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**Original Research Article**

# Seasonal Urban River Restoration Strategies in Face with Environmental Hazards Based on an Ecological Resilience Approach

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Abstract | Resilience is a response to the crisis in the face of environmental risks in today's changing world. Seasonal urban rivers are one of the causes of environmental hazards in cities whose characters are subject to change during droughts and floods. They have often been turned into channels for flood control and have lost their ecological identity. Developing the best strategy for the resilience of seasonal urban rivers requires research on the contribution of the resilience approach to the preservation of seasonal urban river ecosystems against environmental hazards. Moreover, the way to implement such a strategy could be a response to the crisis. This resilience approach research examines and criticizes the field of ecology and is concerned with preserving urban rivers according to their ecological structure. Based on the literature review in the two fields of resilience and ecology, principles and components were identified and analyzed using a deductive-inferential method. As a result, the best macro strategy for seasonal urban river ecological resilience is process-based river restoration, driven by the ecological structure of the river ecosystem, which is made possible by micro-strategies such as understanding the main causes of ecosystem degradation or change, determining physical, chemical, and biological processes, sustainable watershed management, increasing the resilience of river ecosystems in the face of future environmental hazards, preventing human interference in natural processes, and creating a new balance between socio-economic needs. This research presents strategies to create diversity in plant and animal species in the riverbed, generate modularity in the ecological patches of the river ecosystem, improve the services of the river ecosystem, limit and control the effects of ecological variables that are associated with the river, adapt river restoration to slow key variables, develop regulations based on non-human interference in the structure of the river ecosystem, raise cultural awareness in this area using social capital, and ecological innovation in creating sustainable conditions after the crisis and disruption.

Keywords | *Seasonal urban rivers, Environmental hazards, Resilience, Ecology, River restoration.*

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Introduction| Natural disasters are one of the main challenges confronting developing countries, wreaking havoc on social and economic situations at the local and regional levels, leading to the destruction or delay of development goals. Such hazards can turn into very horrific and devastating disasters for human societies if the necessary measures are not taken. In the meantime, floods are considered one of the most common natural hazards in the world today, causing extensive damage and destruction, endangering the lives of thousands of people, and inflicting severe damage on their property. Compared to other natural disasters, floods account for about 20% of deaths and 33% of global economic damage (Davis & Izadkhah, 2008). Meanwhile, the development process of some countries leads to an increase in the destruction of the environment and natural resources, which in turn increases the damage caused by floods. The information provided by the Forestry Organization to Hamshahri News Agency in July 2022 shows that in the last 70 years, 8449 floods have occurred in Iran. Fars, Golestan, Khorasan Razavi, Hormozgan, Sistan, and Baluchestan provinces have hosted 43% of the total floods in the last 20 years. These five provinces have been the sites of 1923 small and large floods since 2001 and are the main victims of this environmental phenomenon (Ten flood-prone provinces of Iran, 2022). Flooding is often caused by urban rivers.

The river is part of the city's important network, and its survival is dependent on its maintenance. Managers and urban planners have employed a variety of techniques to cope with the natural risks of rivers in the past. The porcelain wall and concreting the beds of urban rivers are the most common actions in this sector. This rigorous engineering technique has been utilized many times as a long-standing solution for most metropolitan rivers, yet floods continue to harm urban settings, particularly areas near rivers. Furthermore, over time, flood control canals destroy river structures by decreasing the river's ecological efficiency (Saeedi, 2020). The natural structures of rivers are gradually changing as a result of ecological challenges, and their ecosystem functions are being disturbed.

Some river basins are facing greater floods, while others are gradually drying up. There are numerous seasonal urban rivers in Iran, such as the Mehraneh River in Tabriz, the Qamroud River in Qom, and the Khoshk River (Khorram Dareh) in Shiraz, passing through the city. The above-mentioned urban rivers are reciprocally influenced by the pattern of urban growth. Due to such growth in recent years, and along their routes covered primarily with concrete and stone walls, using technical solutions, they have turned into flood repellants. Due to the increase in the numbers of social and residential nuclei surrounding them, the riparian zones have been reduced to a great extent and a portion of them has been granted to riders. In addition to hiding the rivers' natural faces, such actions have reduced the spatial quality of the rivers and harmed their vitality. In recent years, studies have been conducted to change the status of inner-city rivers in some cities in Iran. Ghazavi, Haghighatbin, and Bemanian (2019) conducted a study on the factors affecting the sustainable design of the ecological landscape of the Zayandehrood in Isfahan during the drought and defined the stability of the river landscape in physical, social, and semantic dimensions. Then, they proposed ecological, social, and economic strategies and solutions that contribute to the conservation of the nature of the river in the environment.

To promote a sustainable landscape for the Khoshk River in Shiraz, Pourjafar, Ahmadi, and Sadeghi (2015) examined effective factors in the natural bed of this river to preserve and enhance the natural landscape and biodiversity of the region. In their proposal, the emphasis was on eliminating environmental pollutants and increasing the possibility of plant and animal species diversity. Sadeghi, Ahmadi, and Chizfahm Daneshmandian (2019) proposed ecological assessment methods in the aesthetic design of natural urban landscapes. In their study, they focused on the Khoshk River in Shiraz. Preservation and restoration of biological and ecological resources of the river were major goals. Sabokro, Bahrami, and Motedayen (2021) selected the Darkeh River in Tehran as a case study to discuss urban design and planning for river resilience against floods and a new approach to resilience. They proposed a new approach to resilience that considers different dimensions of rivers in relation to environmental and social conditions. They emphasized that their approach could be a good alternative to channels as a method for flood control because canalization is a rigid and resistant approach to nature and natural forces.

The issue is that in the current climate change, the nature of urban rivers is susceptible to changes in the face of environmental hazards. Provided that they become resilient after a crisis and their ecological nature does not change, appropriate strategies and solutions can be sought. As a result, the changes and expansion of cities will occur in an environmentally friendly way. In this research, the focus is on those urban rivers that are seasonal and do not always have water. According to the United States Environmental Protection Agency, a river is a seasonal stream or stream that flows at certain times of the year but does not flow during dry seasons (Water: Rivers & Streams, n.d.). These rivers can usually be found in arid and semi-arid regions. Changes in the nature of rivers tend to occur frequently since the climate is often

changing in the contemporary world. This results in ecological threats to rivers on different scales. Moreover, a lot of problems are often raised as a result of negligence and lack of proper management of seasonal urban rivers and their abandonment during drought, for instance, declining quality of appearance and urban landscape, and social and economic problems. Changes in the natural beds and walls of rivers add to their destructive power and the ecosystem associated with the river. The concerning point is that the river basin is very important from a hydrological, economic, and environmental point of view. A review of theoretical research and global experience in this field shows that the best approach to adapting to the dynamic and unpredictable conditions of seasonal urban rivers is resilience. Resilience is used as a contemporary approach in the field of the landscape against a wide variety of natural hazards, such as floods and river dryness. This approach, which systematically adapts the river to potential natural hazards, in addition to preserving the environmental, ecological, and structural conditions of seasonal urban rivers from hazards, strengthens their resilience to environmental hazards. This study attempts to find applied-development strategies and formulate related strategies for river resilience and the preservation of both the ecological environment and the ecosystem of seasonal urban rivers against environmental hazards. In developing the strategies, the focus has been on the provision of the natural and ecological potentials of the city and the growth of the urban landscape. Therefore, the present study seeks to develop strategies for the resilience of seasonal urban rivers in the face of environmental hazards and preserve their ecological structure based on the relevant theoretical literature using a deductive-analytical research method. To this end, this study attempts to answer the following questions:

1. How does resilience affect the landscapes of seasonal urban rivers and preserve their environmental nature?
2. What is the best strategy to promote the resilience of seasonal urban rivers while preserving the environment? What strategies should be adopted to achieve this?

