Islamic Azad University
Shiraz Branch

Journal of Land Use and Sustainable Development
Spring 2025. Vol 2. Issue 1

https://sanad.iau.ir/journal/jlusd

Original Research Paper

Assessment and Evaluation of the Status of Vulnerable Urban Fabrics in Babol Neighborhoods against Flood Hazards

Fatemeh Fotouhi Ahli: Ph.D. Candidate, Department of Geography and Urban Planning, Nour Branch, Islamic Azad University, Nour, Iran.
Gholamreza Janbaz Ghobadi*: Associate Professor, Department of Geography, Nour Branch, Islamic Azad University, Nour, Iran.
Sadroddin Motevalli: Associate Professor, Department of Geography, Nour Branch, Islamic Azad University, Nour, Iran.
Jalal Azimi Amoli: Associate Professor, Department of Geography, Nour Branch, Islamic Azad University, Nour, Iran.

ARTICLE INFO

Received: 2025/06/21
Accepted: 2025/07/18
PP: 1-14

Use your device to scan and read the article online

Keywords: *Regeneration, Vulnerable Urban Fabric, Natural Hazards, Flood, Babol.*

Abstract

Adaptation and regeneration of vulnerable urban fabrics in Babol appear essential to prevent further damage. The aim of this study is to regenerate vulnerable urban fabrics in Babol in the face of flood crises. To achieve the research objectives, key indicators affecting the regeneration of vulnerable urban areas will be identified using a combination of library research, field surveys, and theoretical studies. In fact, these indicators, including relevant criteria and sub-indicators, will be recognized and analyzed. Subsequently, to prioritize the influential indicators for the regeneration of vulnerable urban fabrics against natural hazards with an emphasis on floods in Babol—the Friedman test will be applied using SPSS software. The findings indicate that each component of urban regeneration contributes differently to the neighborhoods with vulnerable urban fabrics exposed to flood hazards. The results show that various factors, such as poor water resource management, deteriorating infrastructure, and neglect of crisis management planning, play a significant role in increasing the vulnerability of Babol's urban areas to floods. Furthermore, empowering the local community and establishing green infrastructure have been identified as effective strategies in mitigating damages. The study highlights that the regeneration of vulnerable urban fabrics in Babol must adopt a comprehensive and multidimensional approach. The use of modern technologies, community participation, and enhancement of the resilience of natural resources are among the essential strategies in this regard. Therefore, it can be concluded that the implementation of these measures can significantly improve the city's capacity to cope with floods and other natural hazards.

Citation: Fotouhi Ahli, F., Janbaz Ghobadi, GH., Motevalli, S., & Azimi Amoli, J. (2025). **Assessment and Evaluation of the Status of Vulnerable Urban Fabrics in Babol Neighborhoods against Flood Hazards**. *Journal of Land Use and Sustainable Development*, 2(1), 1-14. https://doi.org/10.82173/juep.2025.1210074

* **Corresponding author:** Gholamreza Janbaz Ghobadi **Email:** gghobadi@yahoo.com **Tel:** +09112469025

Introduction

In the face of today's escalating global risks and tensions, it is no longer feasible to respond reactively to sudden changes. In a world confronted by a complex set of evolving pressures, strategic thinking and adaptation are not only necessary but should also be viewed as an opportunity. For societies, the lack of such strategic adaptability can jeopardize public health, social cohesion, stability, and overall success (Pelling, 2013: 32).

The present study focuses on Babol, where the researcher aims to explore the regeneration of vulnerable urban fabrics in response to floods—one of the most persistent natural hazards threatening urban areas. The flooding of the Babolrud River is a major environmental threat in Babol. In its mountainous section, the river flows through a steep valley, but as it enters the Caspian coastal plain, the terrain slope drops significantly, transforming the river into a meandering stream. The land slope within Babol city ranges from 1.5 to 2 per thousand. As the river flows through the center of Babol, it passes near numerous urban neighborhoods. The minimal gradient of the coastal plain contributes to the river's meandering nature.

When embankments are constructed without adequate geological understanding or adherence to hydrological principles, they are quickly destroyed by the first flood event. An example is the Janbazan Bridge in the Chak-Sar neighborhood, a non-standard structure that sustains damage in every flood. A flood barrier has been built 30 kilometers from Babol to protect agricultural lands. The oldest significant flood event in recent memory occurred in 1976, when water levels reached five meters and overflowed the Mohammad Hassan Khan Bridge. The floodwaters penetrated up to 500 meters into the city, severely damaging citrus orchards and rice paddies. In the 1996 flood, nearly all buildings in the Mollakola neighborhood were destroyed. In the 2000 flood, the Vozdehkola Bridge was damaged, and concrete river walls suffered heavy destruction. In the 2005 flood, the Kamangar dirt road (2 km southeast of Amol) was seriously damaged. The high-risk flood zone of the Babolrud River begins 1.8 kilometers south of Babol and ends 800 meters north of the city. The flood-prone section of the river extends from the coastal road to Hamzeh-Kola, encompassing neighborhoods such as Oshib, Qazi-Kati, Darzi-Kati, and Sad Dastgah.

Additionally, urban neighborhoods in Babol are more vulnerable to flooding due to changes in ground permeability and increasing residential density. The city's geographical position—located along multiple watershed pathways—further emphasizes the necessity of predictive flood planning. Urban planners, geologists, and geographers must thoroughly assess the causes of such natural disasters and develop strategies to mitigate their effects. Consequently, addressing urban regeneration in response to natural hazards such as urban flooding is both vital and unavoidable.

