that provides an option for users to visualize and inquire the spatial data. The websites such as Google Maps, TomTom, Mapbox, Here, Leaflet, Openlayers, LocationIQ, MapTiler, Sygic Maps, OpenStreet Maps, and Jawgmaps develop API applications for different purposes. These web GIS applications with different interfaces provide an opportunity to create maps according to the demands and requests of the users. The developed API Maps can ''conduct effective teamwork, initiate field and office work simultaneously and share the results momentarily with external stakeholders'' (Ocak and Bahadır, 2021). Thus, the data sets created by users are always available. That also helps for research where the data collection is difficult from the field. This research proves the usage of Web GIS applications in calculating the loss of life and property, after disasters such as an earthquake.

Today, GIS software is widely used to combat disasters and analyze spatial data. Spatial data and related technologies, particularly Geographical Information Systems (GIS) with the capability of display, retrieval, analysis, and management of spatial data, have proven crucial for disaster management (Mansourian, Rajabifard, and Valadan Zoej, 2005; Cağlıyanand Dağlı, 2022). Technology-based applications have become essential resources that should be applied, especially to solve complex problems such as urban settlements and to minimize disaster risk. (Cağlayan, Satoğlu, and Kapukaya, 2018; Sun, Bocchini, and Davison, 2020; Sürmeli, 2011; Tarhan and Partigöc, 2021; Yigitcanlar, Desouza, Butler, and Roozkhosh, 2020). Comprehensive studies are carried out such as making predictions before disasters with technology-based applications (Internet of Things (IoT), Geographic Information Systems (GIS), Remote Sensing (UA), sensors, Radio Frequency Identification Systems (RFID), artificial intelligence, sensors, robots, and smart systems), predicting risks with models, creating alternative scenarios, identifying high-risk urban areas, developing response forms according to different disaster types, distribution of roles and duties of stakeholders, and determination of post-disaster strategies and actions (Tarhan and Partigöc, 2021). In the aftermath of a disaster, technology-based applications are used to assess the damage, establish communication between institutions, coordinate the disaster management system, and create a social organization scheme. Especially after a devastating disaster such as an earthquake, technology-based applications are used in determining the assembly areas, temporary shelter areas, the damage status of the existing building stock, and choosing the location of new housing areas.

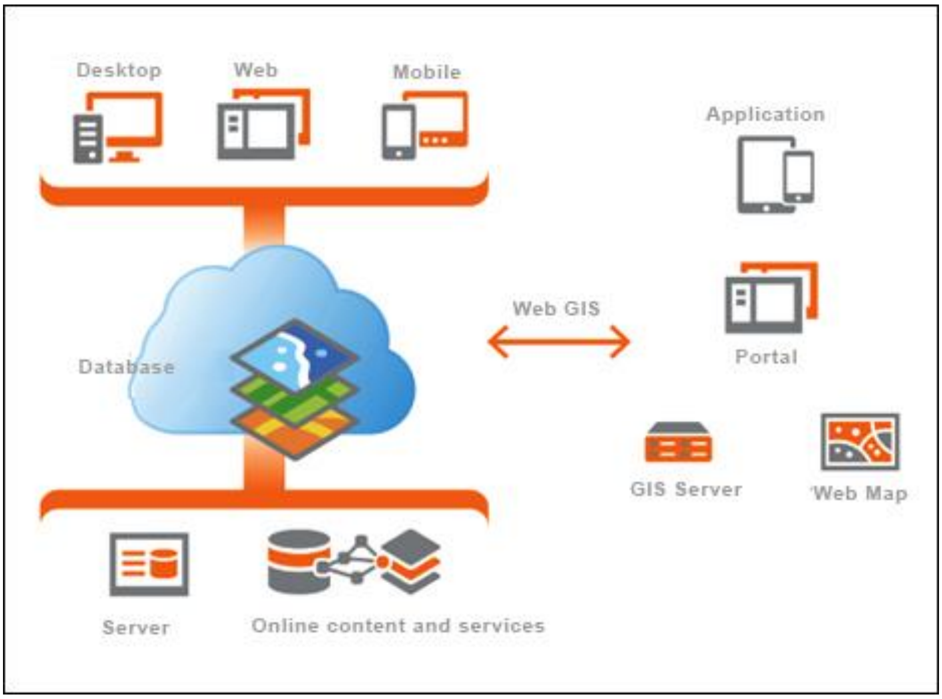


Figure 1. Web GIS Flow Diagram (modified from Law, 2014)

Recent disasters have drawn attention to the vulnerability of human populations and infrastructure, and the extremely high cost of recovering from the damage they have caused (Goodchild and Glennon, 2010). The case studies include; the Sivrice (Elazig) and İzmir Earthquake 2020, the flood disaster in Bozkurt (Kastamonu) in August 2021, and the Mediterranean forest fires of July-Agust 2021. In all of these cases, impacts were severe, in damage, injury, and loss of life, and were spread over large areas. GIS and its components were used in all of these cases, and several reports have been published accordingly. Furthermore, up-to-date satellite images have been used to generate damage assessments and web-based maps and applications in post-disaster response.

Nevertheless, it has become clear that the potential of the geospatial data, other data types, and the benefits of technological tools has not been recognized and needs further research on several key issues to improve the situation (Goodchild and Glennon, 2010). However, GIS-based risk and disaster management should be implemented in natural disaster management procedures of the country and local governments (Zerger and Smith, 2003). The importance of Internet-based GIS is that it is easily accessible by many institutions and organizations and is authoritative in many areas involved in planning, decision-making, and communication during disaster management operations (Abdalla and Esmail, 2019).

Web GIS technology provides the capability to map and analyze hazards of all types (e.g.; Flood Risk Assessment, Earthquake Disaster Management, Volcanic Hazard Identification, and Forest Fire Hazard Area Mapping) and visualize their potential impacts. To effectively reduce the impact of every disaster, governments prepare a complete disaster management strategy. Availability of data such as buildings, lifeline systems, roads, hospitals, etc., will help the managers to better decision-making. The majority of this data is spatial and can be mapped. So, a Geographic Information System (GIS) can support disaster management as a powerful tool for collecting, storing, analyzing, modelling and displaying a large amount of data. Many organizations involved in disaster management require access to the correct data at the right time to make the right decisions. So, designing a GIS to distribute geospatial information on a network such as the Web, gives a chance of easy access for the managers of organizations information on disasters anytime and anywhere (Abdalla and Esmail, 2019).

2. MATERIAL AND METHOD

Many settlements were exposed to imminent destruction due to recent natural disasters. GIS has an inclusive role in viewing (supervising or rating) the disasters and befitting and timely responses before and after destruction. The earthquake in Sivrice (Elazig) on 24 February 2020, whose rate is 6.8, caused a lot of damage to many buildings. Buildings were destroyed at amount of five, thirty-seven people lost their lives, and six hundred and fifty five people were injured in the city of Elazig. After the earthquake, an immediate damage assessment was initiated in the countryside and civic settlements. In this research, the EBIS (Elazig Building Information System) has been developed to view and manage the damage assessment. The three-stage research has developed to create earthquake risk maps and the base of the databank which will influence the urban transformation. The first stage of the research includes the phases of creating the design of the database and thematic map base collecting the spatial data. The second stage will consist of publishing the spatial data in map API providing services, production of web maps, and conclusion (result) map. Lastly, the publishing of web maps the and creation of a web application base will be the third stage of the research.

