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Prioritization of old urban fabrics models based on the damages caused by the earthquake, Case Study: Ghouchan, Iran

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Abstract
According to the conducted investigations, the greatest losses will occur in old and ancient parts of cities if the earthquake happens. Therefore, one of the urban managers' principal concerns is locating these areas to provide emergency aids. For this reason, this study aims at determining these areas in Ghouchan city and then by taking advantage of the analytical power of GIS software, first the indices of determination the old context were prioritized. Accordingly, we can introduce the regions with the highest rate of vulnerability in two forms of descriptive and spatial. The results showed that the area of interest is mainly located in the central and western part of the city. According to this model, it is necessary to consider essential predication for the establishment and installation of facilities and relief equipment as well as appropriate uses in accordance with the relief in the region due to the possible vulnerability rate. In descriptive analyses we also estimate the rate of vulnerability and thus the residential, commercial, service and industrial applications have the most vulnerability.

Keywords: vulnerability, old context, urban uses, Ghouchan

Introduction

Earthquake is one of the most destructive natural events which cause a great deal of damages to densely populated parts of earth every year. Since Iran is located on seismic belt, it is one of the areas that yearly is faced with several large and small earthquakes and thus suffers a number of financial losses and fatalities. Earthquakes occurring in Iran indicate that the greatest losses and damages in the areas that have faced the devastating earthquakes occur in the deprived urban areas. Hence, it seems if we identify these areas and if we take necessary arrangements for providing emergency aids into action, parts of these damages and fatalities will be decreased. Old urban contexts can be considered as parts of urban space whose biological system becomes inefficient and disordered in terms of both structure and function of its critical components. In recent decades, this context which once had the dynamism and strength with appropriate structure and function to the needs of its residents has lost its importance with the sudden increase in urbanization. Furthermore, this area has not only lost its indigenous population over the years, but also has become a low-income immigrants' residence that look for the cheapest urban place to live. These Economic and environmental failures have caused the quality of life in these areas to be less suitable than other urban areas (Soltanzadeh, 2010:3) [20] regarding old contexts, it seems that urban managers must accurately identify and analyze them before dealing with their problems. Since before taking any action, it is necessary that government determines the relevant rules, different kinds of contexts, nature, method and its range of involvement with the public institutions (Andalib, 2018: 28) [2]. However, locating old fabrics does not seem to be enough, rather the severity of these deprived areas and the vulnerability rate of the possible occurrences of earthquakes are also important, so as tointervene in good time and make necessary prediction for the establishment of facilities and special equipment. In this case, if we cannot prevent the occurrence of such events, at least parts of the losses can be prevented. The use of GIS technology and its analytical tools such as Spatial Analyst is one of the accurate ways of identifying and analyzing old and prioritized contexts in terms of providing services. Since with the entrance of GIS software to the descriptive and spatial analyses arena, its use in all urban areas is somehow obligatory due to the high analytical power. GIS is a new database that its distinction from an ordinary database lays in its intelligence and pervasiveness (Azimi Housseini et al., 2011: 17) [5]. In case of identifying old and prioritized contexts in terms of occurrence of crisis and natural events such as earthquakes in GIS, in addition to the possibility of accurately recognizing deprived area, the severity and rate of it as well as vulnerability can be analyzed and not only it provides the possibility of relief, determination and establishment of necessary equipment and aids, but also it prepares the ground for awareness andidentification of target groups in order to prepare them for the possible occurrence of events. Investigation the condition of Ghouchan old contexts is the aim of the present study.

Theoretical Foundations Principles

Since the introduction of the sustainable development paradigm in the late twentieth century, and considering man as the center in this kind of development (Saberifar and Marzavi, 2011) [16], nearly all studies done in this area, consider health and welfare of the people as the first goal. In this way, in natural events the lives of human beings and their belongings become the first priority in the studies and planning related to crisis management and natural events such as earthquakes, floods, etc. Meanwhile, the