Moreover, due to inadequate urban construction standards for natural disaster resilience, the urban system often lacks the dynamism and recoverability necessary during a crisis. Following the Islamic Revolution, population growth and rural-to-urban migration from surrounding villages to Babol have created numerous challenges. Limited urban expansion capacity, along with the proliferation of residential and commercial complexes and an inclination toward high-rise development, has led to environmental issues such as flooding, river pollution, rising temperatures, and unmanaged waste disposal. Socially, the city faces increased migration, settlement by non-native populations, and the spread of second homes. These conditions cast doubt on the effectiveness of Babol's most recent urban development plan in addressing such complex and multifaceted issues. Furthermore, many of the crises experienced in daily life are often intangible, leading to a lack of urgency in urban decision-making. As a result, these problems often remain at the level of damage assessment without progressing to actionable solutions.

This study seeks to explore the theoretical background of urban regeneration and its practical application in urban planning, specifically focusing on the concept of regeneration as a response to flood hazards. The study examines the role of urban regeneration components in addressing flooding and their transformative potential. The importance of regeneration lies in its ability to manage and organize urban spaces—especially rivers—and to revitalize and repurpose these areas under various conditions. In other words, this approach not only preserves the environmental, ecological, and structural conditions of urban

rivers but also strengthens their resilience to diverse disturbances.

Accordingly, this dissertation proposes a theoretical framework for urban regeneration in response to natural hazards, particularly flooding. The findings of this research will be significant for urban planners and designers in applying its recommendations to city development projects, as well as for urban policymakers and decision-makers in shaping strategic urban regeneration policies.

Table 1. Number of Floods in the Province over a Five-Year Period

Statistical Period	Number of Years	Number of Floods in the Province	Average Annual Occurrence
2011–2016 (1390–1395)	5	56	11.2

Source: Authors, 2025

Table 2. Recent Flood Events in Mazandaran Province

Flood Name	Cause	Casualties	Damages
October 2018	Heavy rainfall for approximately one day	6 dead and several injured	Destruction of several bridges and urban infrastructure; disruption of telecommunication networks in some areas
Late March 2019	Continuous rainfall, temperature drop, and soil erosion due to deforestation	Several dead and injured; large loss of livestock and poultry	Submergence of several villages, evacuation of others, disruption of drinking water supply, and railway damage
July 2020		2 dead and several injured	Damage to wheat fields close to harvest, as well as potato and orchard crops

Source: Authors, 2025

Table 3. Dimensions, Components, and Sub-Indicators of Urban Resilience

Dimension	Component	Indicators
Socio-Cultural	Awareness	Citizens' awareness of disaster risk – awareness of potential damages – awareness of building safety and resistance
	Knowledge	Citizens' knowledge of disaster causes – knowledge of appropriate behavior during disasters
	Skills	Skills of authorities in providing relief – citizens' psychological resilience during disasters
	Attitude	Household attitudes toward disasters – attention to building resistance
	Social Capital	Level of citizen interaction – trust in urban authorities – trust in public communications – crisis management effectiveness – volunteer cooperation in vulnerability reduction
Economic	Damage Severity	Safety of urban assets (homes, shops, etc.) against hazards – vulnerability and potential loss of jobs due to disasters
	Compensation Capacity	Potential for support from government and local institutions in compensating for damages
	Recovery Capacity	Ability to return to previous job and income conditions – citizens' professional and occupational skills
Institutional–Managerial	Institutional Infrastructure	Citizens' awareness of disaster management organizations – presence of volunteers and relief groups – adherence to preventive regulations – citizen participation in planning
	Institutional Relations	Communication with urban management institutions – preparedness of service organizations – training sessions held by institutions
	Institutional Performance	Citizens' satisfaction with the performance of crisis management institutions
Physical–Infrastructural	Building Resistance and Age	Quality of construction materials – structural condition of buildings

Dimension	Component	Indicators
	Incompatible Land Uses	Distance from man-made hazard zones (e.g., fuel stations, high-voltage power lines)
	Accessibility	Access to medical centers – access to main road networks
	Density	Building and population density
	Open Spaces	Access to parks and green spaces
Environmental	Site Characteristics	Distance from natural hazard-prone areas – geographical features
	Pollution	Water, air, and soil pollution
	Diversity and Sustainability	Environmental diversity – environmental sustainability
	Environmental Health	Quality and health of water, air, and soil

Source: (Rezaei, 2009); (Salehi et al, 2011); (Mohammadi & Pashazadeh, 2017)

Literature Review

The Concept of Urban Regeneration

In its literal sense, regeneration refers to the natural reproduction (or restoration) of a part of a living whole that has been subjected to deterioration or decay. Initially, the term urban regeneration was not distinct from urban renewal; however, over time, and in response to the negative consequences of urban renewal, it emerged as an independent concept. In other words, this transformation reflects a dual perspective of metamorphosis and sustainability, encompassing urban restoration and conservation, which collectively represent a form of "soft urbanism" (Tan et al., 2014). From this viewpoint, the restoration of urban heritage and the preservation of the physical structure of the old city are aligned with preparations to accommodate new urban functions (Latifi, 2013).

Urban regeneration refers to a comprehensive and integrated approach and practice aimed at resolving urban issues in targeted areas. Ultimately, it leads to sustainable economic, physical, social, and environmental advancement (Boyle et al., 2018).

Dimensions of Urban Regeneration

Urban regeneration occurs across multiple dimensions social, economic, physical, and environmental each emphasizing specific objectives:

≠ Physical regeneration involves assessing the structural elements of urban fabric, identifying limitations and latent potentials, and aligning the physical city with rapid economic and social transformations.

≠ Economic regeneration generally includes strategies such as attracting domestic investments, encouraging self-employment, creating temporary and part-time jobs, enhancing education, increasing professional skills, and reducing living costs.

≠ Social and cultural regeneration focuses on minimizing crime and violence, providing adequate healthcare services, reducing cultural deviance, strengthening micro-communities, empowering local groups, and addressing the needs of diverse population segments.A key dimension of urban regeneration is sustainability. The approach known as sustainable urban regeneration represents one of the most recent and widely accepted global strategies for addressing deteriorated urban areas. It aims to establish a continuous and sustainable process of urban development. On one hand, it seeks to make optimal use of internal urban potentials to meet new needs; on the other hand, it prioritizes the revitalization of old urban fabrics and the restoration of social life and economic vibrancy.