2.1. Data Collection

The potential of the regions and also unbalanced distribution of investments made by the government or private sector cause regional inequalities (Akdemir, et. al., 2015). In this context settlements are subjected to significant losses as a result of natural disasters. The losses vary according to the magnitude of the disasters. The research field experienced several earthquakes in different periods due to Elazig's proximity to East Anatolian Rift Zone (Figure 2). As a result of earthquakes, there has been significant structural damage to urban built areas. One of the most destructive natural disasters, earthquakes have the possibility of occurring in the future. Therefore, the current structural stock analysis is one of the most important decisions to make before disasters. The collected data within the scope of the research is obtained as a result of field research on building stock in Elazig city.

After the Elazıg-Sivrice Earthquake (2020), the GIS database was created by examining some of the buildings in the city with the data collected by the Firat Structural Damage Examination Group. Considering the structural features of the buildings, the attribute information of the buildings is entered into the database (Table 1). Within the scope of the research, it has been aimed to evaluate the resistance of the buildings and to draw attention to the ones which have a lower endurance of the earthquake during the urban transformation. For that purpose, the structural condition of the buildings has been -considering their exposure to earthquakes- examined and how buildings would perform under a possible destructive earthquake was revealed. The collected spatial data during the design and production phase is classified according to the exposed damage (heavy, middle, low, undamaged), building date, occupancy, construction technique, etc (Şahin et al., 2020).

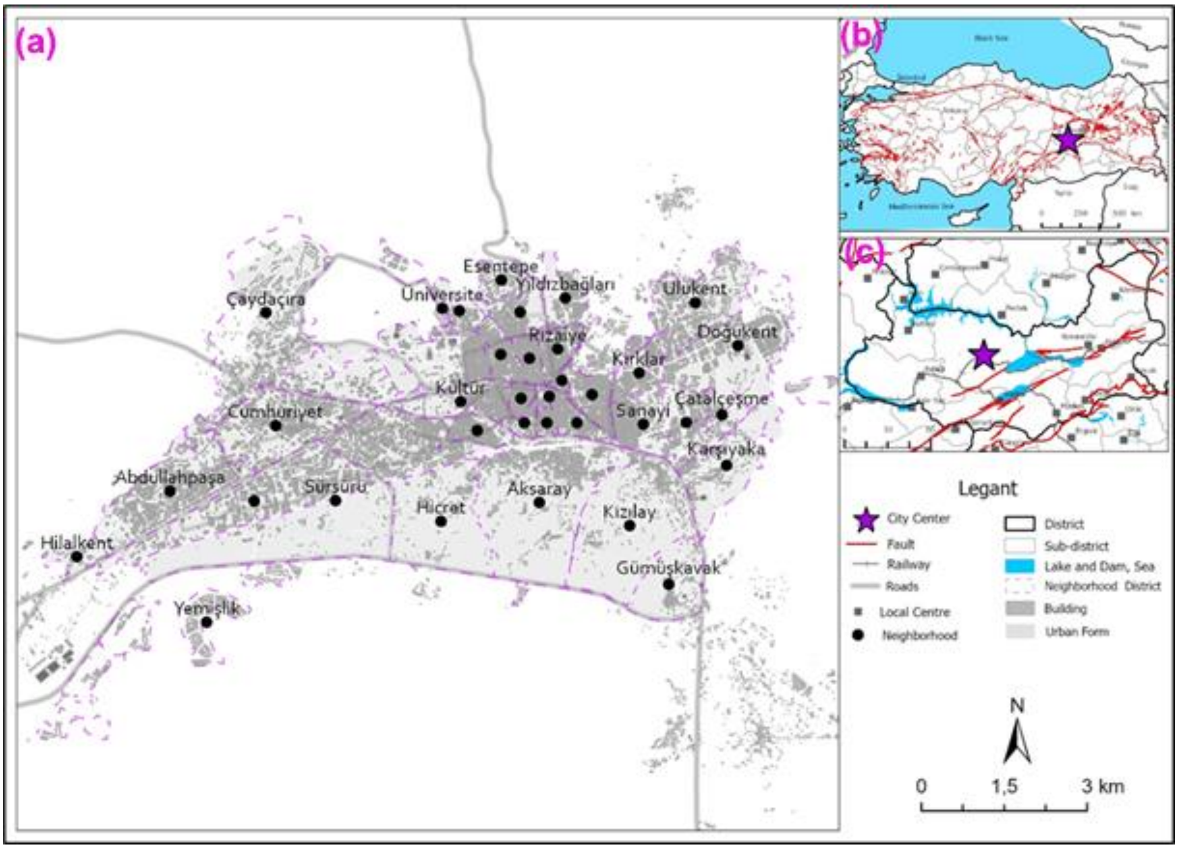


Figure 2. Location of Elazig, Turkey: (a) Elazig neighborhood borders (Source: Elazig municipality), (b) Active Fault Map Series of Turkey (c) Active Fault Map Series of Elazig (Source: General Directorate of Mineral Research and Exploration)

As a result of this classification, quick assessment methods have been used to estimate after-disaster structural damage to reveal the hazardous condition of the buildings that generate the city's urban pattern. During the examination of the performance of the buildings under a possible destructive earthquake, a quick new building risk assessment method has been used by AFAD National Earthquake Research Program within the scope of a project titled 'The Creation of the information bank framework to Influence Urban Transformation and Earthquake Risk Maps for the Center Neighborhoods of the Elazıg City'. The parameters of quick evaluation methods consulted with expert opinions. The data input on the created database has been conducted by professional field researchers (Photo 1).

The shapefile (shp) formatted data of the buildings which create the current urban pattern are produced by public institutions. The missing and incorrect parts of these data have been digitized through current satellite images, also called ''ESRI World Imagery. All of the field research data was serviced on ArcGIS online after being conjoined on ArcGIS Pro 2.9.3 software. Also in field research, online maps indicating the endurance of the building stock have been prepared. These maps are presented to all users through a web application. Thus, the disaster information system foundation -a part of the city information system- was created. A databank of urban transformation and renovation work was created to increase urban endurance in the future. Furthermore, the ultimate pattern of earthquake danger is revealed considering the criteria related to transportation to damaged buildings after a possible destructive earthquake and the number of living residents in addition to structural risk conditions of buildings within the scope of research. Finally, how much danger buildings are exposed to under the possible destructive earthquake is determined.

