



## Studying the vulnerability reduction and physical-spatial organization of Bojnord city through the urban land use planning (case study: flood)

### Estudo da redução da vulnerabilidade e organização físico-espacial da cidade de Bojnord por meio do planejamento do uso do solo urbano (estudo de caso: inundação)

### Estudio de la reducción de la vulnerabilidad y la organización físico-espacial de la ciudad de Bojnord a través de la planificación del uso del suelo urbano (estudio de caso: inundaciones)

Ali Gholamzadeh Doab<sup>1</sup> , Saeed Kamyabi<sup>1</sup> 

<sup>1</sup>Islamic Azad University, Semnan, Iran.

#### Corresponding author:

Saeed Kamyabi

E-mail: saeidkamyabi@gmail.com

**How to cite:** Doab, A. G., & Kamyabi, S. (2021). Studying the vulnerability reduction and physical-spatial organization of Bojnord city through the urban land use planning (case study: flood). *Journal of Research and Knowledge Spreading*, 2(1), e12503. <https://doi.org/10.20952/jrks2112503>

#### ABSTRACT

Flood is one of the most important natural disasters that cause the casualties and losses every year. Today, the massive growth of the population, the leveling of the land and the occupation of rivers and waterway s, along with the climatic and physiographic factors in big cities, have caused the urban flood spread .Bojnourd City has a high degree of vulnerability to natural hazards due to its geographical location in the Kopet Dag and Aladagh mountains, and the presence of rivers and waterway s inside it, on the one hand, and placing on the faults on the other hand.In this research, a descriptive-analytical method and the aerial maps have been used to collect the information.The results of the research indicated that Bojnord City is highly expected to flood in terms of the probability of flood-related vulnerability.

**Keywords:** Bojnord. Flood. land use. Sustainable urban development. Vulnerability.

#### RESUMO

A inundação é um dos mais importantes desastres naturais que causam vítimas e perdas a cada ano. Hoje, o crescimento massivo da população, o nivelamento do solo e a ocupação de rios e hidrovias, juntamente com os fatores climáticos e fisiográficos em grande escala cidades, causaram a propagação das inundações urbanas. Bojnourd City tem um alto grau de vulnerabilidade a desastres naturais devido à sua localização geográfica nas montanhas Kopet

Dag e Aladagh, e à presença de rios e hidrovias em seu interior, por um lado, e colocação nas falhas, por outro lado. Nesta pesquisa, um método descritivo-analítico e os mapas aéreos foram usados para coletar as informações. Os resultados da pesquisa indicaram que a cidade de Bojnord é altamente esperada para inundar em termos de probabilidade de vulnerabilidade relacionada às inundações.

**Palavras-chave:** Bojnord. Desenvolvimento urbano sustentável. Inundação. Uso do solo urbano. Vulnerabilidade.

## RESUMEN

---

Las inundaciones son uno de los desastres naturales más importantes que causan las bajas y pérdidas cada año. Hoy en día, el crecimiento masivo de la población, la nivelación del terreno y la ocupación de ríos y vías fluviales, junto con los factores climáticos y fisiográficos en gran medida. ciudades, han provocado la propagación de las inundaciones urbanas. La ciudad de Bojnord tiene un alto grado de vulnerabilidad a los peligros naturales debido a su ubicación geográfica en las montañas Kopet Dag y Aladagh, y la presencia de ríos y vías fluviales en su interior, por un lado, y la ubicación de las fallas, por otro. En esta investigación, se ha utilizado un método descriptivo-analítico y los mapas aéreos para recolectar la información. Los resultados de la investigación indicaron que la ciudad de Bojnord tiene altas expectativas de inundaciones en términos de probabilidad de vulnerabilidad relacionada con las inundaciones.

**Palabras clave:** Bojnord. Desarrollo urbano sostenible. Inundaciones. Uso del suelo urbano. Vulnerabilidad.

## INTRODUCTION

---

Natural hazards have always existed as a natural phenomenon during the life of the planet. The occurrence of natural hazards such as flood, earthquake, storms, etc. has often left destructive impacts on human settlements and has caused heavy casualties on their inhabitants, destroy the buildings and infrastructure of these areas, and impose high economic and social costs on human societies and countries of the world. Cities as a gathering place for human populations are not excluded from the occurrence of these natural hazards, and there is a need for serious measures to reduce the vulnerability of these settlements to natural hazards. Today, urban needs and the demand for housing and migration of villagers to cities have caused the over-development of cities. The lack of attention to the correct location of cities, the development of cities, as well as the lack of planning to prevent the unintended development of cities, have caused many problems for the protection of cities. This process has led cities to expand on faults or in the vicinity of rivers and waterway s. This can increase the vulnerability and the financial and life-threatening consequences of these events. It is important to note that the flood cannot be prevented, but its casualties and losses can be reduced through the proper planning of land use. It is impossible to eliminate the disaster, but reducing the damage caused by it, is one of the most important factors in reducing the risk of flood.

On the other hand, Bojnord City, has a high degree of vulnerability to the natural hazards due to its geographical location in the Kopet Dagh and Aladagh mountains, and the presence of rivers and waterway s inside it and placing on faults. Another problem of these contexts is their inappropriate and limited access, which makes it difficult for residents to relieve them after natural hazards. The results of this research can be effective in reducing the financial and life damages caused by the inadequate location of Bojnurd City context and the occurrence of natural disasters such as flood.