evaluation of the seismic vulnerability of buildings is regarded as the first step to their strengthening and one of the necessary measures for crisis management in cities. At the same time it was claimed that the recognition of parameters that affect the vulnerability of buildings will prepare the ground for promoting human knowledge for designing and retrofitting against earthquake (refer to Javadin, 2003) [11]. The experiences obtained in studies of earthquake events in the world show that old, dense fabrics have the highest rate of vulnerability. Accordingly, this area is the main focus of attention in most studies conducted in connection with the vulnerability of cities against earthquake. Generally, the reduction of performance of any phenomenon leads to its erosion. While the life of a part of city is in recession for any reason, its urban context is in the process of erosion. City contexts will be in this process sooner or later in terms of their properties (Andalib, 2008: 36) [2]. Nowadays, with the rapid changes of cities, parts of city contexts cannot establish the proper relationship with their surroundings due to their inefficiency and erosion (Moghadam Aryayee et al, 2018: 2). Old areas of city are known in urban planning literature and urban management with different titles such as "undeveloped context", "dysfunctional and inefficient context" and "unstable urban fabric" (Andalib, 2008: 37) [3]. Dysfunctional, inefficient and eroded city contexts are parts of city that its components become eroded and inefficient over the past years, including superstructure, and infrastructure facilities, buildings, constructions and streets and their inhabitants suffer from numerous economic, social, cultural and physical problems (Islamic Consultative Assembly of Iran, 2010) Old contexts differ from suburbanization in that they are located within the statutory part of cities and have legal ownership. Nevertheless, in terms of safety, strength and urban services are deficient (koolabadi, 2019: 3) [12]. Urban erosion is the result of various economic and social factors. These factors include passage of time, poor planning, and poverty, profound lack of interest of communities, the legal red tapes, suburbanization and the income gap in town. Each of these factors will not lead to wise erosion in cities, singly, but together they intensify it (Mousavi, 2009: 5). Erosion penetrates in the "framework" or in the "activity" or in the "framework and activity" at once. Based on this, some equations can be formed, indicating the types of erosions. One group of these equations can be as following:

The first equation: form (healthy framework) + activity (relative erosion) = relative erosion of space

The second equation: form (relatively old framework) + activity (healthy) = relative erosion of space

The third equation: form (old framework) + activity (eroded and old) = complete erosion of space (Habibi and Maghsoudi, 2009: 15) [7].

n our country, the erosion indices set forth by the Supreme Council for Planning and Architecture are the criteria for urban planners and managers, which include:

Index 1, Fine grained:blocks that more than 50% of their plaques have an area of less than 200 square meters

Index 2: Instability, blocks that more than 50 % of its building blocks are unstable and have no structural systems

Index 3: Permeability, Blocks that more than 50 % of its passages are less than 6 meter wide.

Furthermore, it was decided that the Secretariat of the Council does the necessary evaluations about the prediction of new indices and dealing with exceptions that all their three-fold indices are not applicable and then recommends them to the High Council. Hence, until the investigation and evaluation of the Secretariat is done and adopted by the Council, those contexts are being examined and approved that have all of the three indices (Iran's Supreme Council for Planning and Architecture, 2006) [9]. Considering that the method used in this research mainly focuses on GIS performance, in this section we briefly discuss GIS. Regarding GIS, many definitions have been proposed by experts in this field, but according to the present study, the best definition that can be related to the subject is as following:A powerful tool for information retrieval in the future, transforming and displaying spatial data from the real world (Rostami and Nazmfar, 2008: 2) [15]. At present, this software is very common as a powerful tool for planning and helping to an optimized urban management. Malsuzyki considers the development and expansion of this system as an area for the evolution of planning horizons (Malczewski, 2009: 3). Preparing an urban GIS, will have lots of helps in planning, decision-making and urban policy, considering the theoretical and practical instructions, with the help of a specific method and by considering short-term and long-term basic needs with regard to the quality of the data used in it (Zangiabadi et al, 2011:5) [21]. One of the most important capability of GIS that cannot be done with analog methods is the possibility of performing complex analysis by different spatial and non-spatial data sets, simultaneously (Sanjari, 2008: 10) [17]. We should provide an analytical model of the intended subject for optimal use of GIS system due to the complexity of urban structures, in urban contexts and especially in old urban contexts. Simplifying the real world is the purpose of modeling. This is done by geographic information system GIS, by providing a set of facts in forms of a set of map layers and the relationships between them (Aronoff, 1989: 54) [4]. Two problems of spatial effects modeling are how to select the type of effect that can provide the best symbolization for the effect modeling and how to easily apply the portrayal of changes by affecting various factors in it (Ghalambar Dezfouli and Ghahghaee, 2010: 120) [6]