Table 1. Building Layer Attribute Data to Use in Damage Assessment

FID	Floor on Façade Long (m)
Group No	Ground Floor Height
Parcel No	Protrusion
Building Status	House Type
Neighborhood	(M) Masonry building Type
Street	(M) Carrier Wall Material
Building No	(M) Wall Material Quality
Building Use Type	(M) Masonry Wall Working
Build Year	(M) Building Visual Quality
Pavement (m)	(M) Ground Floor Total Space
Road (m)	(M) Width Short Corner Tough (m)
Number of Lanes	(M) Vertical Space Irregularity
Free Floors Number	(M) Floor Type
Number Flats on Floor	(M) Material of Mortar
Construction form	(M) Roof Type
Neighbor Building with Floor Level	(RC) Carrier System Type
Distance Between Neighboring Buildings	(RC) Vertical Irregularity
Floor Difference According to Facade	(RC) Retract Irregularity
Current Damage Status	(RC) Floor Gap Irregularity
Irregularity in Plan	(RC) Short Column
Soft Floor Irregularity	(RC) Concrete Quality
Weak Floor Irregularity	(RC) Column End Stirrup Range (cm)
Elements Fall Hazard	Additional Remarks
*RC =reinforced concrete ** M=Masonry	

Photo 1. The damage assessment and collecting data phase of the current structure stock.

2.2. Research Methodology

In this research, which was prepared with the purpose of determining the urban transformation zone and manifesting the risk maps, the GML (Vector Database) and Raster images obtained by using web map servers were analyzed by visualizing with the web GIS (Figure 3).

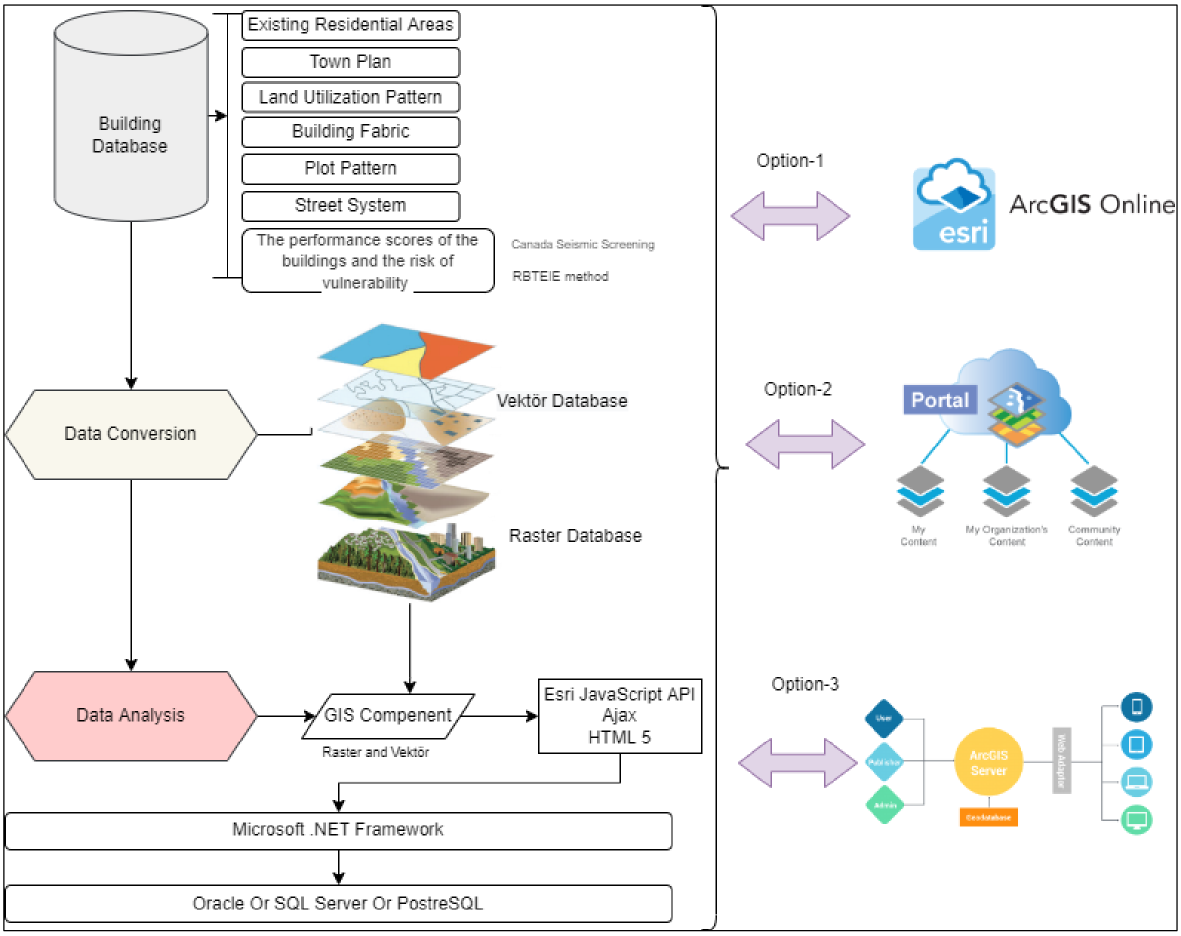


Figure 3. Flow Diagram of Study and Arcgis Geographic Information Model the System Architecture

Created web map consists of three phases. In the first phase, an attribute database of urban buildings in the research field was created. The information in the database is based on project data developed by the AFAD National Earthquake Research Program titled 'The Creation of the information bank framework to Influence Urban Transformation and Earthquake Risk Maps for the Center Neighborhoods of the Elazıg City'. The structural attributes of the buildings were examined after the earthquake, considering the hazard status of the current building stock. The data such as building construction date, number of floors, hazard status, and building construction type is processed on the database. The collected positional and attribute data were transformed into Geographic Markup Language (GML) format. Then, the data is uploaded into ArcGIS Online with WFS services. In the second phase, after the spatial data were transformed into a proper format, GLM files and WFS layers were uploaded to the web browser as distinctive data layers. To regulate and inquire about GLM data, web application development methods such as Asynchronous javascript (AJAX) and XML were used. AJAX is not a new technology on its own but it is an efficient data programming method that uses HTML, XML, Cascade StyleSheet (CSS), and JavaScript (Chow 2008). Users are enabled to acquire and regulate the data by using JavaScript without reloading the page The ArcGIS server used in this research supports AJAX. Thus, users can easily upload and inquire about spatial data. In the third phase, GLM and Raster databases were superposed on ArcGIS Online. ArcGIS Online offers ready-to-use formats to visualize points, lines, and polygons that represent spatial data. Actually, Web GIS paid software offers a holistic system that provides an opportunity to publish, analyze and visualize the data -produced without coding- of the users. In addition to all of these features, many processes can be conducted on a web environment as in the traditional GIS software.