## Research Hypothesis

It seems that seasonal urban river restoration strategies against environmental hazards such as floods and droughts can be found in the field of ecological resilience. This means that the river continues its ecological life and creates a favorable urban landscape without damaging the surrounding urban areas. Relying on the ecological resilience approach and its effective criteria and components in the face of environmental hazards, this study attempts to extract strategies for the ecological resilience of urban rivers that replace concrete canals (to control floods) and crossings in the riparian zones (caused by the neglect of the riparian zones during drought) and then revitalize and make the river ecosystem resilient.

## Research Methodology

The present study, which is applied-developmental research, examines the ecological resilience of seasonal urban rivers against environmental-natural hazards such as floods and droughts and identifies different aspects of resilience and strategies related to the landscape of seasonal urban rivers. After reviewing the research literature, we examined the types of resilience, resilience in the areas of urban systems, resilience in the landscape, resilience in seasonal urban rivers, ecological principles in resilience, and the best strategy for preserving and maintaining the river ecosystem in seasonal urban areas. To limit the issue and achieve accurate results from the two dimensions affecting resilience (i.e., social and ecological dimensions), we focused on the ecological one. Then, based on leading studies published in scientific sources and on the views of researchers and contemporary global experiences, we selected the best strategies for the resilience of seasonal urban areas. Finally, we used the deductive-inferential method to examine the principles of landscape-oriented urban planning and ecological urban planning and then compared them with the effective components of resilience. Then, we presented strategies against environmental hazards. The strategies and solutions proposed in this study will be effective in formulating urban development plans in the face of inner-city rivers rather than seasonal inner-city rivers in all seasons (floods and drought days) as a living urban organ. Certainly, the proposed solutions should be based on the context. They need to be specific and accurate and be applied and practical.

## Literature Review

The term resilience is often used to mean "going back in time", which comes from the Latin root "resilio", meaning "jump to the past" (Klein, Nicholls & Thomalla, 2003). The word "resilience" in the dictionary has been defined as being healthy and successful after a bad event or the ability of something to return to its original shape after being pulled, pressed, or bent (Webster, 2016). The concept of resilience first evolved in ecology but is now used in various disciplines such as psychology, disaster management, economics, geography, and urban and environmental planning (Davoudi, Shaw, Haider, Quinlan, Petersn & Wilkinson, 2012).

Holling first introduced resilience as an ecological concept in 1973 (Gunderson, Allen & Holling, 2012). Then Adger (1997) used this term in the social ecologic system, Carpenter et al. (Carpenter, Walker, Anderies & Abel, 2001), and Folke (2006) also used it in the

human-environmental reciprocal system. Apart from the areas associated with ecosystems and communities, the concept of resilience has been used in ecological social systems by Berkes, Colding & Folke (2008). Tierney (1997), Bruneau et al. (2003), and Rose (2004) have used it to refer to short-term disasters and it has been used in long-term phenomena such as climate change by Timmerman (1981), Dovers & Handmer (1992) and Zhou et al. (Zhou, Wan & Jia, 2010). There is still much debate about the field of knowledge from which the term originated: one group of researchers (e.g. Batabya, 1998) argue that the term originated in ecology, while another group (e.g., Ernstson et al. 2010) argue that the term originated in physics. Some scholars believe that this term was used in the laws of the 1940s to attribute to psychology and psychiatry (Rezaei & Rafiyan, 2010). The widespread use of this concept implies that resilience has different meanings for different groups. Some of the most important definitions related to the concept of resilience extracted from the review literature of the research are given in Table 1. This reflects the various definitions of resilience and the multidisciplinary nature of the subject. Nevertheless, there are similarities between related theoretical texts. The results of examining the theories in Table 1 indicate several dimensions of "resilience perception":

1. Most researchers have used the terms "capacity" or "ability" to define resilience perception. When it is used in the case of individuals, groups of people, communities, and groups, this suggests that resilience is directly related to the capacity and ability of individuals, communities, and groups to cope with the negative effects of risk (Burton, 2012).
2. The widespread use of the word "recovery" in the definitions also indicates how individuals, groups of individuals, or a community can recover from the effects of disasters (Mayunga, 2007). Resilience is intended as a long-term post-accident recovery process. In other words, the time required to recover from accidents and return to the original state is considered (Klein et al., 2003).
3. Some researchers have an "ecological" view of resilience, defining it as a "systemic approach" and emphasizing interactions within and between systems (natural and social systems) (Manyena, 2006).
4. A group of researchers has considered "adaptation" in the definition of resilience as "a process-oriented structure".
5. Some associate resilience with "sustainability" to use society's resources more sustainably.

Based on the literature review in Table 1, the following effective components of resilience can be extracted (Fig. 1).

## Resilience in Urban Systems

Over the years, the concept of resilience has undergone significant changes during a four-step path. In theoretical texts, resilience first emerged as an ecological concept. Second, resilience was developed as a concept in the social sciences. Third, urban resilience was considered as an urban system (ecological, social, and economic). Fourth, based on a more comprehensive approach that looks at the resilience of the urban system as a whole (Tasan-Kok, Stead & Lu, 2013), theoretical texts of urban planning highlighted the principles of urban resilience and emphasized dealing with environmental hazards. According to Alberti et al. (2003), urban resilience is "the degree to which cities can survive change before reorganizing into new sets of structures and processes." In Alberti's definition, "change tolerance" refers primarily to the city's ability to withstand shock and then reset the pace of reaction (and adaptation). Godschalk (2003) acknowledges that a resilient city is "capable of withstanding severe shocks without immediate turmoil or permanent damage." This view focuses on city power and risk reduction rather than speed reduction. In the definitions of urban resilience, a distinction must be made between system equilibrium and resilience. A resilient system may experience fluctuations or changes in various conditions, and such fluctuations or changes may affect the urban system during its persistence. In addition, urban resilience is not necessarily the ability of a system to return to its previous equilibrium path after disruption or stress. The reason is that the previous equilibrium path may disappear after disruption for a variety of reasons, and a new path may emerge, all of which may change the direction and flow of a system. Given that cities are complex social-ecological systems, they are constantly changing, evolving, and interacting (Tasan-Kok et al., 2013).

## Resilience in the Landscape

Landscape as an environmental knowledge has always been exposed to various and many environmental disturbances. Therefore, experts have tried to explain the concepts of equilibrium in the field of landscape to maintain the landscape in the face of various environmental disturbances (Bahrami & Hemmati, 2020). Resilience is a holistic view of a system's ability to adapt to the disruptions, uncertainties, and changing processes in a society that can be challenged by external pressures or climate change. Landscape resilience focuses on the time required and system recognition processes to deploy and function optimally, and is not necessarily "as before". Landscape resilience is discussed in the fields of engineering, ecology, and development (Table 2).

A: Engineering resilience: The roots of resilience can be

Table 1. Definitions of resilience through the lens of researchers 1973-2016. Source: Authors.