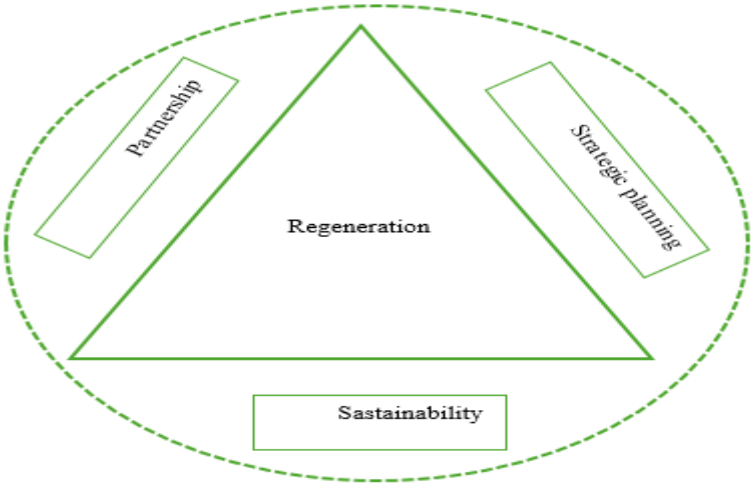

Fig 1. illustrates the main components of urban regeneration
Source: (rasouli et al., 2021: 89)

Review of Key Perspectives in Urban Regeneration

Urban regeneration, in its general definition, emerged after numerous reforms to the urban renewal process. It is now considered an integrated approach encompassing both physical and functional considerations, reflected through several sub-approaches and narratives. Therefore, urban regeneration can be defined as a comprehensive and integrated view, along with a set of actions that lead to solving urban problems and ensuring continuous improvement in the economic, physical, social, and environmental conditions of a changing area.

Table 4. Perspectives Influencing Urban Regeneration

Perspective	Key Considerations	Source
Culturalism	- Emphasis on cultural heritage and prevention of historical loss. - Consideration of national culture and traditional values in urban development, rehabilitation, and restoration. - Completion of buildings in historical style, museum-like use, and restoration of urban fabric.	Habibi, 1996: 1
Humanism	- Focus on nature and culture. - Attention to human movement within urban spaces. - Drawing inspiration from hidden structures and highlighting them in urban renewal. - Improving urban environments and residents' quality of life with citizen participation. - Integration of restoration projects with spatial planning and geographic studies. - Conducting regeneration based on the organic fabric and functional hierarchy of historic cities, considering spatial-temporal alignment with urban planning studies	Hall, 1995: 229
Intermediate/Realist	- Views the historic urban fabric as a heterogeneous and uneven whole, ranging from highly valuable heritage sites to severely deteriorated zones, some of which may lack preservation value altogether	Arman Shahr, 2007: 14

Source: Zangiabadi & Moeidfar, 2012: 316

Natural Hazards

0 Natural hazards refer to sudden events that cause harm to humans and the environment. These events include earthquakes, floods, volcanic eruptions, storms, locust infestations, and the like (Crisis Management Organization, 2016).

0 Natural disasters are defined as incidents that impact the lives and security of people and

cannot be managed through ordinary resources. Disasters can be categorized into:

0 Climatic hazards (e.g., floods, droughts, frost, lightning, sandstorms, avalanches, cold spells, forest fires)

0 Geotectonic hazards (e.g., earthquakes, landslides, rockfalls)

0 Human-induced hazards (e.g., incidents caused by human activity)

Different Definitions of Natural Disasters:

≠ Manitoba Emergency Measures Organization (2006): Any actual or anticipated event that threatens the life, safety, welfare, or health of a group or entire population and cannot be managed through regular governmental services.

≠ Fritz (1961): An event occurring in a specific time and place that affects a portion of society, causing damage to the physical environment and disrupting social functioning.

≠ Burton & Kates (1964): A component of the physical environment that is harmful to humans and caused by external forces (Ramazanzadeh Lasbouei & Badri, 2014).

Urban Vulnerability Factors:

Rapid population growth and high density in hazard-prone areas

Lack of local resources and capacities

Weak local governance and poor participatory planning

Inadequate water management and poor drainage infrastructure

Ecosystem degradation due to human activity (e.g., road construction, pollution, wetland reclamation)

Aging infrastructure and unsafe building materials

Poorly coordinated emergency services

Climate change affecting the frequency, intensity, and location of floods and other natural disasters

(Hyogo Framework for Action, UNISDR, 2012)

Floods

Floods are the result of hydrological and topographical conditions in flood-prone areas, wherein river discharge exceeds the river channel capacity and spills over into the floodplain. A flood occurs when the river channel cannot contain the excessive flow. Technically, a flood involves the rise of water levels in rivers and channels, causing overflow into adjacent plains, which can damage infrastructure, public facilities, and cause loss of life and livestock.

Flooding can also result from rising water levels in lakes or seas, where strong winds exacerbate the situation (Zand-Moghaddam et al., 2019, p. 84).

During rainfall or snowmelt, a portion of water is absorbed by soil and vegetation, some evaporates, and the rest becomes surface runoff. Flooding occurs when the soil and vegetation cannot absorb the precipitation, and the natural channel lacks the capacity to carry the runoff. On average, about 30% of rainfall becomes runoff—a rate that increases with snowmelt.

Flood events create an area known as a *floodplain* around the river. River floods are mostly caused by intense rainfall, sometimes accompanied by snowmelt. A *flash flood* refers to a sudden flood with little or no warning, typically in small catchments, often resulting in higher fatalities compared to larger river floods (Dorfesh et al., 2020: 169).