3. FINDINGS

Currently, together with rapid urbanization, overgrown urban areas became less resilient to disasters. Especially the cities which are unplanned and lack of infrastructure and upper structure become defenseless against disasters. The field surveys conducted by the Ministry of Environment and Urban Planning and Firat Structural Damage Examination Group after the Elazıg-Sivrice Earthquake (2020) determined the damage ratio of the urban structural areas. In the damage determination research for minimizing the loss of life and property after a possible earthquake, hazardous buildings were identified with rapid scanning methods. The obtained data was constructed on a cloud-based platform which was initially based on ArcGIS Online and Enterprise.

3.1. System Architecture and Case Study

An expert team of the Ministry of Environment and Urbanization conducted damage determination research after the Elazıg-Sivrice Earthquake (2020). During the research, earthquake damage was observed and the buildings were classified as undamaged, low damaged, moderate damaged, and heavily damaged (Demirtaş, Şahin, and Durucan, 2021). According to the data of the Ministry of Environment and Urbanization and damage assessment research in the city centre of Elazıg 51792 buildings were examined and it is determined that %45 of the buildings were undamaged, %24,4 were low damaged, %2,7 have moderate damage, and %11,8 were heavily damaged (Şahin et al., 2020). For this research, a web GIS application prototype was developed to analyze and visualize the empirical data obtained by the Ministry of Environment and Urbanization and UDAP.

The first two phases of the GIS application include creating the database and collecting data. First of all, the former building data was transformed into Web GIS layers. Web layers are stored as vector and raster layers just as in the traditional GIS research. Though, layers are needed to be recorded as web services to the data can be transfered to the end-user. In this context, vector data (building, parcel, ward, and roads) transformed into a web layer feature (Table 2).

In the second phase after the filed data were transported to the cloud data, web maps that stakeholders can easily access were organized. A web-based map includes browsing tools for scrolling and zooming and interactive pop-up windows include information of data (Fu, 2015). Thanks to Web Maps, it is easy for users to inquire about the hazardous condition of buildings in Elazıg after the earthquake. The maps are shared with different institutions and organizations to determine priority areas. These maps can easily be updated on web services, mobile tools, and desktop PCs. Thus, the database foundation of field research can be checked by all institutions and organizations.

Table 2. Services Used in Web GIS Application

Web Service Layer	Web Service Type
Building	Feature Service
Numbering	Feature Service
Roads	Feature Service
Parcel	Feature Service

3.2. Web GIS Usage on Collecting Spatial Data After Disaster

Experts need to collect and be credible from the field during field research after a disaster. After a disaster, an immediate damage assessment has the purpose of securing the citizens by researching the durability of the buildings and evacuating the dangerous ones during the continuous aftershocks (Yüksel, 2008). This crucial and critical process is conducted by expert civil engineers after disasters such as earthquakes. At this point, an engineer has to assess the current hazard of the building and report it after an earthquake. Traditional methods are generally used at this particular phase. However, Web GIS is quite useful in managing the information exchange between decision-makers and decision mechanisms.

Web GIS is an inclusive system that offers a variety of easy-to-use options such as uploading data on web services later with only an internet connection without any additional software. Thanks to these advantages, the spatial data of building stock can easily be processed on positional reference points on web layers through a server, during the damage assessment research after the earthquake. The data, which were formerly processed on web layers, are also the method of mapping where several cartographical information screening -including the hazard status information of building stock-conducted.

Web services, web layers, and web maps were used integratedly during the damage assessment process of current building stock after the earthquake in Elazıg. ''Collector for ArcGIS'' has been utilized by experts to create the attribute information of building stock. ArcGIS Collector assists in collecting the process of spatial data and web maps, which work integrated with web services. The field researchers can update the attribute information of the current building and add further information, visuals, video, and photograph through the web map (Figure 4).

Expert teams entered the building data on the attribute board by using Collector for ArcGIS, without an internet connection. Thus, the whole data of current building stock became easily accessible. Considering the analyzing and reporting process of current building stock as the most crucial task after the earthquake, Web GIS and its add-ons shorten these processes, providing a budget-saving and efficient working environment.

3.3. Elazıg Building Information and Management System (EBIS)

Elazıg building information system -created with GIS as a base- is a dashboard working on ArcGIS Online and ArcGIS Enterprise. ArcGIS portal provides various standby applications for publishing application layers, including ArcGIS Web App Builder, to create the EBIS system. ArcGIS Web App Builder is an application that creates an opportunity for portal users to create web applications customized with ready-to-use templates, widgets, and themes (Wu et al., 2022). As its most advantageous aspect, the application enables its users to collect and analyze data by creating 2D maps and 3D stage(arena) applications without coding. Thus, the spatial data of field research could be visualized on short notice.

EBIS, including building information of Elazıg, makes analyses with spatial data to determine primary response areas and share these with authorized institutions and organizations momentarily after disasters. The up-to-date application has a structure where spatial data is collected on a cloud system and holds all the current internet technology and risk analysis. Also, there is an admin interface where the data is available to update and citizens acquire information momentarily.

Thanks to the admin interface spatial data are available for updates in a sustainable way and experts support the data with diagrams, charts, and maps on one screen to make momentarily decisions (Figure 5). That provides an opportunity for analyzing and determining an enormous amount of data. The application which is available for active usage for institutions and organizations provides important information to make split-second decisions. The admin interface was designed considering the expectations and demands of the end user.