## **LITERATURE REVIEW**

---

Rajabi et al. (2018), in an article titled "Zoning the Vulnerability of Natural and Geomorphologic Hazards of Saqez Settlements (A Case Study of Flood and Earthquakes)", showed that among all villages in Saqez City, 145 villages were located on relatively high risk zone and 135 villages in a relatively moderate risk zone.

Esmailie Aloygeh et al. (2017), in an article entitled "Assessing the vulnerability of urban areas against flood with fuzzy logic (Case study: Tehran 22nd District)", showed that according to the final map and percentage of population density in the northeastern region near Ken river (more than 1.07%), the probability of vulnerability is predicted high in that area.

Mousavi et al. (2016), in an article entitled "Assessment and Zoning of Flood Risk Using Fuzzy Logic of Topsis in GIS Environment (Case Study: Baghmalek Drainage Basin)", showed that 17.86 percent of the areas located at very high risk zone and 24.15 percent is in high risk zone.

MajidiHeravi et al. (2015), in an article entitled "Urban Flood Vulnerability in Northwest of Tehran (Farahzad to Ken Basins)", showed that the combination of natural waterway factors such as high rainfall basins, current non-compliance in flood management, will exacerbate the vulnerability of these areas. Other factors such as context and vulnerability of urban areas are also involved.

Leon & March (2014), in a study state that the urban areas will become the main source of many natural disasters. Factors that increase the risk of disasters in urban areas include the population growth, unplanned urban development, property concentration, poverty, rapid development of informal settlements, population overflows, apartment buildings, erosion of the ecosystem, lack of the ability to guarantee infrastructure and poor urban management.

Leon & March (2014), studied the role of urban morphology in creating a rapid resilience to tsunami. The results of this study indicate a dramatic increase in the safety of evacuees and an increase in the speed of proposed reforms.

Lu & Stead (2013), in a study stated that the land use planning with the effects of avoiding the formation of bad neighborhoods through the isolation of certain uses from one another, and the guidance of urban development towards distant areas, is an effective tool for urban planners to minimize the risk.

Smith (2006), believe that planning land use correctly and fairly does not solve our vulnerability but can reduce it.

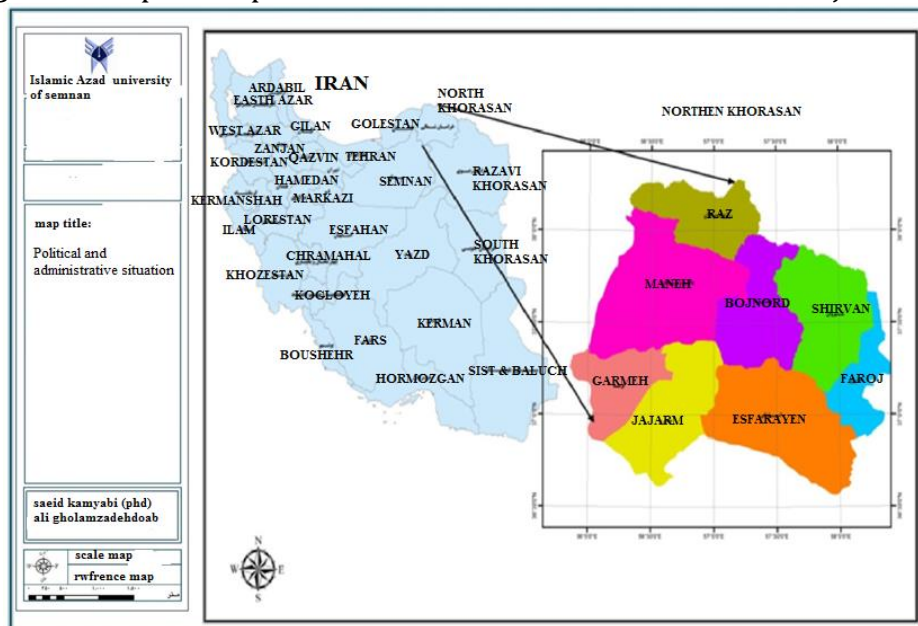
## **METHODOLOGY**

---

Bojnord city is located in the North Khorasan province, in latitude 36° 56' to 37° 57' and longitude 57° 37' to 58° 38'. This city with a total area of 3215 square kilometers, is located in the center and continues in the north and northwest. From the north and the northeast is co-border with Turkmenistan, and from the northwest with Raz and Jargalan County, from the west with Maneh and Samalqan County, from the south west with Jajrom County, from the south with Esfarayen County and from the southeast and east with Shirvan County. Bojnord City is extended between 37 degrees and 27 minutes and 27 seconds to 37 degrees, 29 minutes and 31 seconds of northern latitude and 57 degrees, 17 minutes and 4 seconds to 57 degrees, 21 minutes and 36 seconds to eastern longitude, and its height from sea level is 1070 meters. Bojnord is located in 30 kilometers northeast of Saluk Mountains and 13 kilometers south of Atrak River and is located 270 kilometers northwest of Mashhad and 695 kilometers east of Tehran. The city is 55 kilometers from the border with Iran and Turkmenistan. The area covered 1900 hectares of Bojnord plain lands (Statistics Center of Iran, 2011).