Motevalli et al. (2022), in their article titled "Analysis of Urban Resilience to Floods (Case Study: District 2 of Sari City)", concluded that factors such as the formation of deteriorated urban fabric, impervious surfaces, weak management, unemployment, underutilized critical areas, and a large number of vulnerable individuals have contributed to the low level of resilience in this area. The study emphasizes the necessity of solutions such as increasing public participation in regional management and enhancing coordination and integration in local governance under the guidance of urban management to address these issues and improve resilience.

Research Background

Motavalli et al. (2021), in their study entitled"Identifying the Components of Resilience in Coastal Border Cities to Natural Hazards: Case Study of Behshahr", found that the overall resilience status of Behshahr, a coastal border city, was unsatisfactory. The empirical mean obtained for overall urban resilience and its dimensions was below the medium threshold value of 3. Among the six

studied zones, Zone 3 showed relatively better conditions compared to others, while Zone 4 had the poorest status with an average score of 2.43. Another key finding of the study was that among the urban resilience components, the "physical component" had the greatest path coefficient (0.376) and the most significant impact, whereas the institutional-managerial component had the lowest path coefficient (0.168), indicating the least influence on urban resilience.

Prawira et al. (2024), in their article "Community Empowerment in Sustainable Outdoor Tourism in the Pangandaran Tourism Destination", applied a qualitative approach to investigate various forms of local community participation in the tourism industry of Pangandaran, Indonesia. The results show that Pangandaran features 270 tourist attractions—64% natural, 27% cultural, and 9% man-made. The highest concentration of these attractions was observed in the Parigi area, indicating the region's strong potential for tourism development. Notable growth in restaurants (a 34.1% increase in 2023 compared to the previous year) and small businesses (over 700% growth between 2020 and 2021) reflects economic dynamism and the close connection between the local economy and the tourism industry. The active engagement of the community in professional tourism associations (e.g., a cycling association with 310 members and a boating group with 150 members) demonstrates a robust network and the crucial role of local stakeholders in the sustainable development of tourism. Despite these strengths, the study identified challenges such as infrastructure strain during peak tourist seasons, insufficient awareness of sustainable tourism practices among residents, and limited access to education and financial resources. Moreover, the conflict between environmental conservation and local livelihoods remains a key barrier to sustainable development. The authors highlight the importance of improving public education on environmentally friendly practices and establishing collaborative frameworks among stakeholders to foster a sustainable tourism ecosystem. Proposed strategies include infrastructure upgrades, educational programs, and facilitating financial access to enhance the role of the local community in the tourism sector. Ultimately, the study concludes that by addressing these challenges and leveraging local capacities, Pangandaran can serve as a successful model for balanced and sustainable tourism development across economic, cultural, and environmental dimensions.

Risfandini (2024), in her article "Implementing Sustainable Tourism in Indonesia: Emphasizing Green Tourism, Community-Based Tourism, and Local Empowerment", explores the key concepts of sustainable tourism development in Indonesia. Using a systematic literature review method, the study analyzes previous research in the field of sustainable tourism. Three core concepts—green tourism, community-based tourism, and local empowerment—are identified as essential pillars of sustainable development. The findings indicate that green tourism requires the active involvement of all stakeholders, including the government, local communities, and tourists. Success in this area depends on appropriate policymaking, environmental certifications, and related education. Community-based tourism contributes to the preservation of natural and cultural resources while enhancing the economic and social well-being of host communities. Local empowerment—particularly through the penta helix model (collaboration among government, industry, academia, community, and facilitators)—is considered a fundamental driver of sustainable tourism. The study also recommends further quantitative research to evaluate the effectiveness of these strategies and calls for empirical testing of step-by-step models for empowering local communities.

The Area under Study

Babol is one of the central cities of Mazandaran Province, located 217 kilometers northeast of Tehran and 48 kilometers from the provincial capital, Sari. It is bordered by Amol to the west, Babolsar and the Caspian Sea to the north, Qaemshahr to the east, and the Alborz mountain range to the south. Geographically, Babol is situated at approximately 36°34′N latitude and 52°44′E longitude.

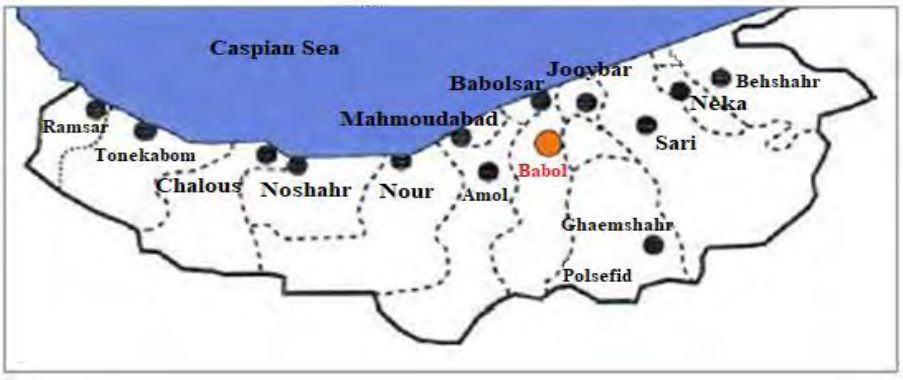

Fig 2. The Area under Study
Source: Haft Shahr Arya Consulting Engineers, 2009

Methodology

The present study is descriptive–analytical in nature and applied–developmental in terms of its objectives. The main goal is to regenerate vulnerable urban fabrics in the city of Babol in the face of flood risk. To achieve this goal, effective indicators for the regeneration of vulnerable urban areas were first identified through a combination of library research and field studies. Specifically, theoretical foundations were reviewed, and relevant indicators and sub-indicators were recognized.

To prioritize the identified indicators affecting the regeneration of vulnerable urban areas in the context of natural hazards, particularly flooding in Babol, the Friedman test was employed using SPSS software. To assess the degree of impact of each indicator, a single-sample t-test was conducted using expert questionnaire responses. Additionally, multiple linear regression was applied to analyze the current condition of vulnerable urban fabrics in Babol against flood threats. Finally, practical strategies for improving the situation were proposed.