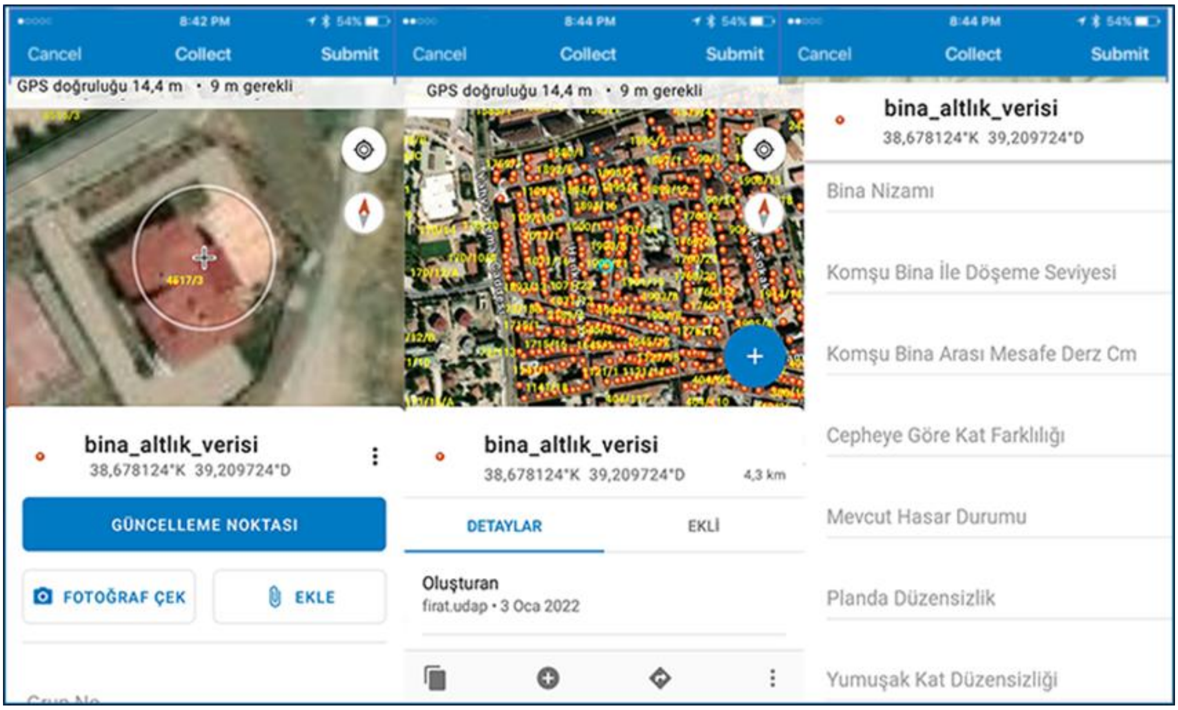


Figure 4. The Data Collection Process of ArcGIS Collector Application from The Field.

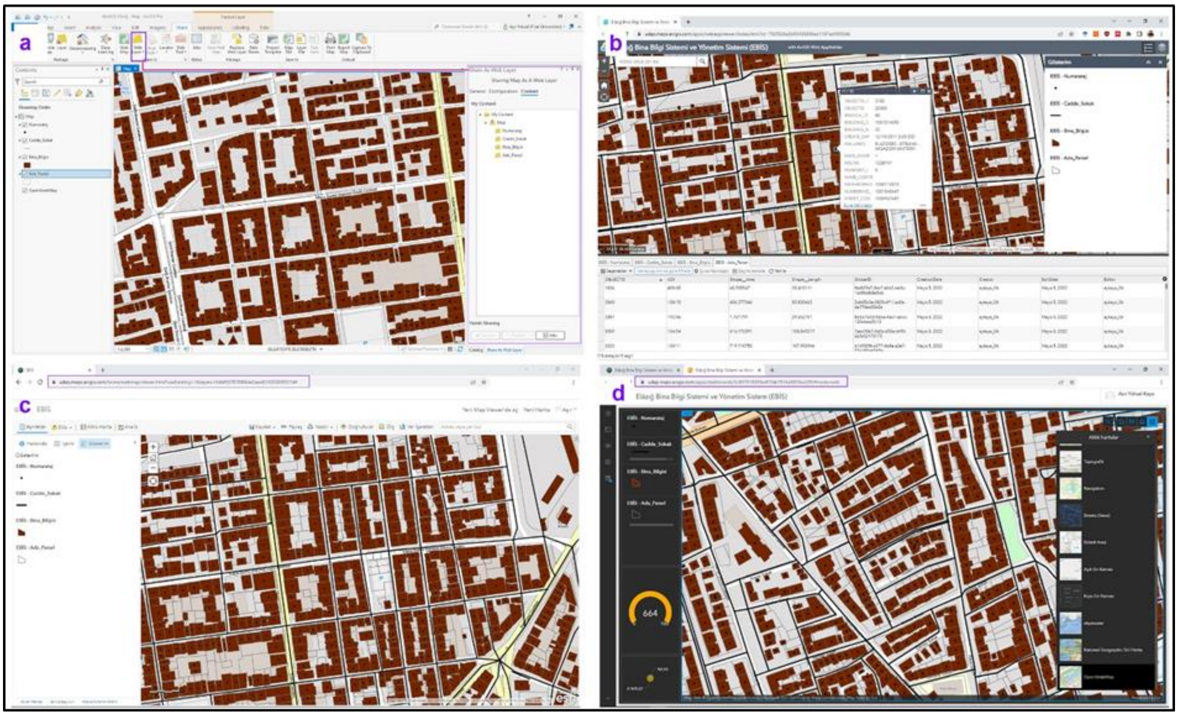


Figure 5. Design Phases of Elazıg Building Information System and Management System. a: Creating Feature Service with ArcGIS Pro Software, b: ArcGIS Web App Builder Admin Interface, c: Web Map Control Panel, d: Dashboard.

The user interface is designed for citizens to use basic map features and inquire about the hazard conditions of the current buildings. Users can make simple inquiries and learn about the hazardous condition of their buildings. Also, citizens can create request forms on the system. Thus, the requests on AFAD (Disaster and Emergency Management Presidency) and the Ministry of Environment, Urbanization and Climate Change are available for management.

3.4. The Usage of The Application

The Web GIS application of the Elazıg building information system provides the screening of building stock and structural features in the city after the 2020 Sivrice Earthquake through web maps. Users can check, inquire and analyze the data. The application is available to various institutions and organizations, new data can be added and function as an immediate decision system after a possible disaster in the future. As a user-friendly system, the application has other features such as distance and field measurement, location, indicator, and basic base map modifier.

EBIS application is an integrated analyzing system for analyzing and inquiring about the attributes of current building stock after the earthquake. Since it is an up-to-date system and available for analysis of spatial data based on locational reference points. In addition to those features, it is available for users to add different data formats to the application.

Users can integrate ArcGIS Server web service, kml, OGC WFS, OGC WMS, OGCWmts, and GeoJSON formatted data on the application. Thus, various inquiries and analyses with different data sets are available. In the application, it is possible to acquire various statistical inquiries, which show changes in building stock within the scope of the city and neighborhoods and deductive and inductive statistical results, depending on positional data. To illustrate, statistical information on buildings within the neighborhoods -depending on attribute data- such as the number of floors, construction date, earthquake hazard status, ground properties, and building construction type (ferroconcrete -masonry) is available for inquiries on neighborhood base priority areas.

ArcGIS Online System includes a variety of spatial analysis tools to analyze through web maps for users who logged in with username and password. With these analyzing tools, it is possible to conduct various analyses such as intensity, buffer zone, finding location, outlier, and interpolation (Figure 6-7). These tools are also able to make vector and raster data analyses. By using building attribute data within the application, it is possible to prove the relation between population density analysis and emergency muster points to make planning decisions. The features of the application provide an option to use geographical data efficiently in terms of making simple and rapid decisions. For example, the post-earthquake damage status of the existing building stock can be analyzed using the Ebis application. After the January 24, 2020 Elazig-Sivrice Earthquake (Mw=6.7-6.8), the damage status of the buildings in the neighborhood examined by the technical staff of the Ministry of Environment and Urbanization; 3% of the buildings were severely damaged, 7% moderately damaged, 47% slightly damaged, and 43% were undamaged.

Additionally, the performance rate and risk distribution of the buildings can be examined with the analysis, which was created with a rapid evolution of building stock. The performance rate distribution of the buildings was obtained in the RBTEIE analysis using parameters such as the number of floors, soft floors, apparent quality, vertical irregularity, irregularity in the plan, and short column obtained as a result of the field studies. Performance scores range from -38 to 120 (Figure 13). In the rapid evaluation method proposed in RBTEIE, the number of floors is effective in the scoring system, the base points given to the buildings decrease with the increase in the number of floors, and the negativity parameter scores increase (Demirtaş et al., 2021).