According to the latest divisions of a country approved by the Ministry of the Interior, Bojnord consisted of two districts and five villages.

**Figure 1.** Map of the political and administrative situation of Bojnord city.

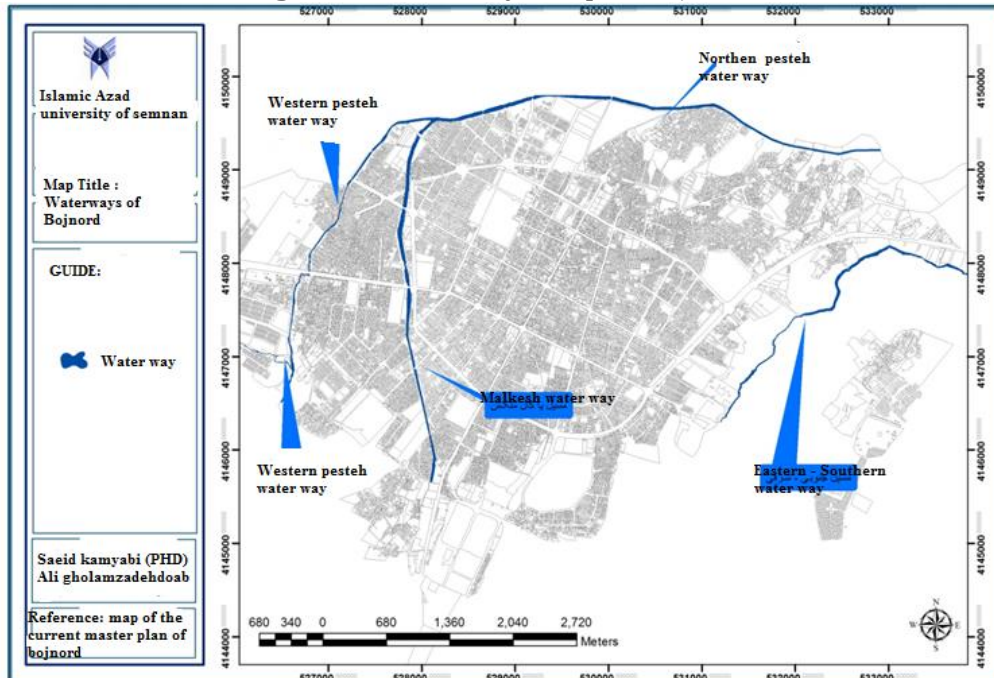


## RESULTS

### Waterways of Bojnord city

Three major waterways in Bojnord city are the subject of this study and, based on an overview of the status and characteristics of these waterways, are as follows:

**Figure 2.** Waterways map of Bojnord.



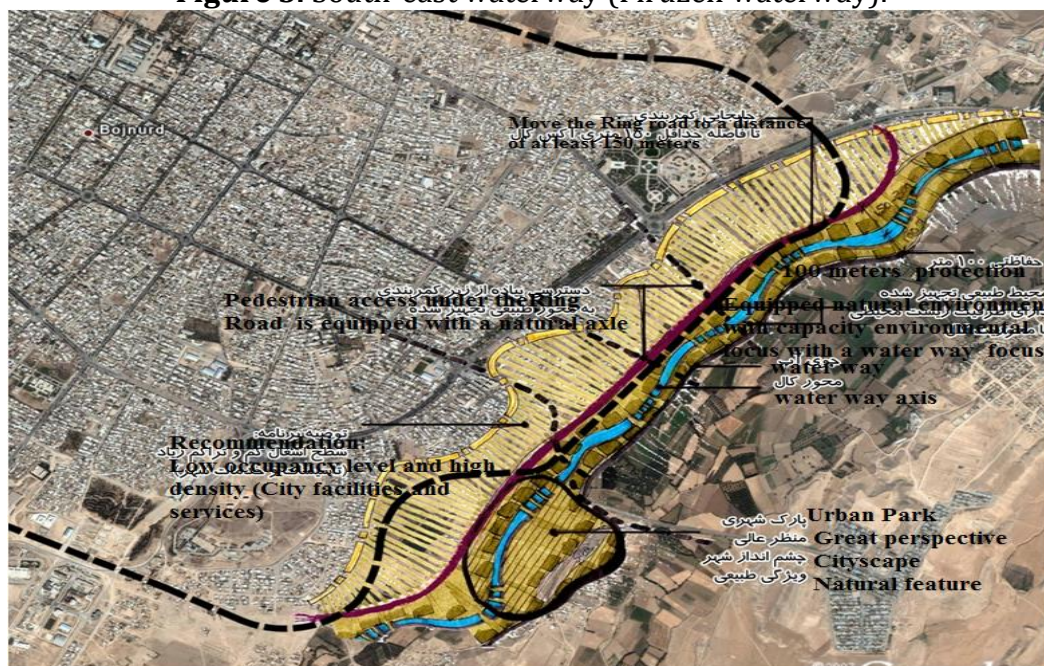
### South-east waterway (Firuzeh waterway)