The reliability of the questionnaire was confirmed through Cronbach's alpha coefficient, which yielded an acceptable value indicating high internal consistency of the research instrument. The validity of the questionnaire was ensured through expert reviews and academic feedback.

Results and Discussion

To achieve the main objective analyzing the regeneration of vulnerable urban fabrics in Babol in the face of flood risks various methods and techniques were utilized.

Main Hypothesis Test

H : Regeneration of vulnerable urban fabrics in Babol is not adequate against flood risks.

To examine whether the regeneration of vulnerable urban fabrics in Babol is adequate or not based on the views of both citizens and experts a one-sample t-test was conducted. The results are presented in Table 5.

Table 5. Assessment of the adequacy of regeneration of vulnerable urban fabrics in Babol against flood risk

Variable	Sample	N	Mean	SD	t-value	df	Sig. (p-value)
Regeneration	Citizens	384	3.735	0.696	20.709	383	0.000
	Experts	30	2.918	0.221	-2.027	29	0.052
Combined		-	3.327	0.459	9.341	-	0.026

Source: Research Findings, 2025

Based on Table 5, citizens reported a mean score of 3.735 with a t-value of 20.709 and a significance level of 0.000, indicating that regeneration efforts are perceived as adequate. However, experts reported a lower mean of 2.918 (below the theoretical average of 3), and a negative t-value of -2.027 with a borderline significance level of 0.052, suggesting that, from their perspective, regeneration is insufficient.

Considering the aggregated responses from both groups, the overall mean was 3.327, with a t-value of 9.341 and a significance level of 0.026. Therefore, the null hypothesis is rejected, and it can be concluded that regeneration of vulnerable urban fabrics in Babol is considered adequate against flood risk.

First Sub-Hypothesis Test

H : Physical–infrastructural–environmental components contribute to the regeneration of vulnerable urban fabrics in the face of flood risks.

To evaluate whether physical, infrastructural, and environmental components play a role in the regeneration process, a one-sample t-test was conducted using responses from both citizens and experts. The results are presented in Table 6.

Table 6. Role of physical–infrastructural–environmental components in the regeneration of vulnerable urban fabrics against flood risk

Variable	Sample	N	Mean	SD	t-value	df	Sig. (p-value)
Physical–Infrastructural–Environmental	Citizens	384	3.766	0.826	18.187	383	0.000
	Experts	30	3.069	0.277	1.371	29	0.181
Combined		-	3.418	0.552	9.779	-	0.091

Source: Research Findings, 2025

According to Table 6, the overall mean for this variable was 3.418, which is above the theoretical average of 3. The t-value of 9.779 confirms the positive and statistically significant influence of these components. Hence, the first sub-hypothesis is confirmed: physical, infrastructural, and environmental components play a key role in the regeneration of vulnerable urban fabrics against flood risk.

Testing the Second Sub-Hypothesis

Second Sub-Hypothesis:

Socio-economic components can contribute to the regeneration of vulnerable urban fabrics in response to flood hazards.

To analyze whether socio-cultural and economic components can support the regeneration of vulnerable urban areas in Babol against flood hazards, the one-sample t-test was employed, based on responses from citizens and experts. The results are presented in Table 7.

Table 7. Effects of Socio-Cultural and Economic Components on the Regeneration of Vulnerable Urban Fabrics against Flood Hazards

Variable	Sample	N	Mean	SD	t-value	df	Sig. Level
Socio-Cultural	Citizens	384	3/522	0/593	17/277	383	0.000
	Experts	30	3/394	0/268	8/054	29	0.000
Economic	Citizens	384	3/787	0/736	20/96	383	0.000
	Experts	30	2/560	0/199	-12.092	29	0.000
Combined		-	3/316	0/449	8/538	-	0.000

Source: Research Findings, 2025

Based on Table 7 and the perspectives of citizens and experts, the overall mean of the socio-cultural and economic variables was calculated as 3.316, which is higher than the theoretical median. With a significance level of 0.000, the overall t-value of 8.538 indicates a statistically significant positive impact. This confirms that socio-cultural and economic components play an important role in the regeneration of vulnerable urban fabrics in response to flood hazards. Hence, the second sub-hypothesis is supported.

Testing the Third Sub-Hypothesis

Third Sub-Hypothesis

Institutional components influence the regeneration of vulnerable urban fabrics in response to flood hazards.

To assess whether institutional components contribute to the regeneration of vulnerable urban areas in Babol against flood hazards, the one-sample t-test was employed using responses from citizens and experts. The findings are summarized in Table 8

Table 8. Effects of Institutional Components on the Regeneration of Vulnerable Urban Fabrics against Flood Hazards

Variable	Sample	N	Mean	SD	t-value	df	Sig. Level
Institutional	Citizens	384	3/866	0/804	21/110	383	0.000
	Experts	30	2/650	0/637	-3/011	29	0/005
Combined		-	3/258	0/721	9/0495	-	0/0025

Source: Research Findings, 2025

According to Table 8, the mean score for the institutional variable was 3.258, exceeding the theoretical median. The positive t-value (9.0495) with a significance level of 0.0025 indicates that institutional (i.e., governance and management) components have a significant and positive effect on the regeneration of vulnerable urban fabrics in the face of flood hazards. Thus, the third sub-hypothesis is confirmed.

Testing the Fourth Sub-Hypothesis

Fourth Sub-Hypothesis:

Each component of urban regeneration has a different level of contribution to the regeneration of vulnerable neighborhoods in response to flood hazards.

To evaluate the relative contribution and impact of each urban regeneration component in vulnerable neighborhoods of Babol when facing natural hazards such as floods, separate analyses of citizen and expert opinions were conducted using one-sample t-tests. The results from citizens' responses are shown in Table 9.