| Theoretical area | Theory | Name of theorist |
|---|---|---|
| Ecology | The rate at which a system reaches its equilibrium state after a disturbance | Holling (1973)<br>Pimm (1984) |
| Ecological and social | Excess capacity or the ability of a system to absorb disturbance is called resilience | Holling, Schindler, Walker & Roughgarden (1995) |
| Ecology | - The amount of damage and loss that the system can absorb without being out of balance<br>- The ability of the system to organize and renew itself in -different situations<br>- The ability of the system to create and increase learning capacity- and strengthen adaptation to conditions | Carpenter et al. (2001) |
| Ecological and social | Resilience is the potential of a system to remain in a particular configuration and to maintain its feedback and performance | Folke, Carpenter, Elmqvist, Gunderson, Holling, Walker (2002) |
| Urban planning | A set of physical systems and human communities, capable of managing severe accidents | Godschalk (2003) |
| Ecology | The amount of disturbance that a system can absorb and remain stable | Klein et al. (2003) |
| Social | The ability of the community to respond to extraordinary or unique critical events | Kendra & Wachtendorf (2003) |
| Economy | Resilience is an inherent or adaptive response to hazards that enables individuals and communities to avoid potential harm | Rose (2004) |
| Ecology | Ecosystem resilience is the capacity of an ecosystem to withstand disruption without being qualitatively different, controlled by a set of different processes | Perrings (2006)<br>(Resilience Alliance) |
| Social | Resilience is a measure showing how people and communities can adapt to changes in reality and invest in new opportunities | McDowell, Stevens, Cave, Paton,<br>Johnson (2006) |
| Social | Resilience is a process that connects a set of adaptive capacities to functional and positive satiety and postoperative adaptation | Norris, Stevens, Pfefferbaum, Wyche & Pfefferbaum (2008) |
| General | The capacity to withstand and recover from loss is called resilience | Zhou et al. (2010) |
| Social | The ability of communities to participate in governmental and non-governmental institutions and the interaction with people and government. Strengthening infrastructure increases people's resilience | Pelling (2012) |
| Social and Economic | The capacity of a system or community at risk to adapt through resistance or change increases this capacity to learn from past disasters, to better protect in the future, and promote risk reduction measures | United Nations International Strategy for Disaster Reduction UNISDR, (2012) |
| Ecological and Social | The capacity of ecosystems or communities to absorb and recover from adverse effects | Khazai, Bendimerad, Cardona, Carreño, Barbat & Burton (2015) |
| Social | The ability of societies to withstand the dangers of stress and pressure, to be able to accept the next threats, and face them properly | Manyena (2009)<br>Pendall, Foster & Cowell (2010)<br>Cutter (2016)<br>Davoudi et al. (2012) |

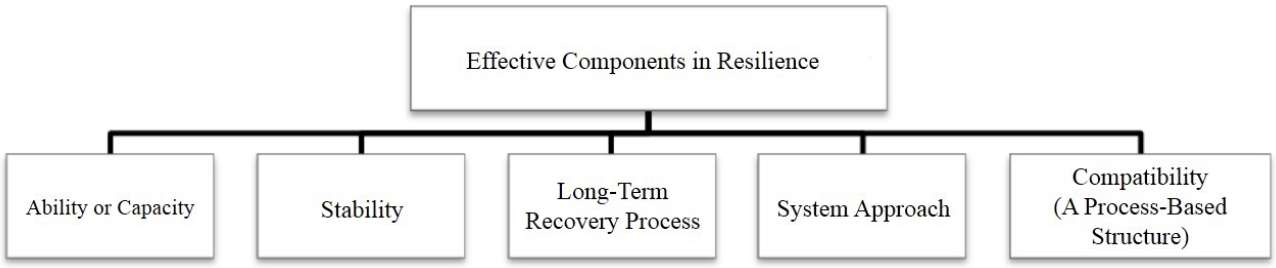


Fig. 1. Components in resilience extracted from the theories of researchers. Source: Authors developed based on Researchers' opinions. Source: Authors.

Table 2. Types of landscape resilience and their characteristics. Source: Authors.

| Types of landscape resilience | Target | Emphasis | Response |
|---|---|---|---|
| Engineering flexibility (Step backward) | Maintaining performance efficiency | Efficiency, stability Predictability | External disturbance |
| Ecological flexibility (Moving ahead) | Maintaining functionality | Continuity, change and Unpredictable | Internal and external disturbance |
| Transformational flexibility (Forward deformation) | Maintaining the ability to change | Continuity, adaptability, and the ability to transform and deform | With or without any disturbance |

traced to ecology and engineering, and its application to the risk and crisis management is one of the new achievements of knowledge (Berkes, 2007). Resilience is often raised when the system is exposed to turbulence and stress. The issue is to return to equilibrium. Resilience engineering is defined in terms of the time it takes for a system to return to a stable state. The existence of such conditions indicates that a system is always in a state of equilibrium with ups and downs. Under such circumstances, a system that recovers more quickly is considered more resilient (Pimm, 1984). Such a complex adaptive system always changes its equilibrium by changing its equilibrium points (Folke et al., 2004).

B: Ecological resilience: In engineering resilience, the concern is the ability to maintain stability and prevent changes in the state of the system or decrease fluctuations to the minimum level. However, ecological resilience refers to the ability of a system to survive regardless of its status. A system with high engineering resilience may have low ecological resilience and vice versa (Holling, 1996). In ecological resilience, each system has several stable subsets that are transferable between these stable structures when faced with turbulence. More precisely, "the permanence of a system depends on the relationships within that system and the ability of systems to absorb change in different states" (Holling, 1973). Ecological resilience is based on an evolutionary perspective that acknowledges that nature is constantly evolving and adapting (Gunderson et al., 2012). A complex system is never exactly at the equilibrium point but is moving between a series of variables (Genkai-Kato, 2007). The ecological resilience approach does not address the final state or the best performance that a system can have but seeks to find a way to maintain the evolutionary process of the system while preserving and keeping the socio-ecological system alive.

C: Transformational Resilience: This is the third type of evolutionary resilience that challenges all ideas of balance. Transformational resilience recognizes that the nature of a system can change over time with or without external disturbances (Davoudi, Brook & Mehmood, 2013). This view emphasizes Folke (2006) 's evolutionary perspective on the socio-ecological system and multiple, changing processes, rather than a fixed state, so it cannot be defined as a moving forward transformation. Folke (2006) highlights the possibility of transforming and rebuilding, reorganizing, and expanding. This idea has strong scientific foundations in ecological resilience, and in both of them, multiple balances or different regimes are assumed (Lennon, Scott & O'Neill, 2014; Wu &Wu, 2013).

According to Bahrami and Hemmati (2020), the definitions of resilience in the field of ecology have been mainly focused on the objective dimension of the landscape and have considered it as an ecosystem. Such definitions have ignored the perceptual dimensions of the landscape, in which case it does not have comprehensiveness in expressing landscape features. However, in this research, considering the orientation of the subject and focusing on the ecological characteristics of resilience, these definitions are complete and practical, and only the objective dimensions and environmental structure of the landscape are considered.

## Seasonal Urban River Resilience

According to the principles of landscape and regional ecology, landscapes have a structure and function consisting of patches and corridors in a matrix. The patches are fundamentally different in nature and dynamics, the size, shape, and spatial configuration of which are important. Linear corridors, strip corridors, and waterway corridors are structural elements of the landscape. Rivers are a very important part of natural urban corridors. Ecological resilience and its solutions are also important because urban rivers have a high level of ecological sensitivity and environmental perception. In the field of "engineering resilience," which aims at returning to the past state, resilience in seasonal rivers does not match an approach consistent with their nature because of their changing and unstable nature in different seasons (Fig. 2). Instead, "ecological resilience" and "evolutionary resilience," with an attitude based on acceptance of change, give a flexible and dynamic response to the resilience of urban rivers (Fig. 3). Accepting the

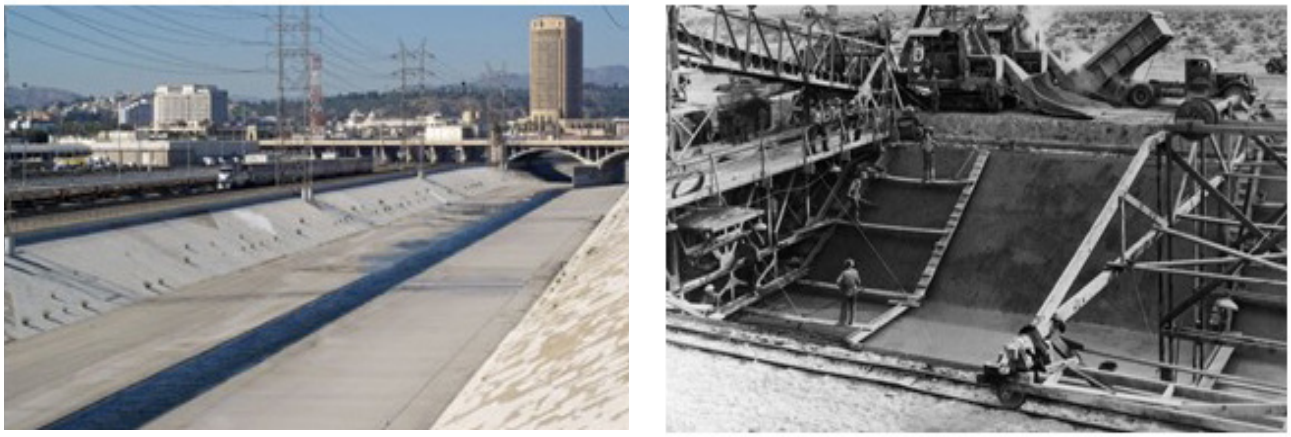

Fig. 2 The Los Angeles River engineering resilience against the 1938 flood (Left) and canalization of the river (Right). Source: www. nextcity.org.

