https://doi.org/10.22645/udi.2024.6.30.01
도시과학 제13권 제1호 2024. 6 53-64쪽

축소도시를 위한 도시 녹지 활용 방안

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Urban Greening Strategies for Shrinking Cities

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ABSTRACT : 최근 우리나라는 인구감소와 이로 인한 도시 축소를 경험하고 있다. 이 연구는 축소도시의 개념을 인구감소와 공간구조변화 관점에서 정리하고 축소도시에서 사용할 수 있는 도시 내 녹지 활용 방안에 대한 연구이다. 이를 위해 축소도시의 정의를 검토한 후 축소도시의 특징인 인구감소와 도시 내 공간구조의 변화에 대해 정리하였다. 축소도시는 인구감소와 경제적 침체를 경험하고 있으며 이로 인한 유휴지, 유휴건물 등 공간적 변화를 동반하고 있다. 이러한 특성으로 인해 도시 내 지속가능한 발전 방안이 필요하며 녹지의 전략적 활용이 요두된다. 또한 도시에서 활용할 수 있는 녹지의 유형을 도시숲, 도시농업, 벽면녹화, 옥상녹화, 가로수로 구분하여 각 유형의 개념을 검토하였다. 도시 내 녹지 유형은 각 유형에 대한 정의와 함께, 유형별로 필요한 규모를 검토하고, 해당 유형을 제공하는데 필요한 기술의 정도로 분류하였다. 이후 축소도시 활성화에 도움이 될 수 있는 도시 내 녹지 활용 방안을 제안하였다. 축소도시 내 녹지의 활용은 지속가능한 개발을 지향하며 다음 세대를 위한 환경적 비용과 혜택에 대한 고려가 필요하다. 이 연구는 축소도시의 개념과 도시 내 녹지 유형 및 활용 방안에 대한 기초적 연구로 그 의미를 가진다.

키 워 드 : 도시 그린인프라스트럭처, 축소도시, 녹지 활용 전략

Key words : Urban Green Infrastructure, Shrinking City, Greening Strategies

1. Introduction

Cities that have experienced shrinkage are replacing transportation infrastructure with urban parks to revive these areas through greening strategies. Such urban parks are successfully regenerating economies (Lim, Kim, Potter, & Bae, 2013; Wolch, Byrne, & Newell, 2014), communities (Kraft-Klehm, 2015), and the environment (Cataldi, Kelley, Kuzmich, Maier-Rothe, & Tang, 2011) in shrinking areas. A successful example is the High Line in New York, which contributed $100 million in property tax increases in just one year after its opening. Following the High Line's success, replacing transportation infrastructure with urban parks has become a trend for revitalizing shrinking areas. Many cities are focusing on the success of these projects but rarely consider the underlying mechanisms of this type of redevelopment.

There are three main themes behind the redevelopment of transportation infrastructure into urban parks: the cause of redevelopment is the issue of shrinking cities needing solutions, the medium and tool is an urban greening strategy to address the issue, and the goal is sustainable development. This type of redevelopment also functions as sustainable development, considering economic, equity, and environmental factors in the planning process. Understanding shrinking cities helps comprehend their background and causes. Urban greening strategies explain various greening types to make cities green and their role in sustainable

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development. These three concepts derive research questions.

This study focuses on the following questions: (1) What are shrinking cities and how can we adapt to their dynamics? (2) Are urban greening strategies helpful to sustainable development in shrinking cities?

This study has three objectives. The first is to demonstrate the causes of shrinking cities to guide planning direction through sustainable development. The second is to present urban greening strategies as tools for sustainable development in shrinking cities. The third is to assess the benefits of urban parks that replaced transportation infrastructure to strengthen the sustainable development of shrinking cities.

2. Shrinking Cities

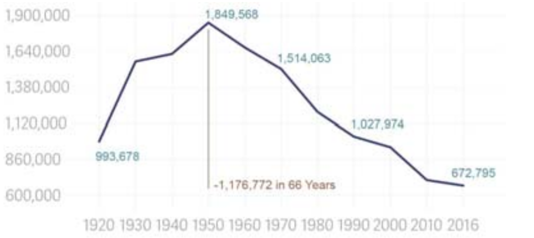
Despite the expectation that the world's urban population will grow from 54 percent to 66 percent by 2050 (United Nations, 2014), the urban growth paradigm has shifted from growth-oriented urbanization to urban shrinkage (Herrmann, Shuster, Mayer, & Garmestani, 2016; Pickett et al., 2013). A shrinking city can be considered the end of growth (Herrmann et al., 2016), representing a long-term loss in population and economic decline. Shrinkage is also accompanied by structural and spatial changes in industry, land use, properties, and demographic transitions (Reckien & Martinez-Fernandez, 2011). Many researchers define shrinking cities as urban areas that have faced significant population loss and decreased economic transformations (Blanco et al., 2009; Pallagst et al., 2009; Schilling & Logan, 2008). These definitions are summarized in Table 1.