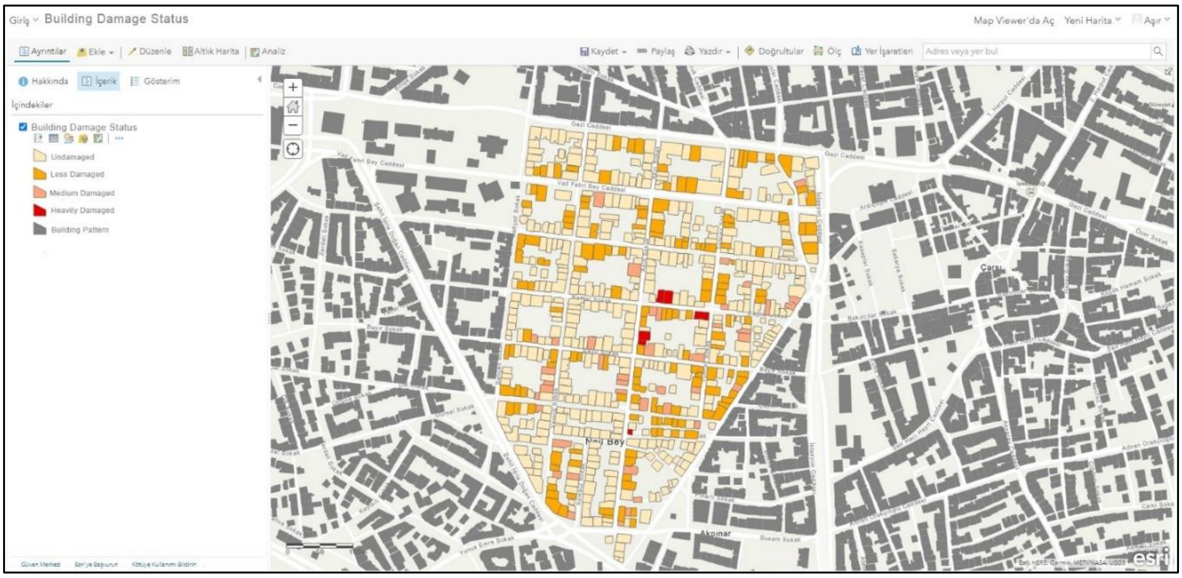


Figure 6. Post-Earthquake Damage to The Building Stock

Data was collected from 530 buildings in the Nailbey district following field studies. 81% (430 units) of the inspected buildings consisted of reinforced concrete and 19% (100 units) masonry. As part of the study, a risk assessment of the reinforced concrete structure was carried out. 78% of buildings subject to risk assessment were constructed before 1990, while 22% were constructed after 2000 (Figure 7). In terms of the distribution of building floors, 5 floors and below account for 79.5%, and 5 floors and above account for 20.5%. Buildings with 5 or more flours were constructed after 2000 (Figure 8).

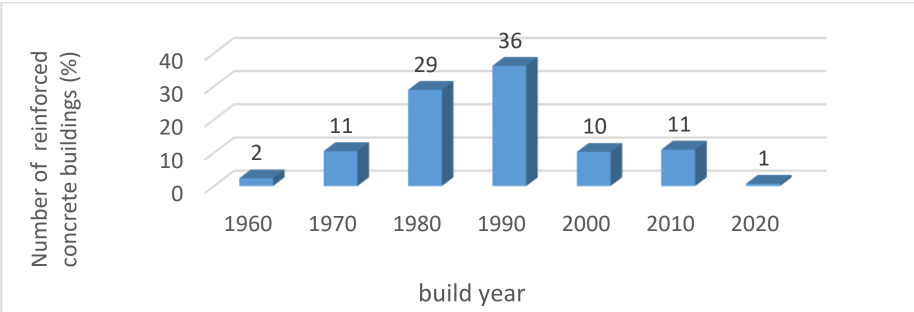


Figure 7. Years of Construction of Reinforced Concrete Buildings (%)

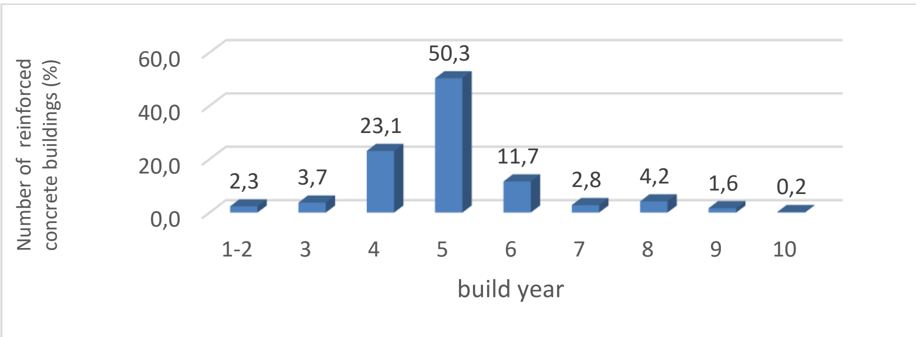


Figure 8. Distribution of Reinforced Concrete Buildings by The Number of Floors.

Half of the reinforced concrete buildings in the Nailbey area were found to have soft/weak roughness and severe drape defects. Plane irregularities and stub irregularities were not frequently observed in the buildings inspected. In communities where most existing buildings were built side by side, the impact of collisions was found to increase potential risk due to insufficient spacing and different floors (Figure 9-10).

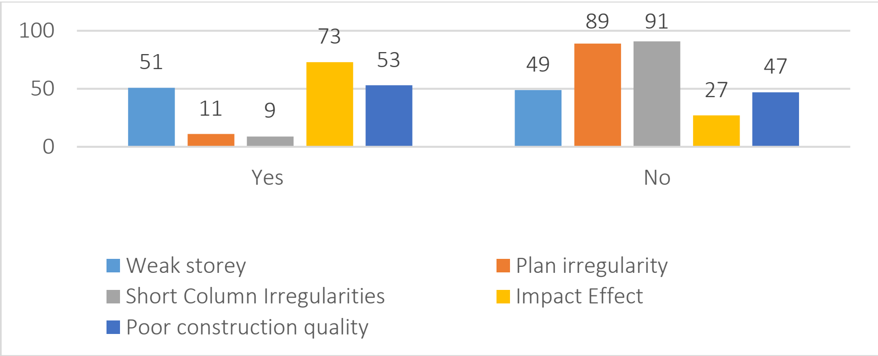


Figure 9. Distribution of Irregular Buildings (%)