Fig. 3. Right: The Los Angeles River Ecological Rehabilitation 2017, Left: River Restoration. Source: www. la.curbed.com.

nature of seasonal rivers and adapting to their nature, instead of confronting them, helps urban planning and design be resilient to nature and achieve a sustainable system after destructive natural events. In cities, human activities affect river systems and take them out of their natural structure (Pedroli, 2014). Ecological resilience is formed first by focusing on the rate of return and rehabilitation of disturbance, and then by emphasizing how a system is rehabilitated. Ecologists always consider a situation of uncertainty and act in such a way that there is always a kind of surprise and unpredictability in the situation and consider resilience in both predictable and unpredictable conditions.

Landscape urbanism and ecological urbanism are two major fields that focus on the ecological and social resilience of urban rivers. The basic assumption in "landscape-oriented urban planning" is that the landscape should be the main pillar and infrastructure in urban design. Through landscape-oriented urban planning, natural and cultural processes affect the design and organization of the urban form (Dabiri & Masnavi, 2015). Ecological urbanism is an attitude that shapes the future of cities. Professor David Harvey, a cultural geographer, sees the future of urbanism not in form but in understanding the process of space and time. He points out that to understand fluid and organic urbanism, ecology is the best window to show attitude and review analysis of alternative methods for future urbanism (Waldheim, 2006). In "ecological urban planning", the purpose of the ecological approach to inner-city rivers is to bring the morphological structure of the river closer to its complex natural structure to connect different parts of the river ecosystem with the urban ecosystem and surrounding lands (Koukabi & Aminzadeh, 2009). According to the results obtained from studies in the literature related to resilience including urban resilience, landscape resilience, and ecological and landscape-oriented urban planning approaches in the face of ecology, we selected the field of "ecology" in relation to the resilience of seasonal rivers. Certainly, the impact of issues related to social criteria is also influential in landscape resilience and landscape resilience approaches

to urban rivers, which require extensive and separate studies and research and further research.

## Ecological Resilience Principles

Brian Walker & David Salt in the book "Resilience Thinking", have emphasized the ecological dimensions in resilience, and in "the shrinking world" they propose ecological-social resilience as a way to align with the "changing world". Based on the opinions of many researchers, they summarize and present values as follows: Ecological Diversity, Ecological Variability, Modularity, Slow key Variables, Tight Feedbacks, Unpriced Ecosystem Services, innovation,Overlap in Governance (Different Levels of Governance), Social Capital. (Schouten, Van der Heide, Heijman & Opdam, 2012; Walker & Salt, 2006). the World Resilience Forum and some other researchers have developed criteria that include diversity, freedom or openness in relation to the coexistence of feedbacks, system reserves and modularity (Slootweg & Jones, 2011; Walker & Salt ,2006; Gunderson, 2010). These principles are important in the field of ecology and are defined as follows:

Diversity: Diversity (biology, landscape, economy, society) plays a vital role in creating resilience. Due to the variety of components in a system, that system can function in the event of a resilient disturbance (Walker & Salt, 2006; Ahren, 2011). If the amount of variability in a system is low, that system becomes vulnerable to hazards and may even lose its function. Therefore, it is necessary to identify those cases that lead to a decrease in diversity in a collection (Gunderson, 2010). Oran and Iran's studies show that as space in the landscape becomes heterogeneous with the availability of resources in different species, the resilience increases in the event of a crisis (Oliver et al., 2015).

Ecological variables: A resilient world works with ecological variables, not controls or destroys them. Many of the problems of the past are posed by incorrect exposure to ecological variables intended to control them. Flood control is not the way to deal with it, but it should be explored within its boundaries to find a suitable solution to increase the flexibility and resilience of the system (Walker & Salt, 2006).

Modularity: This means that a system is composed of separate functional parts that can be independently completed by each part (Berkes, 2007). In resilient social systems, different sectors are related in anesthetic form but are not completely interdependent, so disturbances do not spread rapidly throughout the system. There is no optimal limit for modularity, but a system whose components are fully connected can quickly transfer any shock to the entire system (Gunderson, 2010). Some of the hardware and its components are interconnected, transmitting data to the entire system. "Slow" key variables: The resilient world should focus on "slow" control variables and related domains. By focusing on the "slow" key variables that configure a socio-ecological system and the areas that lie within them, there is more capacity and ability to manage and flex a system. The capacity of the system for desirable structures and the absorption and acceptance of undesirable structures increases (Walker & Salt, 2006).

Tight Feedback: Feedback is a secondary effect of the direct effect of one variable on another (Walker, Anderies, Kinzig, & Ryan, 2006). The difficulty of feedback is how fast and powerful the effects of change are felt in one part of the system and respond to other parts. Recognizing and analyzing the tight feedback on the state of each system in the face of disruptions helps to identify the method of re-exposure and to plan for resilience.

Ecosystem services: Apart from the other strategies mentioned (such as pollination, nutrient cycle, and water treatment), some system elements that can contribute to the system's resilience are ecosystem services. According to Walker and Salt, ecosystem services serve as strategies for creating resilient systems. Unique biodiversity and geophysics and ecological aspects of the landscape create potential constraints and opportunities for resilience (Yarnell et al, 2015).

Innovation: A resilient world emphasizes learning, experimentation, developed rules, and acceptance of the change. Resilience thinking is about accepting change and disruption. When the previous cycle breaks down and destroys rigid communications and practices, different opportunities are created and new sources of growth are created.

Overlap in governance: Flexible socio-ecological systems have many overlap methods. Responding to a changing world increases corporate redundancy (Ostrom, 1999). Top-down management systems are not responsive to crises. Overlapping and a combination of private and public law can create parallel layers of implementation and increase the efficiency of related ecological-social systems (Dietz, Ostrom & Stern, 2003).

Social capital: In a resilient society, the capacity of people in the community to accept the disorder is very important. Factors of trust, developed social networks and leadership are effective factors that increase social resilience (Ostrom, 1999; Ostrom & Janssen, 2014).

## Ecological Strategies for River Resilience

Boon (1992), Pedroli, Blast, Levy, and Rouge (2002), and Roni and Beichi (2012) highlight five appropriate river conservation strategies based on the state of the river (Table 3): Conservation, Development Restriction, Mitigation of negative effects, Restoration and. Since

Table 3. Boone's (1992) five ecological strategies for the preservation of rivers. Source: Authors.