The Shrinking Cities International Research Network (SCiRNTM) offers a forum for bi-weekly online discussions, deriving several meaningful aspects of shrinking cities, such as locations, patterns, and planning challenges (Hollander, Pallagst, Schwarz, & Popper, 2009). The location of shrinking cities varies among countries. In terms of patterns, the US and several European cities are experiencing a hollowing-out of the inner city, but this pattern is not prevalent in most European cities. Lastly, the shrinking city is often associated with an unhealthy decline.

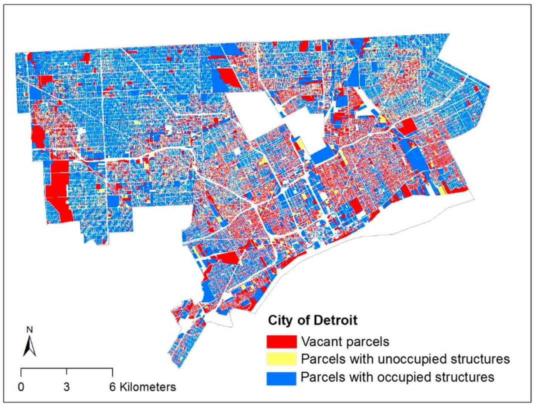
Thorsten Wiechmann (2008), a member of the managing board of the SCiRNTM, investigated Dresden in Eastern Germany to demonstrate the causes of shrinkage, such as economic decline, industrial regression, and high unemployment rates. His study shows the shift in planning from growth-oriented development to the compact city model and its results. By doing so, shrinking and declined areas in Dresden have turned into wealthy communities (Wiechmann, 2008). This study supports the notion that strategic flexibility is crucial in the planning practice of shrinking cities.

Despite the negative perceptions of urban shrinkage, several studies describe it as an opportunity to improve quality of life (Delken, 2008; Nefs, Alves, Zasada, & Haase, 2013). For example, Delken (2008) examined satisfaction with life in shrinking cities to investigate the effect of shrinkage on individual well-being. According to Delken, German cities can be divided into three groups: growing, stable, and shrinking cities, which lost population by -3%. Delken conducted a survey comparing satisfaction with life domains across these groups. The results show that while residents of shrinking cities are more concerned about their economic situation, this does not significantly affect their life satisfaction (Delken, 2008).

Overall, a shrinking city experiences structural and spatial shrinkage as it ceases to grow. Urban planning literature discusses three different concepts related to urban growth and shrinkage: population change, economic performance, and spatial changes in urban areas. In general, there are two indicators of urban shrinkage: long-term declines in population and spatial changes in properties. Population decline is a clear indicator of a shrinking city (Martinez-Fernandez, Kubo, Noya, & Weyman, 2012).



Over six years, Detroit has lost 40,982 people (source: Daily Detroit)



As of 2013, 30% of Detroit's parcels were vacant, and 18% of parcels with structures were unoccupied (Herrmann et al., 2018)

Figure 1. Example of two indicators (top: population loss, bottom: vacant parcels)

2.1. Population loss

Beauregard (2009) traced the historical variations in the United States to investigate correlations of contemporary population loss. He identified dominant factors in population loss by period: (1) during 1820-1920, the aberrant loss period, restructuring from trade to manufacturing and technological changes led to population loss; (2) 1950-1980, the decline period, restructuring from manufacturing to services and anti-urban federal policies caused population decline; and (3) 1980-2000, the shrinkage period, persistence of regional shifts and post-industrialism resulted in population loss. Contemporary urban shrinkage is not easily distinguished from earlier periods of decline, and cities did not suddenly begin to shrink (Beauregard, 2009). This study shows that urban shrinkage is a continuing trend that has not ended.

Großmann, Bontje, Haase, and Mykhnenko (2013) reviewed articles addressing the causes of urban shrinkage and identified three main causes: (1) deindustrialization, (2) suburbanization or urban sprawl, and (3) natural demographic change. They also described four planning issues related to shrinking cities: (1) urban inequality, residential segregation, and gentrification; (2) land use and land consumption; (3) resource efficiency and climate change mitigation; and (4) urban resilience (Großmann, Bontje, Haase, & Mykhnenko, 2013).

Rieniets (2009) explored the causes and effects of population losses in shrinking cities. According to Rieniets, population losses caused by internal migration between cities and suburbs contribute significantly to urban shrinkage (Rieniets, 2009).