It flows from the southeast and east of the city to the northeast, with a length of about 4.5 kilometers, and an average width of 22 meters, with an average distance of 300 meters to the western residential context. The percentage of slope to the north is reduced, therefore the lands around are subject to the flood. There is gardens and agricultural lands in two sides. The waterway is borderline and bounded to the east of the city. The vacant lands around the road

with regard to the ring road and the announcement of residential reserve are highly exposed to plotting and unplanned construction and are considered a future threat. However, nowadays vacant land around the residential context is an exceptional opportunity for the city. The main axis of the city continues as the road of the Farhangiyan town through the waterway and immediately passes through the hill. The waterway in the plan is protected by green area and any construction is prohibited. The area is 30 meters from the west of pit and the total area is about 50 hectares. Due to the relative possibility of providing water and the surrounding environment, this waterway can be a very valuable natural park for the city, with a slight shift offing road.

The eastern and southeastern pit remain relatively clean due to the relative distance from the habitat, and seasonally there is little water flowing there. This pit is the only natural landscape in the natural space of the city, and is surrounded by cultivated fields and gardens, and the construction in this area is smaller than in the western area. It has a good quality as a city landscape.

**Figure 3.** South-east waterway (Firuzeh waterway).



**An overview of the most important role of south-southeast waterway (Firuzeh) at the present and future**

Obviously, the main role of waterway is the disposal of urban floods and surface water, however, it plays a role in the structure and organization of the city (the interaction of artifact organizers and natural organizers). In this regard, the south and south-eastern pit studied in Bojnord can play a role in macro look (A) and along the path (B), and create different and meaningful urban sequences.

**Identify and introduce inappropriate uses based on the plan area**

In objective observations, it has been found that the inadequate use has not been established in the area of the study. There are residential, administrative, educational and cultural space residential, far away from the area of the project, which is currently the only improper use of the warehouse, as well as the macaroni factory, located outside the area of the project and at a distance of about 400 meters.

## **Physical features of buildings and passages: investigation of the fragmentation and full and empty status of buildings**

There are the agricultural lands and gardens around the southeast and south pit. A few residential complexes have been built on this route, all new and small which are outside the area of the plan. The history of floods and construction failures is less in this area, due to the flooding feature. It was also found that, besides the residential spaces, the rest of the pieces were coarse grains.

### **Studying the height and floors of the building of the area**

Bojnord is generally a horizontal city with two to four-floor buildings. The skyline of the city is entirely horizontal and almost uniform. High-rise buildings, especially in the center of it, are rarely observed. In the area of pit, there is no construction, and there are only a few two or three-floor complexes that are new. There are most the garden and agricultural lands within the pit area, with only about 2 hectares of one-floor buildings and about 5882 square meters of two-story buildings.

According to the observations, it was found that in the adjacent area of the pit, most of the buildings have a brick, stone and glass view, which reflects the development of the city towards modernism. Most new buildings are constructed after Bojnord became the center of the province. Most of the residents want to have villa houses, but they have stated that they would prefer to build multi-floor buildings, given the high cost of land and the economic benefits that landlords and housing owners receive.

### **Qualitative study of the passages of the area**

Not nay passage ends to the pit, due to the fact that it is surrounded by the agricultural lands and gardens. Most passages close to it, are also sandy with low width, about 8 meters. In the mental images of the citizens, the only important and paved passage that interrupts it, is the Farhangiyan Boulevard, which passes through this waterway to the Farhangiyan town.

As mentioned, 89% of the residents have assumed the street, the main spaces around the waterway. Even some citizens have described the street as the most interesting place they know.

### **Pesteh (Doberar) waterway**

This is one of the longest waterway s in the city (about 9 kilometers), continuing from southwest to northwest, after the annexation of Malkeshpit to the north of the city; it is divided into two parts by feature.

### **Western Pesteh waterway**

It is located in the west of the city and the current developmental boundary of the city and flows from the north to south, as an urbanpit with a length of about 4 kilometers and an average width of 10 meters and a distance of 8 to 12 meters in the middle of the bed. The green area proposed in adjacent empty contexts is 15 meters from each side (about 15 hectares). In the northwest, there is flooding problems, in principle, the disposal of surface water. This urban waterway is becoming a garbage dump and is extremely polluted due to its bad habitation, border uses and lack of belonging sense.

The western pit (Pesteh) is northern-southern, which goes on to the north after connecting to Malkesh pit. Many parts of this pit is partitioned. Currently, it is a sewage disposal site for the workshops, repair shops and pastoralism. In the past, it was the western border of the city, but at the present time, in the western part of the construction, it passes through the border of pit and has formed the new development of the city along Mashhad-Tehranroad.