| Ecological strategies for river resilience | Characteristics of river conditions |
|---|---|
| Preservation | When several natural or semi-natural systems with hydrodynamics remain intact, they must be preserved |
| Limitation | For rivers of high ecosystem quality and with key environmental factors with performance without major barriers, there is a management option to "limit" the development of watersheds |
| Mitigation of negative effects | When the quality of the river ecosystem is low, negative "mitigation" measures are taken. The development of economic and recreational functions in the riparian zones requires the implementation of measures that help the survival of habitats and organisms and the preservation of ecosystems |
| Restoration | When rivers reach a point where natural hydrodynamics are difficult to detect and only small, scattered remnants of the population remain, the emphasis is on "improving" the river |
| Dereliction | For the worst-case scenario, when there is no hope of recovery, "dereliction" can be used. |

urban rivers have been affected by human interventions used for urban development, they have been out of their completely natural nature. This has brought changes to their natural plant and animal ecosystems. Therefore, there are no suitable conditions for "protection" and "mitigation of negative effects". Seasonal urban rivers are part of the city's nature, and "dereliction "of them means destroying a part of the urban environment." Mitigation "of the negative effects and "conservation" are among the useful strategies that can be used in dealing with the natural features of the river in the urban environment. Since restoration is impossible without mitigating the negative effects, the strategy of "mitigation of the negative effects" can be considered as a subset of the "restoration" strategy. In the scope of ecological strategies, to improve the resilience of seasonal urban rivers, "restoration" can be practiced. Restoration of rivers seeks to improve the natural performance of the river and its landscape as a diverse network of habitats including the function of its corridor for the watershed and contribute to the resilience of rivers against environmental hazards. River restoration is a key strategy to improve environmental quality and biodiversity in recent decades and occurs by increasing emphasis on the value of river performance and ecosystem services provided by floodways (Lemons & Victor, 2008). The term "river restoration" refers to rehabilitation, enhancement, restoration, mitigation, and reclamation (Roni & Beechie, 2012). There is widespread agreement that urban areas need to adapt to climate change, reorganize the natural water cycle, and create water-sensitive cities (Brown, Keath & Wong, 2009; Sharma, Gray, Diaper, Liston & Howe, 2008; Kazmierczak & Carter, 2010; Ward et al., 2012; Everett & Lamond, 2014). Restoring rivers and watersheds to their natural state is a key strategy for improving the quality of the environment and biodiversity on a global scale. River rehabilitation provides an opportunity to restore damaged and lost ecosystem services. In addition, the performance of residential areas near the watershed is becoming more balanced. Restoration of seasonal urban rivers results in biodiversity conservation (supporting), sustainable flood management (regulating), and physical habitat quality restoration (regulating). It also leads to fisheries enhancement (cultural/ provisioning) and pollution control (regulating) (Gilvear, Spray & Casas-Mulet, 2013).

Improving seasonal rivers in developed cities can change people's perceptions of green space and its public resources, but often have little effect on natural regeneration and habitats. Urban growth and climate change threaten the aquatic ecosystems of cities, leading to the extinction of persistent plants and animal habitats. In recent years, the concept of process-based river restoration has received attention. According to Roni and Beechie (2012), this integrated socio-ecological approach adapts to comprehensive techniques contributing to identifying the root causes of ecosystem degradation and striking a new balance between socio-economic needs and sustainable watershed management (Brierley & Fryirs, 2004; Kondolf et al, 2006; Bennet, Peterson & Gordon, 2009).

In addition, preventing human interference in natural processes increases the resilience of river ecosystems in the face of future disturbances (Beechie et al., 2010). This ensures that restoration programs and measures will promote sustainable recovery without the need for frequent human intervention and presence. The purpose of "process-based restoration" is to "redefine the core of physical, chemical, and biological processes that re-create and protect the ecosystem of rivers and floodplains" (ibid.). This process is based on the analysis of various social and economic factors that are proposed at the local,

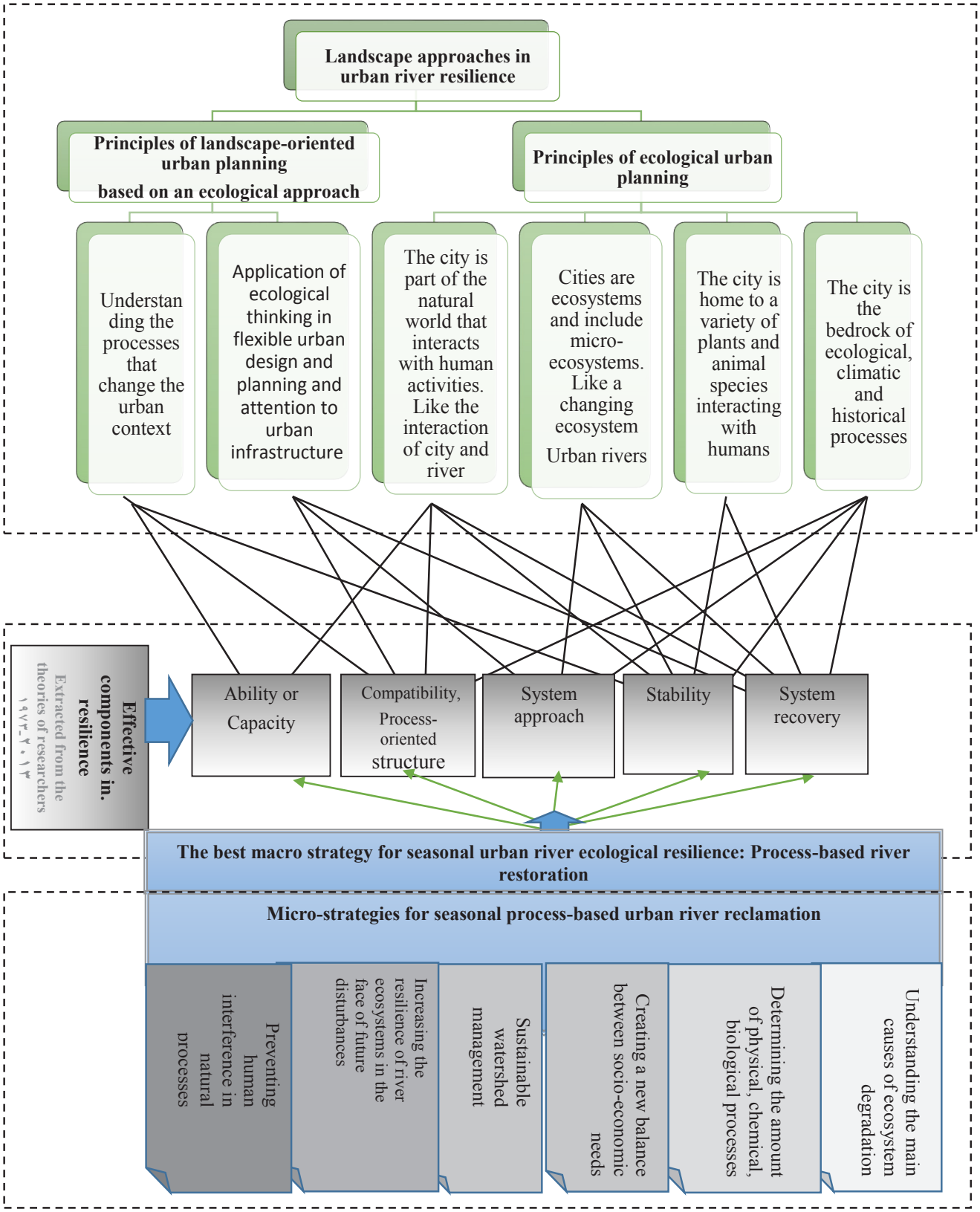


Fig. 4. Inferential-deductive relationship of research literature findings. Source: Authors.

regional, and national levels to maximize the benefits of restoration in the short, medium, and long term (Roni & Beechie, 2012; Gilvear et al., 2013; Sabbion, 2017).

## Results and Discussion

Landscape approaches to the resilience of urban rivers in the two areas of landscape urbanism and ecological urbanism emphasize the ecological and social dimensions of urban design and planning. In the field of resilience, the ecological and social dimensions of resilience focus on preserving the natural environment and strengthening and increasing the capacity of human societies as social capital. Due to the limitations of this study, the issue of "ecology" is examined, and the "social" aspect can be scrutinized in future research. As can be seen in Fig. 4, in the field of ecology, the principles of landscape-oriented urban planning and ecological urbanism have a conceptual and practical relationship with the effective criteria in resilience (Fig. 1). The following results were obtained:

A: "Understanding the processes that change the urban texture" makes it possible to identify the ability or capacity of the urban fabric to protect against environmental hazards, plan for adaptation and the formation of a process-oriented structure, and finally achieve stability after exposure to the disorder.

B: A systemic approach to the city and its environment allows us to "apply ecological knowledge and think in flexible urban design and planning" and "pay attention to urban infrastructure," particularly the water structure of cities such as urban rivers. In the event of any disturbance or environmental hazard in the city system and its environment (seasonal urban rivers), the system is restored and the process of resilience starts.