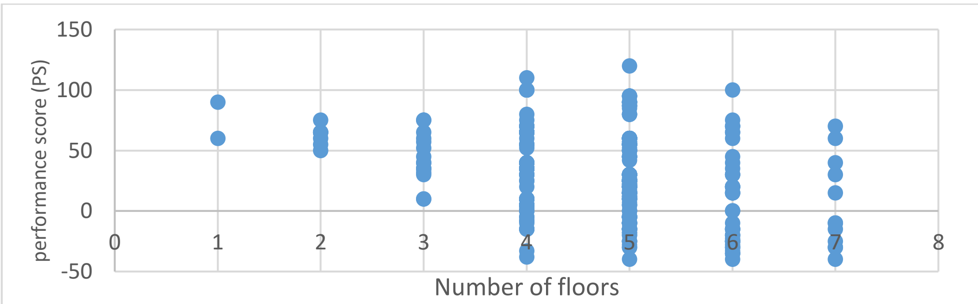


Figure 10. Distribution of Irregular Buildings

The analysis found that the year of construction and the number of floors of buildings in Nailbey affected performance values (Figure 11-12). While the average performance of a building with few floors is high, the performance value of a building with a large number of floors is calculated as low. A similar situation is closely related to the year of construction of the building. In particular, buildings constructed before 2000 were found to have lower performance values, while buildings constructed after 2000 had relatively higher performance values.

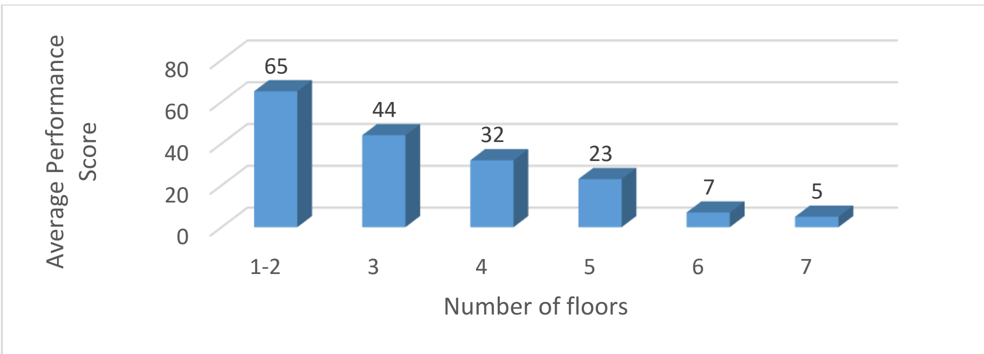


Figure 11. Variation of Average Performance Score (PS) With Coefficient

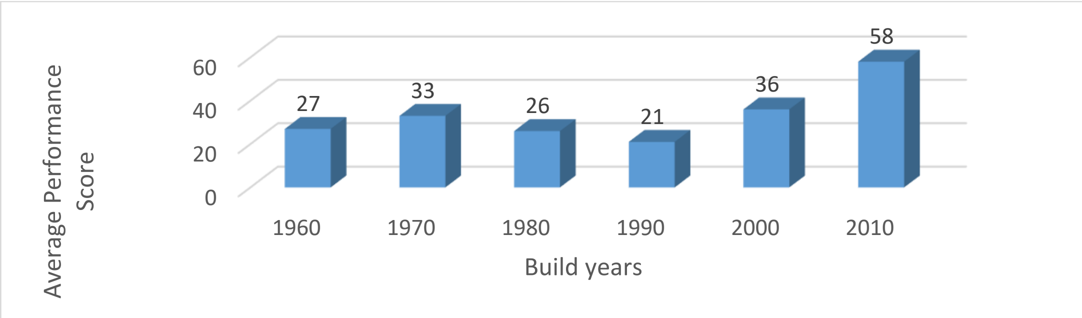


Figure 12. Variation of Average Performance Score (PS) With Building Construction Year.