Table 9. Effects of Urban Regeneration Components on Vulnerable Urban Fabrics in Babol (Citizen Perspectives)

Variable	N	Mean	SD	t-value	df	Sig. Level
Socio-Cultural	384	3/522	0/593	17/277	383	0/000
Economic	384	3/787	0/736	20/964	383	0/000
Institutional	384	3/866	0/804	21/110	383	0/000
Physical–Infrastructure–Environmental	384	3/766	0/826	18/187	383	0/000

Source: Research Findings, 2025

Based on the data in Table 9 and citizen responses, institutional components exhibit the highest mean score, indicating they have the most significant effect on the regeneration of vulnerable urban fabrics in Babol against flood hazards. This highlights the varying degrees of influence that each regeneration component exerts on flood risk mitigation in vulnerable neighborhoods.

Table 10. Effects of Urban Regeneration Components on Vulnerable Urban Fabrics in Babol against Flood Hazards (Expert Perspectives)

Variable	N	Mean	SD	t-value	df	Sig. Level
Socio-Cultural		3/394	0/268	8/054	383	0/000
Economic	30	2/560	0/199	-12/092	383	0/000
Institutional	30	2/650	0/637	-3/011	383	0/005
Physical–Infrastructure–Environmental	30	3/069	0/277	1/371	383	0/181

Source: Research Findings, 2025

According to Table 10 and the views of experts, the socio-cultural component had the highest effect on the regeneration of vulnerable urban fabrics in Babol against flood hazards, compared to other variables. As shown, each component of urban regeneration exhibits a different level of impact, emphasizing the varied contribution of each dimension.

To further illustrate this difference, Chart 1 displays the comparative influence and contribution of each urban regeneration component on vulnerable urban areas from the perspectives of both citizens and experts.

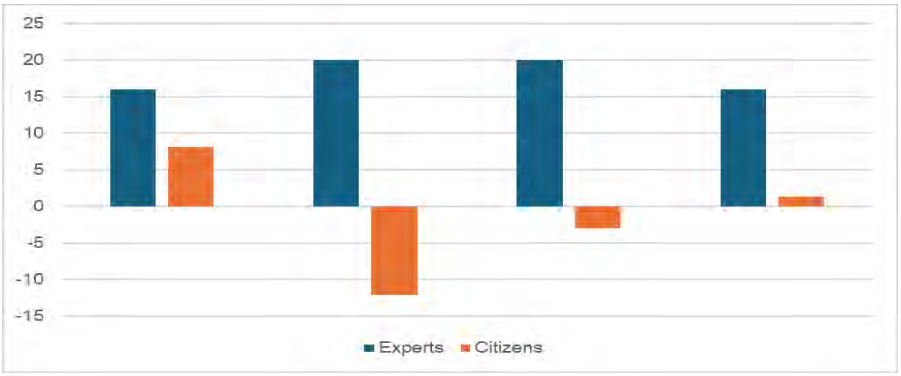

Fig 3. Comparative Effects and Contributions of Urban Regeneration Components on Vulnerable Urban Fabrics in Babol (Citizens vs. Experts) Source: research findings, 2025

Based on the above analysis, it can be concluded that each urban regeneration component contributes differently to the regeneration of vulnerable neighborhoods against flood hazards. Therefore, the fourth sub-hypothesis of this study is confirmed.

Qualitative Data Analysis: Thematic Analysis of Urban Regeneration Dimensions

In the qualitative part of the study, a thematic analysis was conducted to identify the key dimensions and indicators of urban regeneration in vulnerable urban fabrics of Babol in the context of flood risk. The findings, based on expert interviews, are presented in Table 11.

Table 11. Thematic Analysis Results Based on Expert Interviews

Dimension	Indicator	Dimension	Indicator
Socio-Cultural Regeneration	Education and Awareness	EconomicVRegneration	Financial Crises
	Participation and Cooperation		Economic Sustainability
	Community Empowerment		
	Population Density		Employment Conditions
	SocialISustainability		
	EmergencyMResponse Groups		
Institutional Regeneration	New Technologies	Physical–Infrastructure–Environmental	Land Use Buffers
	Water Resource Management		Accessibility
	Urban Planning Research		Structural Resilience
	Protective Structures		Infrastructure
	Crisis Management		Green and Open Spaces
	Sustainable Development Planning		Environmental Pollution |
	Natural Resource Conservation		

Source: research findings, 2025

Conclusion

The evaluation of the socio-cultural regeneration status from the citizens' perspective revealed that they believe there are favorable conditions in terms of education and awareness-raising, cooperation and

participation, social sustainability, and emergency response groups. However, the indicators of community empowerment and population density require improvement. These insights can serve as a guide for future planning and interventions in these areas.

In assessing the economic regeneration status, the citizens rated the indicators of "financial crises," "economic sustainability," and "employment situation" above the theoretical mean (value = 3), indicating their relative satisfaction with the current state of financial and economic conditions in the city.

Regarding institutional regeneration, citizens expressed satisfaction with the status of modern technologies, water resource management, urban planning research, protective structures, crisis management, sustainable development plans, and the management and conservation of natural resources in their locality. These results suggest that urban management and related authorities have performed relatively well in these areas, contributing positively to the city's development trajectory.

The assessment of the physical–infrastructural–environmental dimension also showed that citizens are generally satisfied with the current state of this domain. Indicators such as zoning regulations, accessibility, structural retrofitting, infrastructure, green and open spaces, and environmental pollution were rated positively, forming a solid basis for further improvement and development.