C: "The city and all its constituent elements are part of the natural world," which interacts with man and his activities. If citizens connect with the natural elements of the city, such as urban rivers, they will tend to consider them as one of the identifying elements of the city. Therefore, developing urban development planning to increase the capacity and capability of seasonal urban rivers and formulating a process-oriented structure against environmental hazards will encourage people to interact with the urban environment frequently. In addition, preventing human activities from interfering with natural elements such as seasonal urban rivers (preventing the transfer of municipal wastewater to the river, constructing a street in the riverbed during drought, etc.) would help the river ecosystem recover itself and achieve secondary sustainability and become ecologically resilient.

D: "Cities are large-scale ecosystems and include micro-ecosystems." For instance, the dynamic and variable seasonal river ecosystems in the city. Therefore, to establish a proper and continuous relationship between micro-ecosystems and urban ecosystems, it is necessary to plan based on a systemic approach at the time of disruption. To recover micro and macro structures and achieve secondary stability, it is necessary to increase the capacity and ability of micro-ecosystems like seasonal rivers in the cities and make them resilient from an ecological perspective so that the city's ecosystem will also be sustainable and resilient.

E: Cities are home to many plant and animal species that interact with humans and form their ecosystems, river ecosystems, and other natural ecosystems in the city. Therefore, stability after a disorder is possible only if a systemic attitude is formed. If the nature of an ecosystem such as a river can be related to its plant and animal species, this habitat can maintain its ecological structure in relation to the ecological nature of the city.

F: Cities are the bedrock of ecological, climatic, and historical processes, and they have a dynamic and changing structure. Therefore, they accept the flexibility of change in a crisis to some extent. If a severe disruption occurs and becomes unstable, the capacities of cities and their ability to adapt to new conditions will be partially restored due to their process-oriented contexts. Therefore, in urban development programs in urban planning and design, the flexible capacities of the cities to accept changes should be considered to establish the ecological nature of cities. Since seasonal urban rivers are one of the natural elements influencing the ecological nature of cities, the flexibility, changing capacity, and ecological structure of seasonal rivers during droughts and floods should be considered in urban development plans.

## Conclusion

The purpose of ecological resilience is to preserve the river ecosystem at the time of the crisis so that it retains its features even in secondary stable conditions. The river ecosystem refers to its source at its beginning; the corridors and patches along its body, and the mouth at its end. If these components are preserved, the best macro-strategy for the ecological resilience of seasonal urban rivers is "process-based river restoration." This is a process that fits the ecosystem structure of the river and also covers the process-oriented structure of resilience, by practicing micro-strategies. This will be facilitated by understanding the main causes of ecosystem degradation or change, determining physical, chemical, and biological processes, sustainable watershed management, increasing the resilience of river ecosystems in the face of future environmental hazards, preventing human interference in natural processes; and creating a new

balance between socio-economic needs. In this study, the authors have measured the micro-strategies of seasonal urban river restoration based on ecological resilience and have proposed strategies for the ecological resilience of seasonal urban rivers from the interaction of these two developmental-applied data. In doing so, they hope they can draw upon the ecological identity of resilience and propose the strategies accordingly. Such strategies are detailed in Fig. 5.

1. The main reasons for the destruction or change of ecosystems of seasonal urban rivers, based on ecological principles of resilience, are the disruption of plant and animal species diversity related to the river environment, the reduction of modularity in ecological patches along the river, and the disruption of ecosystem services. It is affected by the biological structure of the river and the engineering control and control of ecological variables to control the crisis, which leads to changes in the river ecosystem and disrupts its ecological resilience.

2. Determining physical, chemical, and biological processes in the bed of seasonal urban rivers based on ecological principles of resilience will draw attention to ecological variables in river beds and their acceptance as key variables with slow and gradual impacts on the watersheds. It will also make the ecological ecosystem services of rivers receive attention. Thus, the ecological nature of seasonal urban rivers will be recognized and won't be forgotten in times of drought. The ecological identity of seasonal rivers will also be considered in urban development plans. Maintaining the ecological resilience potential will be the concern of such plans.

3. Sustainable watershed management based on ecological principles of resilience will be possible by maintaining the biological diversity of seasonal urban river ecosystems and restoring seasonal rivers based on the essential ecological variables with respect to drought and flood conditions, improvement of modularity structure in ecological patches in the riparian zones, assuming proper management of watershed management in the area of seasonal urban rivers.

4. Increasing the resilience of the river ecosystem in the face of future environmental hazards overlaps with sustainable watershed management strategies. In addition, seasonal river reclamation should be adapted to key slow variables. In addition, the ecological characteristics of seasonal urban river ecosystem service should be improved in the case of watershed management on variable and numerous river banks in drought and flood conditions.

It is worth noting that taking advantage of tight ecological feedback after going through the disturbances and critical situations will ensure that the shortcomings of the past are not repeated. This is a move towards the future. Innovation in the face of ecological problems helps create sustainable conditions after crisis and disruption, increasing the ability to create ecological resilience.

5. Preventing human interference in natural processes by formulating laws based on the absence of human interference to prevent urban pollution, vehicles, intrusion, and occupation of the riparian zones, cultural awareness using social capital (popular groups and social activists, social shakes) based on the preservation of the river ecosystem. What has been proposed are social measures that lead to the preservation of ecological conditions in the urban riparian zones?

6. Creating a new balance between socio-economic needs is due to the way of dealing with seasonal urban rivers after restoration. This will contribute to the social and economic position of rivers in the mental structure of people and the city. This will encourage people to know it as part of the essential space-building elements and do their best to maintain it. This also helps people to benefit from crisis management experiences on a national and global scale and find new ways.

In a holistic view, these strategies certainly do not cover all aspects required for overcoming all environmental hazards, but they will pave the way for dealing with some aspects of ecological resilience. The experiences of the past in times of crisis and disruption of urban river systems and current strategic plans increase ecological resilience capacity in the future and ensure that the structure of the river ecosystem in the urban system is properly sustained and resilient.


Fig. 5. Strategies of seasonal urban river restoration strategy based on ecological resilience approach. Source: Authors.

## Reference list


• Adger, W.N. (1997). Sustainability and social resilience in coastal resource use. *Global Environmental Change and Economic Research on the Global Environment*, Working Paper 97-23, Centre for Social University of East Anglia and University College London.

• Ahern, J. (2011). From fail-safe to safe-to-fail: Sustainability and resilience in the new urban world. *Landscape and Urban Planning*, 100(4), 341-343.

• Alberti, M., Marzluff, J. M., Shulenberger, E., Bradley, G., Ryan, C. & Zumbrunnen, C. (2003). Integrating humans into ecology: opportunities and challenges for studying urban ecosystems. *BioScience*, 53(12), 1169-1179.

• Bahrami, F. & Hemmati, M. (2020). Landscape Resilience, an Examination, and Evaluation of Existing Definitions in the Field of Landscape Resilience, a Brief Review of Literature. *MANZAR*, 12(50), 40-49

• Batabyal, A. A. (1998). The concept of resilience: retrospect and prospect. *Environment and Development Economics*, 3(2), 221-262.

• Beechie, T. J., Sear, D. A., Olden, J. D., Pess, G. R., Buffington, J. M., Moir, H., Roni, P., & Pollock, M. M. (2010). Process-Based Principles for Restoring River Ecosystems. *BioScience*, 60(3), 209–222.

• Bennett, E. M., Peterson, G. D. & Gordon, L. J. (2009). Understanding relationships among multiple ecosystem services. *Ecology Letters*, 12(12), 1394–1404.

• Berkes, F. (2007). Understanding uncertainty and reducing vulnerability: lessons from resilience thinking. *Natural Hazards*, 41(2), 283-295.

• Berkes, F., Colding, J. & Folke, C. (Eds.). (2008). *Navigating social-ecological systems: building resilience for complexity and change.* Cambridge: Cambridge University Press.

• Boon P.J. (1992). Essential Elements in the Case for River Conservation. In: P.J. Boon, P. Calow and G.E. Petts (eds.), *River Conservation and Management*. UK: Wiley, (pp. 11– 33).