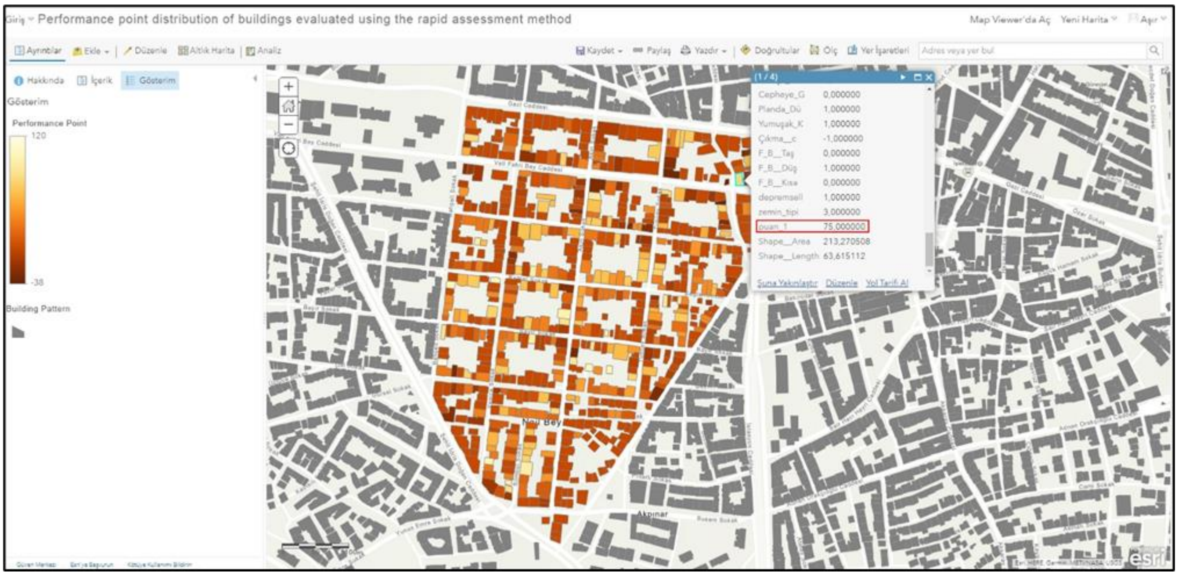


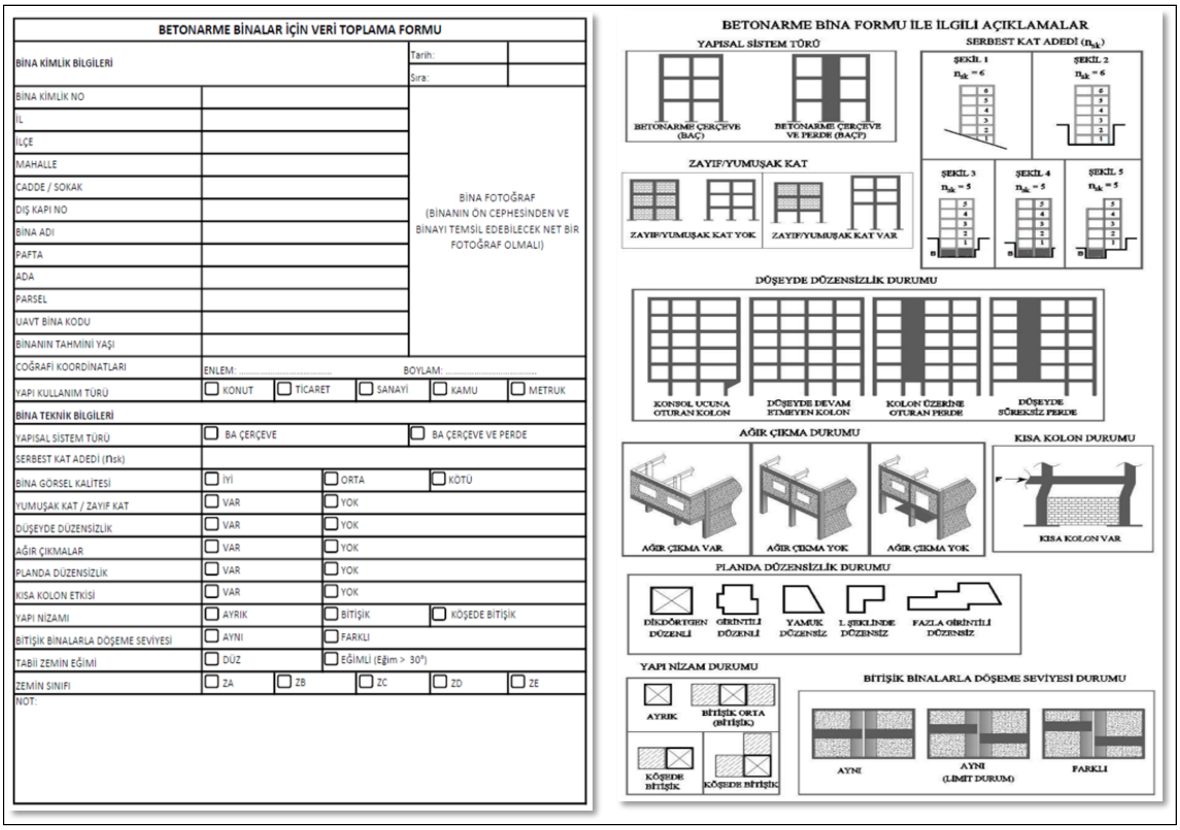
Figure 13. Performance Point Distribution of Buildings Evaluated Using the Rapid Assessment Method.

4. CONCLUSIONS

The information system of currently constructed fields after the 24 January 2020 Sivrice-Elazıg earthquake, has been constructed with a cloud-based GIS platform called ArcGIS architecture. The system made it possible to inquire about and analyze geographical data by providing many options. It is possible to develop Web GIS applications in two ways; paid or free. Initially, it is also possible to create without any expenses by using open-source code data and applications. However, coding and depending on open sourse code data is a difficult process in terms of organizing thousands of spatial data and producing rapid results of analyses after a disaster. It is only possible to collect spatial data, transfer it to the cloud system, analyze it on the web and provide understandable data for users after a long process at this point. Whereas GIS platforms provide ready-to-use APIs without coding. Since the base of the system is ready-to-use, creating any work takes less time. The only factor that prolongs the working time is the database and the designing process. However, it is likely to create a map application in the desired timeline. Especially after the earthquake, the city became the focal point of civil engineers and geologists. Mainly because the most emphasized subjects during the earthquake are building stock and the surface texture. The easy design and functionality of the Web GIS contribute to the decision-making process, analyzing, visualizing, and processing of spatial data on the database of the experts.

The damage determination applications are the important phase after the earthquake. At this point, the accuracy of the organization template of the spatial data is also crucial. In that sense, the regulations on the determination of ''Hazardous Buildings'' has been determined within the scope of Law 6306 -dated 16/5/2012- on the Transformation of Areas Under Disaster Risk. In the process of filling out the damage assessment applications data collection form for each building - the boundaries of which are drawn in Law No. 6306- even the smallest error will likely cause loss of life and property (Figure 15). This article provides a suggestion for a web GIS application with an information dashboard, analysis, data collection, and classic damage assessment applications on a geographical database. The system can be designed as a city information system and be developed with the contributions of different institutions and organizations.

In the end, EBIS is a web-based GIS application that collects, analyzes, and publishes geospatial data at every stage with the power of web technology and GIS. Its most important feature is its self-sufficient substructure requirements, which offer usage options for different institutions, organizations, and individuals. The finished version of the application will allow factual data, such as the damage status of the current building stock, to be easily updated in the event of a future disaster. Thus, data analysis can be provided in many areas, including databases affecting urban transformation.


BETONARME BİNALAR İÇİN VERİ TOPLAMA FORMU

BİNA KİMLİK BİLGİLERİ		Tarih:	
		Sıra:	
BİNA KİMLİK NO		BİNA FOTOĞRAF (BİNANIN ÖN CEPHESİNDEN VE BİNAYI TEMSİL EDEBİLECEK NET BİR FOTOĞRAF OLMALI)	
İL			
İLÇE			
MAHALLE			
CADDE / SOKAK			
DIŞ KAPI NO			
BİNA ADI			
PAFTA			
ADA			
PARSEL			
UAVT BİNA KODU			
BİNANIN TAHMİNİ YAŞI			
COĞRAFİ KOORDİNATLARI	ENLEM:	BOYLAM:	
YAPI KULLANIM TÜRÜ	☐ KONUT ☐ TİCARET ☐ SANAYİ	☐ KAMU	☐ METRUK
BİNA TEKNİK BİLGİLERİ			
YAPISAL SİSTEM TÜRÜ	☐ BA ÇERÇEVE	☐ BA ÇERÇEVE VE PERDE	
SERBEST KAT ADEDİ (n_{sk})			
BİNA GÖRSEL KALİTESİ	☐ İYİ	☐ ORTA	☐ KÖTÜ
YUMUŞAK KAT / ZAYIF KAT	☐ VAR	☐ YOK	
DÜŞEYDE DÜZENSİZLİK	☐ VAR	☐ YOK	
AĞIR ÇIKMALAR	☐ VAR	☐ YOK	
PLANDA DÜZENSİZLİK	☐ VAR	☐ YOK	
KISA KOLON ETKİSİ	☐ VAR	☐ YOK	
YAPI NİZAMI	☐ AYRIK	☐ BİTİŞİK	☐ KÖŞEDE BİTİŞİK
BİTİŞİK BİNALARLA DÖŞEME SEVİYESİ	☐ AYNI	☐ FARKLI	
TABİİ ZEMİN EĞİMİ	☐ DÜZ	☐ EĞİMLİ (Eğim > 30°)	
ZEMİN SINIFI	☐ ZA ☐ ZB	☐ ZC ☐ ZD	☐ ZE
NOT:			

Figure 14. The Data Collection Form for Reinforced Concrete and Masonry Buildings, Prepared Within the Scope of the Application Regulation of 6306 Law Appendix-2 (URL-1).

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