### Studying the main role of the western waterway (Pesteh) at the present and the future

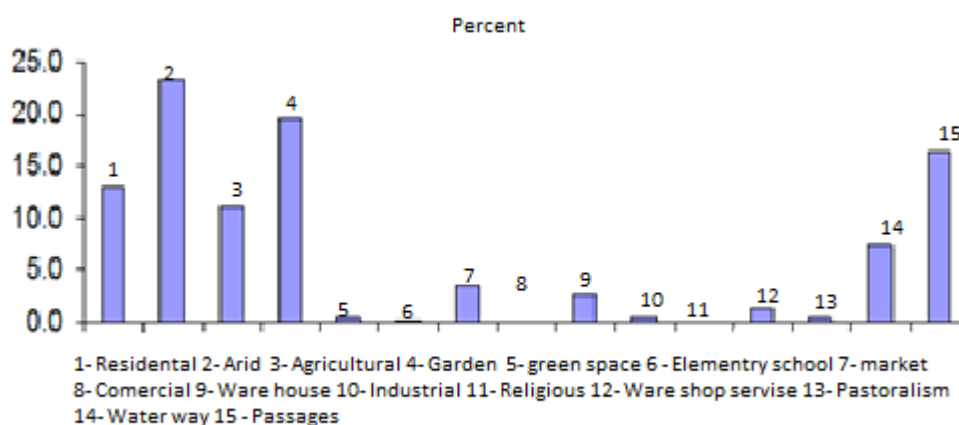
Obviously, the main role of waterways is the disposal of urban flood and surface water, however, depending on their circumstances, and their presence area, play a role in the structure and spatial organization of the city (the interaction of artifact organizers and organizers); they can have positive and effective roles, despite their separating status and edges. In this regard, the studied pits in Bojnord can play the role in some modes: in macro look (A) and in their path (B), and create different and meaningful urban sequences.

### Land use and functions: studying the land use and its quality in relation to the users' classes

The land use of the surrounding area is now more residential. A huge part of Pestehpit has been resettled in the current state.

In general, the waterway does not have a desirable quality and, according to a survey of people, 90% of them consider the waterway as a waste dump and have asked to cover them.

**Figure 4.** Available status use in the western border of western pit (Pesteh).



### Identifying and introducing inappropriate uses based on the western pit (Pesteh)

According to the above, the most important inappropriate uses on the western pit (Pesteh) are the workshops and livestock where are the most important environmental and visual pollutant factors. The transfer of these functional units to the out of city should be one of the main factors on the agenda. Also, defining the airport's entrance and arranging the surrounding housing context will cause the visual enhancement of the area.

### Physical features of buildings and passages: studying the fragmentation and full and empty status of buildings

The quality of the buildings is also somewhat appropriate, due to the approximate location of the waterway in the new parts of the city. The Pestehpit is a western border and actually surrounds the west of the city. Most of the buildings around this pit are new. The largest part of the plain is located between the Golestan Boulevard towards the south. Compressed and fine-grained context is located on the eastern side of the pit, and the buildings in this part are older than the west. Most of the empty spaces are on the west side of pit.

### Qualitative study of the passages of the area

Regarding to the location of the western pit (Pesteh) inside the city, most of the passages end to asphalt, although not suitable. It is observed that the maximum number of passages is 8 to 2 meters. This indicates the traffic importance of the pit and also the importance of it as a part of the city center.

There are many passages on the path or intersection with this waterway , the most important of which is the Golestan Boulevard with a width of 44 meters and Taleghani Boulevard with a width of 36 meters (the table below shows the number and width of the passages along the path of the western Pestehpit and the north).

**Table 1.** The number and width of the passages along the path of the western Pestehpit and the north.

Passage width	6 m	8 m	10 m	16 m	30 m	36 m	44 m	Sum
Numbers	15	4	4	2	2	1	1	29

It is observed that many numbers of connected or adjacent passages with the west and north Pestehpit is 6 meters. At present, the traffic importance of this pit is less than Malkeshpit, but can be planned as a future capacity. The most important problems were the traffic jams and the lack of pedestrian routes, which accounted for 65% of the traffic jams in passages ending to the Pesteh waterway and to Malkesh passage. Nearly 100% of the residents had a lack of equipped spaces for pedestrians.

### Northern Pesteh waterway

It is located in the northwest after joining Malkeshpit to the northeast and on the northern border of the city about 5 kilometers in length, with an average width of 15 meters, and a distance of 12 meters (this are ais not enough); in a detailed plan, protective green area is considered from 15 to 40 meter son each side of pit. There are the agricultural lands and sometimes gardens on this part of the pit; it has the condition for creation of linear protective green space. The vacant land on the south side of pit (within the area) has a very good potential for improving the condition and improving the living conditions of the northern contexts (the region with a general border feature) and setting up the macro uses of urban scale. Continuing the main north-eastern axis of the city, is a good place to use the vacant lands in connection with the pit and its privacy to provide a kind of service between the city and the surrounding villages. The creation of green zone in this area usually does not have a significant effect on the northern view of the city. In general, a clear strategy has to be developed regarding the existence or appearance of tangible green spaces in Bojnord City. The main challenge is that a kind of spread and vegetation is imagined in mind, and make the condition of the city acceptable in terms of green space, due to the presence of gardens and even agricultural lands in urban context, as well as the specific nature of the environment surrounding the city of Bojnord. Therefore, addressing the development and maintenance of public green spaces in Bojnord City should be considered as one of the most basic and priority urban management strategies. Under these conditions, green conservation areas that are appropriately linked to the surrounding area and the city, have the fundamental importance. The green landscapes caused the negligence and the city, in the unpardonable invasion of the unsustainable constructions of Mashhad city, was rapidly losing its green landscapes. Bojnord City, on a much larger scale, may be the victim of this neglected image.