• Brierley, G. J. & Fryirs, K. A. (eds.). (2004). The River Styles Framework. In: *Geomorphology and River Management*. Malden, MA, USA: Blackwell Publishing.

• Brown, R. R., Keath, N. & Wong, T. H. F. (2009). Urban water management in cities: historical, current and future regimes. *Water Science and Technology*, 59(5), 847–855.

• Bruneau, M., Chang, S. E., Eguchi, R. T., Lee, G. C., O'Rourke, T. D., Reinhorn, A. M., ... & Von Winterfeldt, D. (2003). A framework to quantitatively assess and enhance the seismic resilience of communities. *Earthquake Spectra*, 19(4), 733-752.

• Burton, C. G. (2012). *The development of metrics for community resilience to natural disasters* (Unpublished Ph.D. Theses in Geography). Department of Geography, University of South Carolina, Columbia, SC.

• Carpenter, S., Walker, B., Anderies, J.M. & Abel, N. (2001). From metaphor to measurement: resilience of what to what? *Ecosystems*, 4, 765–781.

• Cutter, S. L. (2016). Resilience to what? Resilience for whom? *The Geographical Journal*, 182(2), 110-113.

• Dabiri, M. & Masnavi, M. R. (2015). From Urban Development to Landscape-oriented Ecological Urbanism. *MANZAR*, 7(32), 66-73.

• Davis, I. & Izadkhah, Y.O. (2008). Tsunami Early Warning System (EWS) and Its Integration within the Chain of Seismic Safety. *Disaster Prevention and Management Journal*, 17(2)281-289.

• Davoudi, S., Brooks, E. & Mehmood, A. (2013). Evolutionary resilience and strategies for climate adaptation. *Planning Practice & Research*, 28(3), 307-322.

• Davoudi, S., Shaw, K., Haider, L. J., Quinlan, A. E., Peterson, G. D., Wilkinson, C., ... & Davoudi, S. (2012). Resilience: a bridging concept or a dead end? "Reframing" resilience: challenges for planning theory and practice interacting traps: resilience assessment of a pasture management system in Northern Afghanistan urban resilience: what does it mean in planning practice? Resilience as a useful concept for climate change adaptation? The politics of resilience for planning: a cautionary note: edited by Simin Davoudi and Libby Porter. *Planning theory & practice*, 13(2), 299-333.

• Dietz, T., Ostrom, E. & Stern, P. C. (2003). The struggle to govern the commons. *Science*, 302(5652), 1907-1912.

• Dovers, S.R., Handmer, J.W. (1992). Uncertainty, sustainability and change. *Global Environmental Change*, 2(4), 262–276.

• Ernstson, H., Van der Leeuw, S. E., Redman, C. L., Meffert, D. J., Davis, G., Alfsen, C. & Elmqvist, T. (2010). Urban transitions: on urban resilience and human-dominated ecosystems. *Ambio*, 39(8), 531-545.

• Everett, G. & Lamond, J. (2014). A conceptual framework for understanding behaviours and attitudes around 'Blue-Green' approaches to Flood-Risk Management. In D. Proverbs & C.A. Brebbia (eds.), *Flood Recovery, Innovation and Response IV*. UK: WIT Press Southampton, (pp. 101-112).

• Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C. S. & Walker, B. (2002). Resilience and sustainable development: building adaptive capacity in a world of transformations. *AMBIO: A Journal of the Human Environment*, 31(5), 437-440.

• Folke, C., Carpenter, S., Walker, B., Scheffer, M., Elmqvist, T., Gunderson, L. & Holling, C. S. (2004). Regime shifts, resilience, and biodiversity in ecosystem management. *Annual Review of Ecology, Evolution, and Systematics*, 35, 557-581.

• Folke, C. (2006). Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environmental Change*, 16(3), 253-267.

• Genkai-Kato, M. (2007). Regime shifts: catastrophic responses of ecosystems to human impacts. *Ecological Research*, 22(2), 214-219.

• Ghazavi, F., Haghighatbin, M. & Bemanian, M. (2019). Avamele moaser dar tarahi manzar ecologik roodkhane matabegh ba mizan ab va khohshi fasli (mored shenasi roodkhaneye Zayaderod esfahan) [Factors affecting the sustainable design of the ecological landscape of the river according to the amount of water and seasonal droughts (Case study: Zayandehrud River of Isfahan)]. *Geography and Urban-Regional Planning*, 9(31), 131-152.

• Gilvear, D. J., Spray, C. J. & Casas-Mulet, R. (2013). River rehabilitation for the delivery of multiple ecosystem services at the river network scale. *Journal of Environmental Management*, 126, 30–43.

• Godschalk, D. R. (2003). Urban hazard mitigation: creating resilient cities. *Natural Hazards Review*, 4(3), 136-143.

• Gunderson, L. (2010). Ecological and human community resilience in response to natural disasters. *Ecology and Society*, 15(2).

• Gunderson, L. H., Allen, C. R. & Holling, C. S. (Eds.). (2012). *Foundations of ecological resilience*. Washington: Island Press.

• Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*, 4(1), 1-23.

• Holling, C.S., Schindler, D.W, Walker, B.W. & Roughgarden, J. (1995). Biodiversity in the functioning of ecosystems: an ecological synthesis. In: Perrings C, Mäler KG, Folke C, Holling CS, Jansson BO (eds.), *Biodiversity loss: economic and ecological issues*. Cambridge University Press, Cambridge, (pp. 44–83).

• Holling, C. S. (1996). Engineering resilience versus ecological resilience. *Engineering Within Ecological Constraints*, 31(1996), 32.

• Iran's flood-prone province/ Are we a dry country or a flood-prone country? (2022). *The Islamic Republic News Agency*, Retrieved July