The prioritization of urban regeneration indicators for vulnerable urban fabrics in Babol against flood risks revealed that from the citizens' perspective, "natural resource management and conservation" held the highest priority, followed by "sustainable development plans," while "community empowerment" and "population density" ranked lowest. Experts generally evaluated the socio-cultural dimension of regeneration in Babol as favorable but highlighted the need for stronger focus on community empowerment and the formation of emergency response groups to enhance resilience. The low scores of cooperation, participation, and population density indicated deficiencies requiring targeted interventions. Economically, experts found employment conditions weaker than overall economic sustainability, implying the necessity of more comprehensive policies to mitigate potential labor market challenges. Within the institutional dimension, modern technologies and sustainable planning received positive evaluations, yet weaknesses persisted in water management, urban planning research, protective structures, crisis management, and natural resource conservation, revealing structural gaps in urban resilience. Regarding the physical, infrastructural, and environmental aspects, experts considered the general condition relatively good, particularly in terms of accessibility, retrofitting, green spaces, and pollution control; however, zoning and infrastructure regulations remained problematic. Overall, socio-cultural indicators such as education and awareness, community empowerment, social sustainability, and emergency preparedness demonstrated significant positive effects on regeneration, whereas cooperation, participation, and population density exhibited below-average means with statistically insignificant or negative impacts. These findings underscore the multidimensional nature of urban regeneration in Babol and the urgent need for integrated policies addressing social, economic, institutional, and environmental vulnerabilities to enhance the city's adaptability to flood risks.

In the economic domain, "financial crisis management" had a strong positive effectIonI post-disaster regeneration, with a mean above the theoretical average and significant impact. In contrast, "economic sustainability" and "employment situation" were rated lower and showed minimal influence on regeneration efforts, underscoring the need to consider broader dimensions of crisis management and resilience building.

The institutional dimension analysis showed that modern technologies and sustainable development plans significantly impacted the regeneration of vulnerable areas, with above-average ratings and positive statistical significance. In contrast, indicators such as water resource management, urban research, protective structures, crisis management, and natural resource conservation showed low means and insignificant or negative effects, highlighting the need for increased attention to these institutional mechanisms.

Finally, the physical–infrastructural–environmental indicators of accessibility, retrofitting, green/open spaces, and pollution control demonstrated strong influence on regeneration, with above-average means and

statistically significant impacts. Conversely, zoning regulations and infrastructure were found to have low influence and remain key priorities for future planning and investment

Research Recommendations

0 Investigate the effects of climate change on flood generation and regeneration of vulnerable urban fabrics.

0 Explore innovative urban flood management approaches.

0 Assess the socio-economic impacts of other natural hazards (e.g., earthquakes, storms) on urban populations.

0 Conduct comparative studies of international best practices in urban regeneration.

0 Evaluate the role of emerging technologies in regenerating vulnerable urban fabrics.

0 Develop comprehensive natural hazard risk management plans for vulnerable urban areas.

References

Aghaeizadeh, E., Hessam, M., & Mohammadzadeh, R. (2019). Study of social capital in the process of urban regeneration in problematic fabrics (Case study: Rasht). Urban Structure and Function Studies, 6(19), 145–167. [In Persian]. https://doi.org/10.22080/shahr.2019.15457.1685.

Ahadnezhad, M., Heidari, M. T., & Moharami, S. (2020). Social regeneration of historical fabric with an urban tourism approach (Case study: Historical fabric of Zanjan). Regional Planning, 10(2–3), 947–960. [In Persian]. https://ensani.ir/fa/article/481655.

Akbari, P., Habibi, K., & Ahmadi, M. (2022). Explanation and evaluation of creative space-based urban economy regeneration with a branding approach (Case study: Sanandaj). Geography and Urban Space Development, 9(1), 33–52. [In Persian]. https://civilica.com/doc/1477607

Allam, Zaheer. Dhunny, A. Zaynah. Siew, Gaetan. Jones, David, S. (2018) Towards Smart Urban Regeneration: Findings of an Urban Footprint Survey in Port Louis, Mauritius, smart Cities, 1(1), 121-133. https://doi.org/10.3390/smartcities1010007.

Amirkhanlou, S., Kordavani, P., & Mahdavi Hajilouei, M. (2023). Analysis of environmental capacities for sustainable tourism development in rural areas (Case study: Central district of Galugah County), 2(4), 320–332. [In Persian]. https://doi.org/10.22034/el.2024.432224.1019.

Bates, B. C.; Kundzewicz, Z. W.; Wu, S. And Palutikof, J. P. (2008). Climate change and water. Technical paper of the intergovernmental panel on climate change, IPCC secretariat, Geneva, Climate Change Policy with a Renewed Environmental Ethic, 21: 85-101. https://archive.ipcc.ch/pdf/technical-papers/climate-change-water-en.pdf

Becker, P. (2014). Sustainability science: Managing risk and resilience for sustainable development. https://www.sciencedirect.com/book/9780444627094/sustainability-science.

Bertilsson, L. And Wiklund, K. (2015). Urban Flood Resilience-A case study on how to integrate flood resilience in urban planning. TVVR-15/5005. https://www.lunduniversity.lu.se/lup/publication/8161043.

Bottero, M., Mondini, G., & Oppio, A. (2016). Decision support systems for evaluating urban regeneration. Procedia-Social and Behavioral Sciences, 223, 923-928. https://doi.org/10.1016/j.sbspro.2016.05.319

Boyle, L., Michell, K., & Viruly, F (2018), A Critique of the Application of Neighborhood Sustainability Assessment Tools in Urban Regeneration, Sustainability, 10(4), 1005. DOI:10.3390/su10041005

Capolongo, Stefano. Sdino, Leopoldo. Dell'Ovo, Marta. Moioli, Rossella. Torre, Stefano Della (2019), How to Assess Urban Regeneration Proposals by Considering Conflicting Values, Sustainability, 11(14), 3877. https://ideas.repec.org/a/gam/jsusta/v11y2019i14p3877.