**Figure 5.** The location in the northwest after joining Malkeshpit.



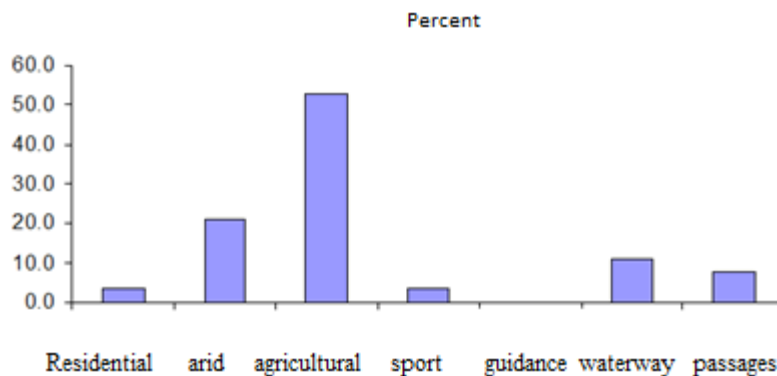
### Studying the main role of the northern Pesteh waterway at the present and future

Obviously, the main role of waterways is the disposal of urban flood and surface water, however, depending on their circumstances, and their presence area, play a role in the structure and spatial organization of the city (the interaction of artifact organizers and organizers); they can have positive and effective roles, despite their separating status and edges. In this regard, the studied pits in Bojnord can play the role in some modes: in macro look (A) and in their path (B), and create different and meaningful urban sequences.

### Land use and functions: studying the land use and its quality in relation to the users' classes

The land use of the surrounding area is now more residential. There are the agricultural and arid lands in the west part. The only large scale use on the west side is Bojnord Airport. In general, the waterway does not have a desirable quality and, according to a survey of people, 90% of them consider the waterway as a waste dump and have asked to cover them.

**Figure 6.** The current status use on the border of North Pestehpit.



### Identifying and introducing inappropriate uses based on the Northern Pestehpit

The only inappropriate use, which may be considered as an advantage, is the establishment of Bojnord airport in the area of this pit; it is also an obstacle to the city progress. The presence of the airport is one of the issues that most people in the area regard it inappropriate. Also, the presence of self-contained and unplanned residential complexes have created an inappropriate visual landscape around this area, which should be one of the first principles to be taken into account.

### **Physical features of buildings and passages: studying the fragmentation and full and empty status of buildings**

The quality of the buildings is somewhat appropriate, due to the approximate location of the waterway in the new part of the city. Pestehpit where is the northern border, has the highest percentage of empty spaces. Most of the residential complexes located within the area are fine-grained and newly built, which are almost entirely to the west of the airport. There are the agricultural lands and gardens in west side of pit from the airport to the end of the pit.

### **Qualitative study of the passages of the area**

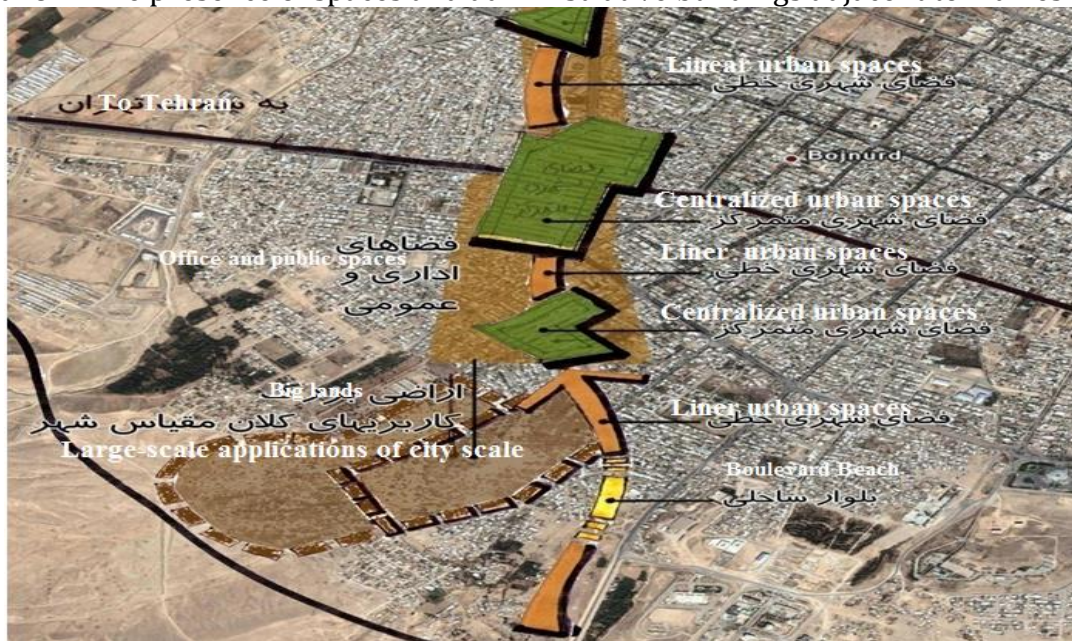
There is only one passage in the length and parallel of this pit, which is sandy and has a width between 6 to 10 meters. Other passages leading to pit are also within the boundaries of the soil plan, with a maximum cross-section percent is between 6 to 10 meters, only passage ending to the asphalt airport and a cross-section of about 12 meters.