28, 2022 from: https://mardnews.ir/news/
• Kazmierczak, A. & Carter, J. (2010). *Adaptation to climate change using green and blue infrastructure*. A database of case studies. Interreg IVC Green and Blue Space Adaptation for Urban Areas and Eco Towns (GRaBS). Manchester, UK. Available at: http://www. grabs-eu. org/.
• Kendra, J. M. & Wachtendorf, T. (2003). Elements of resilience after the world trade center disaster: reconstituting New York City's Emergency Operations Centre. *Disasters*, 27(1), 37-53.
• Khazai, B., Bendimerad, F., Cardona, O. D., Carreño, M. L., Barbat, A. H. & Burton, C. G. (2015). A guide to measuring urban risk resilience: Principles, tools and practice of urban indicators. *Earthquakes and Megacities Initiative (EMI)*, The Philippines: Earthquakes and Megacities Initiative (EMI).
• Klein, R. J., Nicholls, R. J. & Thomalla, F. (2003). Resilience to natural hazards: How useful is this concept? *Global Environmental Change Part B: Environmental Hazards*, 5(1), 35-45.
• Koukabi, L. & Aminzadeh, B. (2009). Application of landscape ecology in conservation and restoration of urban rivers: the case of Khoshk river in Shiraz. *Environmental Sciences*, 6(2), 105-119.
• Kondolf, G. M., Boulton, A. J., O'Daniel, S., Poole, G. C., Rahel, F. J., Stanley, E. H., Wohl, E., B\a ang Asa, Carlstrom, J. & Cristoni, C., et al. (2006). Process-based ecological river restoration: visualizing three-dimensional connectivity and dynamic vectors to recover lost linkages. *Ecology and Society*, 11(2), 5-21.
• Lemons, J. & Victor, R. (2008). Uncertainty in River Restoration. In: S.E. Darby & D.A. Sear (Eds.), *River Restoration. Managing the Uncertainty in Restoring Physical Habitat*. UK: John Wiley & Sons, Ltd, Chichester, (pp. 3e13).
• Lennon, M., Scott, M. & O'Neill, E. (2014). Urban design and adapting to flood risk: the role of green infrastructure. Journal of Urban Design, 19(5), 745-758.
• Manyena, S. B. (2006). The concept of resilience revisited. *Disasters*, 30(4), 434-450.
• Manyena, S. B. (2009). *Disaster resilience in development and humanitarian interventions* (Unpublished Ph.D. Thesis). University of Northumbria at Newcastle, Newcastle, UK.
• Mayunga, J. S. (2007). Understanding and applying the concept of community disaster resilience: a capital-based approach. *Summer Academy for Social Vulnerability and Resilience Building*, 1(1), 1-16.
• McDowell, R. W., Stevens, D. R., Cave, V., Paton, R. J. & Johnson, M. (2006). Effects of shelter belts on fence-line pacing of deer and associated impacts on water and soil quality. *Soil Use and Management,* 22(2), 158-164.
• Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F. & Pfefferbaum, R. L. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology*, 41(1), 127-150.
• Oliver, T. H., Heard, M. S., Isaac, N. J., Roy, D. B., Procter, D., Eigenbrod, F., ... & Bullock, J. M. (2015). Biodiversity and resilience of ecosystem functions. *Trends in Ecology & Evolution*, 30(11), 673-684.
• Ostrom, E. (1999). Coping with tragedies of the commons. *Annual Review of Political Science*, 2(1), 493-535.
• Ostrom, E. & Janssen, M. A. (2004). Multi-level governance and resilience of social-ecological systems. In M. Spoor (ed.), *Globalisation, poverty and conflict. Kluwer Academic*. Netherlands: Dordrecht, (pp. 239-259).
• Pedroli, B. (2014). Resilience and the Cultural Landscape: Understanding and Managing Change in Human-shaped Environments. *Landscape Research*, 39(5), 597-599.
• Pedroli, B., Blust, G., Looy, K. & Rooij, S. (2002). Setting targets in strategies for river restoration. *Landscape Ecology*, 17, 5-18.
• Pelling, M. (2012). *The vulnerability of cities: natural disasters and social resilience*. New York: Routledge.
• Pendall, R., Foster, K. A. & Cowell, M. (2010). Resilience and regions: building understanding of the metaphor. *Cambridge Journal of Regions, Economy and Society*, 3(1), 71-84.
• Perrings, C. (2006). Resilience and sustainable development. Environment and Development Economics, 11(4), 417-427.
• Pimm, S. L. (1984). The complexity and stability of ecosystems. *Nature*, 307(5949), 321-326.
• Pourjafar, M. R., Ahmadi, F. & Sadeghi, A. R. (2015). Affective Factors Investigation of Sustainable Landscape Design of City Seasonal Rivers (Case Study: Khoshk River, Shiraz, Iran). J*ournal of Sustainability, Development and Environment*, 1(4), 71-86.
• Rezaei, M. & Rafiyan (2010). *Strengthening resilience to reduce the effects of natural disasters (earthquakes) in rural areas. Proceeding of the First International Conference on Rural Settlements. Conducted by Deputy of Rural Reconstruction and Housing*. Tehran: Rural Reconstruction and Housing Office.
• Roni, P. & Beechie, T. (eds.). (2012). *Stream and Watershed Restoration: A Guide to Restoring Riverine Processes and Habitats.* Chichester, West Sussex; Hoboken, NJ: Wiley-Blackwell.
• Rose, A. (2004). Defining and measuring economic resilience to disasters. *Disaster Prevention and Management*, 13, 307–314.
• Sabbion, P., (2017). Los Angeles River, USA-Strategies and Techniques. In K. Perini & P. Sabbion (eds.), *Urban Sustainability and River Restoration. Urban Sustainability and River Restoration*. UK: John Wiley.
• Sabokro, D., Bahrami, F. & Motedayen, H. (2021). Resilience Planning and Design of Urban Rivers in the Face of Flood Disturbances (A Case Study: The Resilience Planning of the River Darakeh). *MANZAR*, 13(55), 62-75.
• Sadeghi, A., Ahmadi, F. P. & Chizfahm Daneshmandiani, M. (2019). Application of Ecological Assessment in Aesthetic design of Natural Urban LandscapesStudy Area (Khoshk River, Shiraz, Iran). *Journal of Urban Structure & Function*, 6(19), 6, 7-26.
• Saeedi, M. (2020). *Urban landscape design of the Khoshk River in Shiraz based on a landscape and environment resilience approach* (Unpublished Master's thesis, Faculty of Art and Architecture). Faculty of Art & Architecture, Shiraz University, Shiraz, Iran.
• Schouten, M. A., Van der Heide, C. M., Heijman, W. J. & Opdam, P. F. (2012). A resilience-based policy evaluation framework: Application to European rural development policies. *Ecological Economics*, 81, 165-175.
• Sharma, A. K., Gray, S., Diaper, C., Liston, P. & Howe, C. (2008). Assessing integrated water management options for urban developments – Canberra case study. *Urban Water Journal*, 5(2), 147–159.
• Slootweg, R. & Jones, M. (2011). Resilience thinking improves SEA: a discussion paper. *Impact Assessment and Project Appraisal*, 29(4), 263-276.
• Tasan-Kok, T., Stead, D. & Lu, P. (2013). Conceptual overview of resilience: History and context. In A. Eraydin and T. Tasan-Kok (Eds.), *Resilience Thinking in Urban Planning*. Dordrecht: Springer, (pp. 39–51).
• Tierney, K. (1997). Impacts of recent disasters on businesses: the 1993 midwest floods and the 1994 Northridge earthquake. In B. Jones (ed.), *Economic consequences of earthquakes: preparing for the unexpected. National Center for Earthquake Engineering Research*. Buffalo, (pp. 189–222).
• Timmerman, P. (1981). *Vulnerability, resilience and the collapse of society: a review of models and possible climatic applications*. Institute for Environmental Studies, University of Toronto, Canada
• UNISDR, W. (2012). *Disaster risk and resilience. Thematic Think*

*Piece*, UN System Task Force on the Post-2015 UN Development Agenda.
• Van Der Leeuw, S. E., Aschan-leygonie, C. & Aschanñleygonie, C. (2000). A long-term perspective on resilience. *Paper presented at System 336 Resilience Workshop*, Abisko, Sweden.
• Waldheim, C. (2006). *The landscape urbanism reader.* Princeton: Princeton Architectural Press.
• Walker, B. H., Anderies, J. M., Kinzig, A. P. & Ryan, P. (2006). Exploring resilience in social-ecological systems through comparative studies and theory development: introduction to the special issue. *Ecology and Society*, 11(1), 12-16.
• Walker, B. & Salt, D. (2006). *Resilience Thinking, Sustaining Ecosystems and People in a Changing World*. Washington, DC: Island Press.
• Ward, D. L., Clemens, B. J., Clugston, D., Jackson, A. D., Moser, M. L., Peery, C. & Statler, D. P. (2012). Translocating adult Pacific lamprey within the Columbia River Basin: state of the science. *Fisheries*, 37(8), 351-361.
• Water: Rivers & Streams (n.d.). *Types of streams, Seasonal streams (intermittent)*. Retrieved February 7,2022, from: https://archive.epa.gov/water/archive/web/html/streams.html.
• Webster. (2016). *Resilience meaning*. Retrieved February 1, 2022, from: https://www.merriam-webster.com/words-at-play/woty2016-top-looked-up-words-surreal.
• Wu, J. & Wu, T. (2013). Ecological resilience as a foundation for urban design and sustainability. In S. T. A. Pickett, M. L. Cadenasso, & B. McGrath (Eds.), *Resilience in ecology and urban design: Linking theory and practice for sustainable cities*. Dordrecht, Netherlands: Springer, (pp. 211–230).
• Yarnell, S. M., Petts, G. E., Schmidt, J. C., Whipple, A. A., Beller, E. E., Dahm, C. N., ... & Viers, J. H. (2015). Functional flows in modified riverscapes: hydrographs, habitats and opportunities. *BioScience*, 65(10), 963-972.
• Zhou, H., Wan, J. & Jia, H. (2010). Resilience to natural hazards: a geographic perspective. *Natural Hazards*, 53(1), 21-41.



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