Research Background

Although extensive researches have been carried out about old contexts and vulnerability (International Institute of Earthquake, 2006) [8], no systematic study has been done about the use of GIS technology in diagnosis of rate and intensity of erosion, identifying the rate of vulnerability of urban areas and also the way of its analysis. It seems that using spatial analysis in descriptive and spatial analysis of old urban contexts has not paved that much way. Nevertheless, we use GIS in several researches regarding identifying erosion indices and old contexts. Ahmadi and Naghibi (2019) [1], in an article that is written about Sartapooleh in Sanandaj and entitled "rehabilitation and renovation of old urban contexts with the use of AHP & GIS", extracted the principal indices such as fine granularity, strength and impermeability based on the descriptive-analytical method and eventually located old context areas by AHP method. Ali Shokouhi and Amin Sepand (2007) [19] in a book entitled "extraction of old context identification indices using GIS", locating Husseinieh neighborhood of Zanjan city with emphasis on the physical parameters of erosion. In a different study, Saeed Nazari Adli and Hadi Rezaee Rad evaluated the use of factor analysis model in physical erosion diagnosis. This study has been

done on Khak Sefid Neighborhood in Tehran that by considering physical indices and social stratification intervention priorities have been determined as well as old context identification.

Methodology

The methodology of this study is analytical- descriptive. In order to collect information and data numerous field studies were done while taking advantage of existing administrative documents and for recording and measuring the necessary data firstly a spatial sample of the city Ghouchan was determined. This means that the city is divided into one- square -kilometer parts and from each of the parts according to the type of residential, commercial, industrial and service use we choose 3, 2, 1 and 1, respectively. Then, using evaluation methods, we determine the rate of vulnerability and the condition of vulnerability of the buildings. Thus, using the special software, the rate of vulnerability of different areas of the city was determined. Due to the fact that areas that with old context have the highest rate of vulnerability, the actual range of old context was determined with respect to the parameters used in this field and further analysis was conducted on this basis. Then for better utilization of library information and above documentation plans, we used Spatial Analyst techniques in GIS software. Final results were obtained using combination technique and overlapping layers of information of Ghouchan. As we mention before, the different regions were studied in terms of vulnerability. Normally, for the assessment of buildings, qualitative evaluation methods with high evaluation speed and less accuracy or quantitative methods with higher accuracy and more time are used due to various factors such as time, cost, and accessibility to technical documents of building. Consequently, we deliberately tried to combine the two methods in our study. To this end, we use a combination of two well-known and common methods in Iran that are Saba and Aria. Saba evaluation method is in accordance with ATC and Venezuelan methods with internal regulations and largely determines the safety of structural elements. Aria evaluation method is calculated based on the intensity of the earthquake, damage coefficient for each parameter and the ratio of damage to the whole building (for further information refer to Shakib et al., 2015 [18] and Nasiri Amini, 2005) [14]. In quantitative assessment part we make use of nonlinear static analysis and nonlinear dynamic analysis to identify the actual behavior of building against earthquake with the use of Iran's rehabilitation instruction (for further information refers to International Institute of Earthquake, 2006) [8].

Data analysis

The area of study in this project is Ghouchan which is located in Khorasan Razavi and according to the census, has a population of 103000 people.This city is chosen as a case study because it was completely destroyed due to the devastating earthquake in the year 1312(1933) (Najafi Ghouchani, 1997), changed its original location and was established in another place. Since this displacement happened nearly 100 years ago, and it is likely that another earthquake occurs, if not worse than the previous earthquake at least with the same Richter, vulnerability assessment of earthquake in this city was necessary.

Based on the quantitative and qualitative evaluations, it was revealed that most vulnerability occurs in specific areas of the city that people and the authorities consider them old context. In order to investigate the status of this area completely and accurately, we attempted to delimit this area accurately and based on indices of Iran's Supreme Council for Planning and Architecture. Nevertheless, we admit that reliance on these criteria seem inadequate for all of the Iran's cities. But this sanction is the basis on forthcoming urban development plans and can be documented. In addition, imposing further indices requires more profound investigation in the foundations of old contexts which is beyond the scope of this study and one of the main limitations of the present study is that it hopes to be considered in further researches. To determine the rate of erosion and to locate old context and vulnerability of Ghouchan, we firstly analyze the criteria of impermeability, fine granularity and strength of building separately using the Density function.

Fine granularity: the rate of accumulation of fine granularity pieces that is shown in map number 1 is measured in different parts quantitatively for analyzing fine granularity, based on the layer components of city status quo. Based on the performed analysis, large parts of central and northern city context have the highest number of fine granule than the other areas.

Impermeability: To analyze the impermeability which refers to the less –than- 6- meter wide passages, in order to obtain sections of road with less than 6 meters width, the spatial analysis has been done first. In organic contexts, high length passages have different cross sections in regard to width. Based on the conducted analysis, we have investigated only parts of these passages that have less- than- 6- meters width. According to the map number 2, areas with the highest impermeability rate in Ghouchan are characterized which include Middle Eastern, Middle Western and scattered areas in northern parts.