### **Malkesh waterway**

It extends from the south to the north with a length of about 4 kilometers and an average width of 10 meters and a 12 meter distance from the center of pit, almost from the center of Bojnord, and is considered as the most important urban waterway. A detailed plan in areas where the space has been provided, offers a free vegetation area of latitudes ranging from 15 to 35 meters, with an area of about 10 hectares. Malkesh waterway is a border separating the old urban context from the new development and the activity and movement axis of this waterway, introduce it as an opportunity to link two parts of the city to east and west on one hand, and connect the north and south of city to each other through a urban space with high social capacity, on the other hand. The waterway area is occupied and constructed in some parts. The empty lands of surrounding area should be identified and quickly acquired due to the importance and also the relatively high value of the land on its path. Parts of this waterway have a high potential for creating active urban spaces, and in the intersection with the important inner city axis, eastern-western part of the city, can be one of the most significant urban spaces.

The empty lands from the beginning of waterway in the south of city to BeshQardashroad, several empty spaces along the route, and the presence of spaces and administrative buildings around the pit to Afarinesh Park, the vast open spaces available on the sides of the pit after Afarinesh Park, (intersection of Tehranroute) to the location of Pestehpit, have provided a very good condition for playing the role of urban scale and the role of linking in the adjacent regions. Action in this direction is more important than the other pits, due to the density, importance and relative value of the surrounding areas, which are heavily influenced by the rapid development of Bojnord. Another major challenge for Bojnord development is the creation of suitable urban spaces that are commensurate with the dignity of the province capital and at a relatively short time. As a matter of fact, such spaces are significant in the center of the city, and in the downtown area of Bojnord, (which change is neither possible nor desirable), changes are gradual, costly and intangible. This look, reveals the importance and inescapable value of Malkeshpit in creating the urban spaces of the index and a new urban landscape and perspective in the downtown area in conjunction with the existing urban spaces.

**Figure 7.** The presence of spaces and administrative buildings adjacent to Malkeshpit.



The presence of spaces and administrative buildings adjacent to Malkeshpit and in line with the role of urban scale and the role of linking of this pit

**Studying the main role of malkesh waterway at the present and the future**

Obviously, the main role of waterway s is the disposal of urban flood and surface water, however, depending on their circumstances, and their presence area, play a role in the structure and spatial organization of the city (the interaction of artifact organizers and organizers); they can have positive and effective roles, despite their separating status and edges. In this regard, the studied pit s in Bojnord can play the role in some modes: in macro look (A) and in their path (B), and create different and meaningful urban sequences.

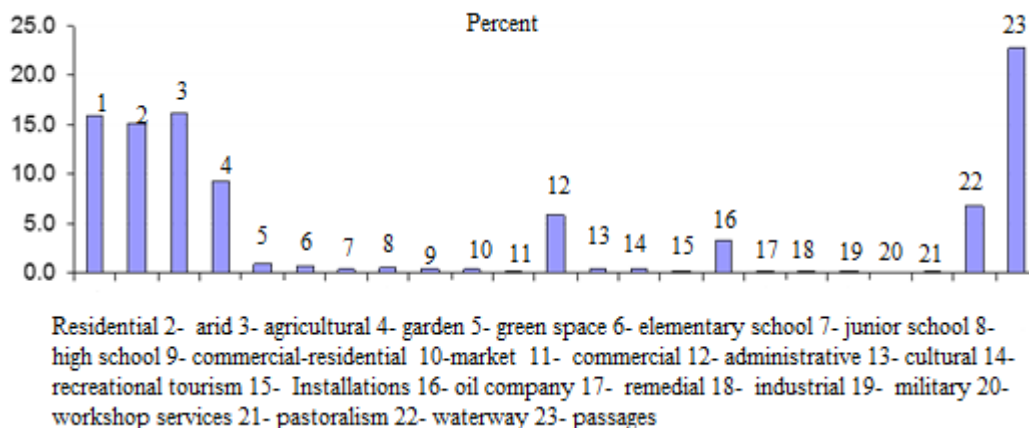
**Figure 8.** Main role of Malkesh waterway.



### Land use and functions: studying the land use and its quality in relation to the users' classes

The land use of the surrounding area is now more residential. Malkeshpit where goes through the city center, has a dense residential context, and in some parts of its center, the administrative uses are more located. In general, the waterway does not have a desirable quality and, according to a survey of people, 90% of them consider the waterway as a waste dump and have asked to cover them.

Figure 9. Use the status quo on the Water way of Malkesh.



### Identify and introduce inappropriate uses on the plan area

Inappropriate uses around this waterway are the existence of workshop and industrial units, with most of the waste water flood into this area. Also, the existence of commercial units such as door and window workshop, engine and machine tools on the border of pit also caused pollution.