Chao, J. C., & Hsu, K. W. (2018, June). The Impact of Taiwan's Urban-renewal Policies, Laws and Decrees on Urban Redevelopment and Urban Disaster Prevention. In IOP Conference Series: Earth and Environmental Science (Vol. 164, No. 1, p. 012034). IOP Publishing. **DOI** 10.1088/1755-1315/164/1/012034

Chen, Y.; Zhou, H.; Zhang, H.; Du, G. And Zhou, J. (2015). Urban flood risk warning under rapid urbanization, Environmental research, 139: 3-10. https://doi.org/10.1016/j.envres.2015.02.028

Derafshi, Kh., Sadough, H., Mehrjounnejad, A., & Khaledi, Sh. (2020). Micro-zoning of flood vulnerability in Babol City. Biannual Journal of Sustainable Development of Geographic Environment, 2(2), 150–167. [In Persian]. https://doi.org/10.52547/sdge.2.2.150

Esmaeilpour, N., Mahmoudi, V., & Esmaeilpour, F. (2018). Assessment of social capacity building in urban neighborhoods and its relation to participation in regeneration of deteriorated urban areas (Case study: Fahadan neighborhood, Yazd). Urban and Regional Development Planning Quarterly, 3(5), 143–181. [In Persian]. https://doi.org/10.22054/urdp.2020.44395.1141.

Haft Shahr Arya Consulting Engineers. (2010). Renovation and rehabilitation plan for deteriorated urban fabric of Babol. [In Persian].

Hassanzadeh Tavakoli, S., Zandmoghadam, M. R., & Karkehabadi, Z. (2019). Evaluation of resilience in deteriorated fabrics against natural hazards (Case study: Semnan). Journal of Sustainable City, 2(4), 83–99. [In Persian]. 10.22034/jsc.2020.222328.1210.

La Rosa, D., Privitera, R., Barbarossa, L., & La Greca, P. (2017). Assessing spatial benefits of urban regeneration programs in a highly vulnerable urban context: A case study in Catania, Italy. Landscape and Urban Planning, 157, 180-192. https://doi.org/10.1016/j.landurbplan.2016.05.031

Latifi, Gh., & Safari Chabok, N. (2013). Regeneration of the neighborhood concept in Iranian-Islamic cities based on the principles of New Urbanism. Urban Studies Journal, 2(8), 3–12. [In Persian]. https://urbstudies.uok.ac.ir/article_6418.html

Liu, G., Yi, Z., Zhang, X., Shrestha, A., Martek, I., & Wei, L. (2017). An evaluation of urban renewal policies of Shenzhen, China. Sustainability, 9(6), 1001. https://doi.org/10.3390/su9061001

MirAsadollahi, Sh. S., Motevalli, S., & Janbaz Ghobadi, G. (2020). Role of urban resilience components in reducing flood damage (Case study: Gorgan). Journal of Spatial Planning, 10(38), 71–88. [In Persian]. https://ensani.ir/fa/article/491931/

Prawira, M. F. A., Prawira, A. B. A., & Susanto, E. (2024). Community empowerment on sustainable outdoor recreation in Pangandaran tourist destination. Jurnal Ekonomi dan Bisnis, 15(4), September 2024. https://journal.ikopin.ac.id/index.php/covalue/article/view/4755.

Rafieian, M., & Motahari, Z. S. (2012). Designing a model for community-based disaster risk management. Crisis Management Research Journal, 12(1), 1–5. [In Persian]. https://www.sid.ir/paper/226013/fa

Ramezanzadeh Lasboei, M., & Badri, S. A. (2014). Explaining the socio-economic structures of local community resilience against natural disasters with emphasis on floods (Case study: Tourism basins of Tonekabon and Kelardasht). Journal of Geography, 12(40), 109–131. [In Persian]. https://mag.iga.ir/article_253525.html

Rasouli, M., Ahadnezhad, M., & Heidari, M. T. (2021). Explaining urban fabric regeneration using integrated FEMA and SMART PLS methods (Case study: Zanjan). Journal of Geography and Urban-Regional Planning, 11(40), 87–104. [In Persian]. https://doi.org/10.22111/gaij.2021.6512.

Rezaei Tabar, Z., Motavalli, S., & Janbaz Ghobadi, G. (2024). Analysis of local community empowerment for sustainable tourism development with emphasis on natural potentials (Case study: Mahmoudabad). Geographical Research, 40(1). [In Persian]. https://georesearch.ir/article-1-1672-fa.html

Risfandini, A. (2024). Sustainable tourism implementation in Indonesia: Emphasizing green tourism, community-based tourism, and local empowerment. BARISTA: Jurnal Kajian Bahasa dan Pariwisata, 11(1), 58–67. http://dx.doi.org/10.34013/barista.v11i01.1506 https://doi.org/10.34013/barista.v11i1.1506

Sayyadnia, H., Motavalli, S., Janbaz Ghobadi, G., & Azimi Amoli, J. (2022). Urban flood resilience analysis (Case study: District 2 of Sari). Journal of Urban Management and Energy Sustainability (JUMES), 4(2), 275–288. [In Persian]. https://sanad.iau.ir/Journal/geography/Article/857717.

Sutton, S. A. (2008). Urban revitalization in the United States: Policies and practices. United States Urban Revitalization Research Project (USURRP). https://www.columbia.edu/cu/c2arl/pdf_files/USURRP_Phase_I_Final_Report.pdf.

Tan, S, K., Luh, D. B., and Kung, S. F., (2014) A Taxonomy of Creative Tourists in Creative Tourism. Tourism Management, 42, pp: 248-259. https://doi.org/10.1016/j.tourman.2013.11.008.

Torabi, A., Motavalli, S., & Janbaz Ghobadi, G. (2021). Identification of urban resilience components in coastal border cities against natural hazards (Case study: Behshahr). Border Science and Technology Quarterly, 10(4), 161–190. [In Persian]. https://www.sid.ir/paper/410481/fa.

Zangiabadi, A., & Moeidfar, S. (2012). Urban regeneration approach in deteriorated fabrics: The Six-Badgiri district of Yazd. Armanshahr Architecture and Urban Development, 5(10), 297–314. [In Persian]. https://www.armanshahrjournal.com/article_33263.html

Zhai, B., & Ng, M. K. (2013). Urban regeneration and social capital in China: A case study of the Drum Tower Muslim District in Xi'an. Cities, 35, 14-25. https://doi.org/10.1016/j.cities.2013.05.003.