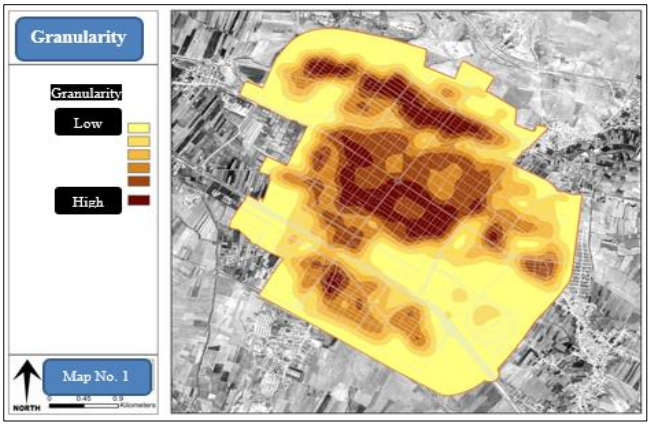

Fig 1: Analysis of fine granularity criterion

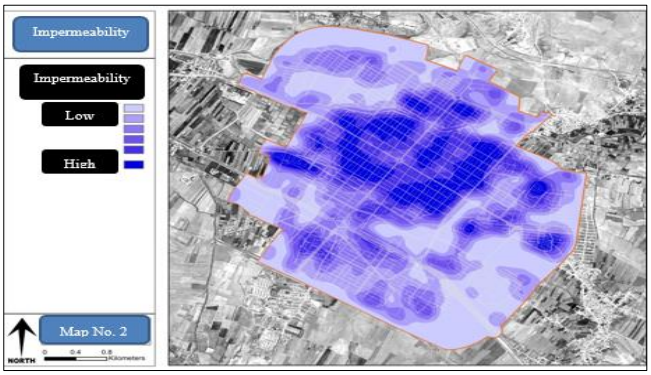

Fig 2: Analysis of Impermeability

Strength of building (stability): This index is analyzed based on construction technology and the quality of construction of the building in the status quo, whether it is dilapidated or restored. According to the map number 3, unstable buildings, are mostly located in the central and southern areas of the city.

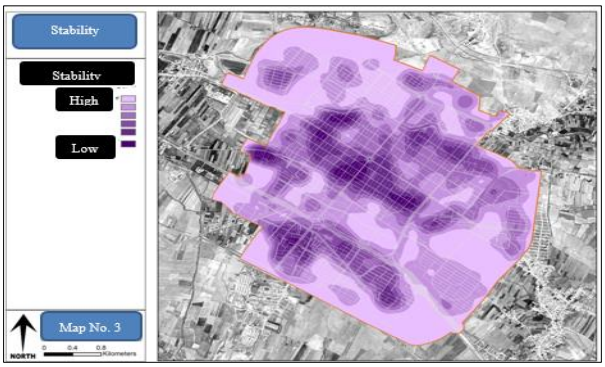

Fig 3: Analysis of Strength and stability of building

Priority of Criteria

To analyze the rate of vulnerability and to determine the location of the old contexts, it is required to distinguish in the rate of effectiveness of the relevant criteria. Among the mentioned indices, the stability and strength of the building are the most important ones that can be generalized directly to all Iran's cities.

Since the existing buildings in an urban context must have minimum of standards and strength in building regardless of context type (organic, radial, checkers, etc.),passage width, residents' income, the rate of building density, use, etc. that we can consider them "acceptable"in terms of building quality. After the factor of the strength of the building, the passage width and impermeability are the next important factors. the minimum width of the urban context passages is considered 6 meter due to residents' optimal access to context, ease of the provision of urban services, shading, proper disposal of surface water, optimal canalization of urban utility, etc. and less than 6 meter width is in contrast with supplyingabove needs. Considering that fine granularity does not apply to cities with less than 50000 populations (blocks that more than 50% of their plaques have an area of less than 200 square meter) (Supreme Council for Planning and Architecture, 2006) [9], it can be said that fine granulation index in Quchan cannot be ignored although considering the population of 103 thousand people. However, due to the average income groups residing in the inner cities such as Quchan and the urban morphology of this city, 82% of residential parts have less than 200 square meter area and this shows that we can consider fine granularity as the least important factor affecting erosion in this city.

Consequently, the way of prioritize and loading criteria in GIS is first shown based on the existing measures which are determined by experts in table 1.

Table 1: 9 quantitative scales for comparing binary criteria

Definition	Description	Score
both criteria have equal importance in achieving the objective	Equal importance	1
experience shows that for achieving the objective i is a little more important than j	Slightly more importance	3
experience shows that i is more important than j	More importance	5
experience shows that i is much more important than j	Much more importance	7
it is proved that i is much more important than j	Absolute importance	9
When there is moderate states	---------	2,4,6,8

Based on the weights of the above table, the experts are asked to rate the importance of criteria that its final result is shown in table 2.