### Physical features of buildings and passages: studying the fragmentation and full and empty status of the buildings

The quality of buildings on the western side is somewhat appropriate due to the approximate location of the waterway in the new areas of the city. Malkeshpit separates the medial context from the border context and has an older context than two other pit s. The number of destructive complexes on the border of this pit, especially on the east and south side, is available. It has the greatest number of coarse-grained complexes in comparison to the other, the largest of these coarse-grained complexes are between Taleghani Street and Imam Reza Street. In the center of the city, almost empty contexts is rarely seen, except for the southern parts of this pit and also on the border of Golestan Boulevard.

### Qualitative study of the passages of the area

Regarding to the location of Pestehpit and Malkeshpit inside the city, most of the passages end to asphalt, although not suitable.

Table 2. Location of Pestehpit and Malkeshpit inside.

Width of passage	6 m	8 m	10 m	12 m	14 m	16 m	18 m	20 m	22 m	24 m	36 m	44 m	sum
numbers	5	12	8	4	1	3	1	4	1	2	1	1	43

It can be seen that the maximum number of passages is 8 to 20 meters. This indicates the traffic importance of this pit asa part of the city center.

The most important problems are the traffic jams and the lack of pedestrian routes leading; 65% of people stated the traffic jams in the passages leading to Malkesh waterway, as the problem. Approximately 100% of the residents expressed regret about the lack of equipped spaces for pedestrians. Some of the referrals to pit have mentioned the problem of passing through the pit.

## DISCUSSION

---

The level of damage and losses caused by the natural disasters depends on the level of community readiness against the risk. Inappropriate conditions of urban body, such as inefficient pedestrian networks, inadequate distribution of open spaces, high urban density, incompatibility of uses and old buildings, are effective in increasing the vulnerability and damage caused by flooding and the time to improve the city. Investigating the research criteria in Bojnord City has been indicative of the inappropriate condition of the most criteria in the old context as well as in the rural neighborhoods of the city. Therefore, these areas are considered priorities of action in the city and the preparation of topical plans with the focus on the risk reduction in these areas is a necessity. With the development of the city around, the use of urban planning and land use (wider streets, more suitable distribution and an increase in the size of open spaces and, as a result, more access to open spaces, better material of structures, etc.), is observed in urban context; so that it can be said that the most criteria in these areas are in a better position. The future development of a city that recognizes the vulnerability and resilience of future contexts, is very important. Considering the fact that in the last years, the city has the most development in the south and west regions and according to the zoning map, the risk of natural hazards, including flood, is high in these areas.

## CONCLUSION

---

In order to determine the vulnerability of Bojnord City, nine indices are specified: hazard centers, aggregation of parts, construction density, population density, building quality, access to relief centers and land and selected public and open lands and vulnerable building blocks against the flood. In general, the results of the present study are as follows: According to the city's vulnerability map, the areas with enough street width and are in a better position in terms of access to relief centers and demographic and construction density are low in them, are in a better position in terms of vulnerability. In other words, according to the division of the vulnerability map, these areas have been ranged into 5 parts: relatively low, low, moderate, high and very high vulnerable.

**ACKNOWLEDGMENTS:** Not applicable.

**AUTHOR CONTRIBUTIONS:** Doab, A. G.: acquisition of data, analysis and interpretation of data, drafting the article; Kamyabi, S.: conception and design, drafting the article, and critical review of important intellectual content. All authors have read and approved the final version of the manuscript.

**CONFLICTS OF INTEREST:** The authors declare that there are no conflicts of interest.

## REFERENCES

Berke, P. H., & Smith, G. (2006). Hazard mitigation, planning, and disaster resiliency: challenges and strategic choices for the 21st century. In: Berke, P. H., & Smith, G. (Orgs.). Sustainable development and disaster resiliency. Netherlands: IOS Press Amsterdam, p. 1-21.

Esmaili Alavijeh, E., Karimi, S., & Alavipoor, F. (2020). Vulnerability assessment in urban areas against flood with fuzzy logic (case study: Tehran District 22). *Journal of Environmental Science and Technology*, 22(3), 349-361. <https://doi.org/10.22034/jest.2020.10940>

León, J., & March, A. (2014). Urban morphology as a tool for supporting tsunami rapid resilience: a case study of Talcahuano, Chile. *Habitat International*, 43, 250–262.

Lu, P., & Stead, D. (2013). Understanding the notion of resilience in spatial planning: a case study of Rotterdam. *The Netherlands*, 35, 200–212.

MajidiHeravi, A. (2015). Urban flood vulnerability in Northwest of Tehran (Farahzad to Ken Basins). *Geography Journal, Scientific Information Database*, 13(46), 181- 201.

Akbari, M., Najafi Alamdarlo, H., & Mosavi, S. (2016). Analysis of the effects of drought risk management using water productivity indicators. *Journal of Natural Environmental Hazards*, 10(27), 197-209.  
<https://doi.org/10.22111/jneh.2020.33550.1634>

Rajabi, M., Hejazi, M., Roostaei, S., & Aali, N. (2018). The role of geomorphology factors in the occurrence of natural hazards in rural settlements case study: city of saqez. *Quantitative Geomorphological Research*, 7(2), 183-195.

**Received:** 15 April 2021 | **Accepted:** 25 May 2021 | **Published:** 7 June 2021



This is an Open Access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.