Table 2: The final weighting of erosion indices

Criterion	normalized weight
Strength of building	0, 521
Impermeability	0, 316
Fine granularity	0, 163

Source: authors, 2014

Areas of old and vulnerable context

By overlapping the layers and applying the weights, we obtain the rate of erosion layer of Quchan. In this layer, the GRIDCODE index which is calculated by GIS software and shows the rate of erosion, have been distributed by the amount 1 to 6 in the city. The larger the mentioned index is, the more eroded the context is and would be more vulnerable against possible earthquakes. Based on the map number 4, areas that their GRIDCODE index is 6, are areas that have all of the three mentioned erosion factors. It is noticed that main parts of central urban areas are really eroded. Furthermore, area of focus in the eastern part has the same conditions. These areas, according to analyzes conducted in this study, are known as Quechan's old, vulnerable contexts.

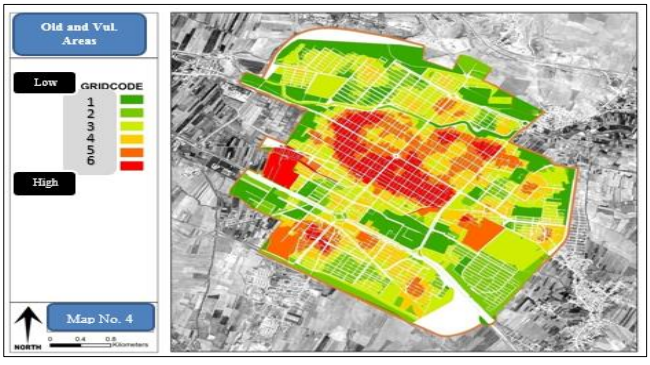

Fig 4: The area of old context

Intensity of erosion and vulnerability analysis

Intensity of erosion and vulnerability analysis, that leads to better planning for old contexts, occurs in two forms:

Spatial analysis: which includes old areas that their erosion index is 6 and it is considered as the priority of interference in old contexts. It seems that based on the defined concepts, these areas have the highest rate of vulnerability in case of earthquake or any unusual event. These areas should be renovated immediately and in short-term plans the best relief facilities and some land uses should be provided which are known as safe places for assembly

and seeking shelter near these areas. In old contexts, physical and spatial erosion reach to its maximum. Areas with the erosion index of 5 or 4, which have relative rate of erosion and vulnerability, must be on agenda as well. And at least in short - term, appropriate relief equipment and facilities must be located there and in long-term, rehabilitation projects must be applied to them. Areas with the erosion index of 3 have mild vulnerability and erosion too. Although these areas erode with the passage of time, their renovation and rehabilitation does not seem too serious and we only must provide relief facilities and shelter seeking so as to reduce the possible damages to a minimum. Nevertheless, we suggest some t measures to be taken in long -term planning so as the erosion and deal with the physical status can be controlled. Descriptive analysis: for descriptive analysis, with the use of Summarize command, we take action to calculate the average of erosion and vulnerability index for uses based on their components numbers. The result of descriptive analysis is that erosion and vulnerability index in residential use (4, 9) is higher than other land uses. After that commercial use has the next highest rate of erosion and vulnerability with the index of 3 and 4. Service use (4, 29) and industrial use (4, 30) are in the next categories. Based on this analysis, if we intend to take action regarding the overcoming of erosion and vulnerability, residential, commercial, and industrial, service use should be in priority. Relevant organizations such as municipalities must follow renovation approach by applying specific criteria for licensing in these land uses.

Discussion and Conclusion

Determination and locating the old areas as well as rating the intensity of erosion and vulnerability, are of more important than erosion and vulnerability criteria determination that are usually carried out in the form of legislation by the responsible organizations in this field. According to the study results, if this process is carried out by using detailed anatomical information and getting assistance from the software analysis such as GIS, a specific trend for dealing with erosion and vulnerability in two forms of spatial and descriptive will be face with the executive managers and responsible institutions. Consequently, in comprehensive and detailed plans prepared by consulting engineers the above process will be very useful in data analysis and executive strategies. In fact, accurate identification of location and rate of erosion in cities must reach the executive managers and responsible institutions from the entry of urban development plans and through laws and regulations, so that if there was a problem of erosion, they take step to apply three-fold approaches of rehabilitation, reconstruction and renovation based on local priorities and operational priorities (descriptive).

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