2.2. Spatial Changes

Measuring changes in urban form can be an indicator of urban shrinkage. While physical transformation is the most visible sign of a shrinking city, shrinkage can occur with time lags (Pallagst, 2005; Rieniets, 2009). Many researchers indicate that abandoned properties are the most visible byproduct of urban shrinkage (Alexander, 2005; Hollander et al., 2009; Mallach, 2017).

Reis, Silva, and Pinho (2016) reviewed literature on spatial metrics addressing urban shrinkage and highlighted the potential for developing new spatial metrics to indicate urban shrinkage. According to their study, the most common spatial change in shrinking cities is the prevalence of vacant properties (Reis, Silva, & Pinho, 2016).

3. Urban Greening Strategies

One form of sustainable development is the urban greening strategy, which is defined as the cleaning, planning, and management of urban green spaces to create meaningful value

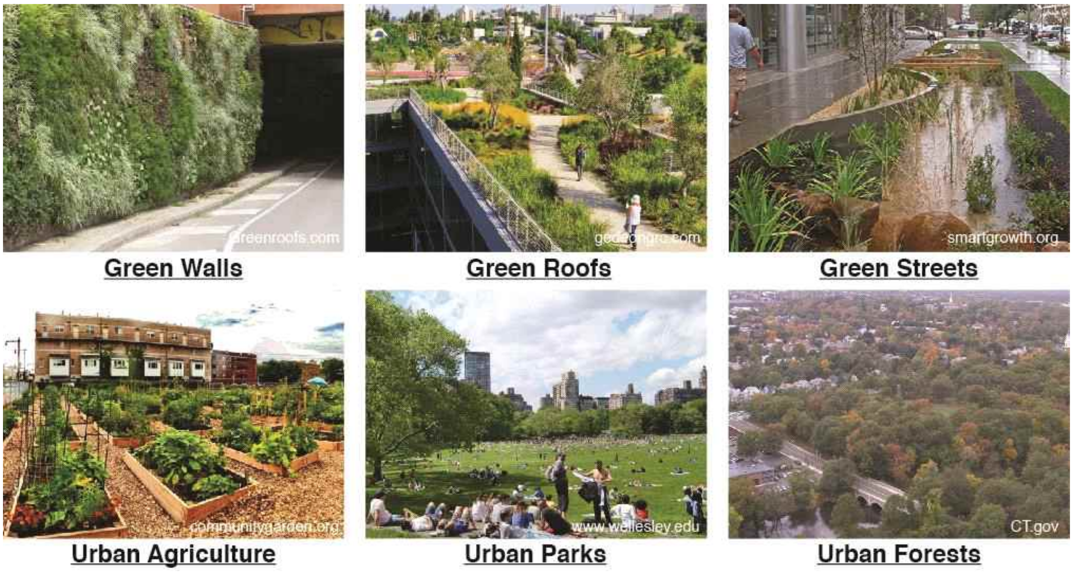


Figure 2. Types of urban greening strategy(Bae et.al., 2022)

for the local and urban areas (Nilsson, 2004). This strategy aims to make and keep cities green by adding multifunctional green areas. It covers various scales in urban areas, from small-scale green walls, roofs, and streets to large-scale urban agriculture, parks, and forests (Figure 2 & 3). Various types of urban greening strategies have contributed to the sustainability of shrinking cities in terms of their economies, equity, and environmental aspects. The following sections explain the urban greening strategy by each type.

Green walls represent all types of vegetated vertical surfaces. They provide several local benefits, such as increasing biodiversity, providing habitats (Francis & Lorimer, 2011), and acting as corridors for wildlife (Angold et al., 2006).

3.1. Green Walls

Manso and Castro-Gomes (2015) reviewed all types of green walls and identified the characteristics and technologies of each type. According to their classification, green walls are divided into green façades and living walls. Green façades are walls covered by climbing or hanging plants. This type of green wall can also be divided into indirect and direct types. Direct green walls have vegetation attached directly to the wall. Most traditional green walls are included in this type. Indirect green walls have vegetation attached to a supporting structure. Living walls are newly invented techniques designed to cover high buildings rapidly. This type uses a specific module designed for walls, and each module is supported by structures (Manso & Castro-Gomes, 2015).

3.2. Green Roofs

Green roofs are the roofs of buildings that are covered with vegetation (Castleton, Stovin, Beck, & Davison, 2010). A green roof offers many benefits to a building and the environment, such as stormwater management, improved air quality, reduction of urban heat islands, and providing urban habitats. Due to their benefits and aesthetics, green roofs have become a popular method for introducing vegetation in urban areas as a greening strategy. Particularly, urban green roofs help overcome the limitations of high-density urban development (Emilsson, 2008). Based on their depth and planting methods, green roofs can be divided into two types: extensive and intensive green roofs.

Castleton, Stovin, Beck, and Davison (2010) reviewed literature related to green roofs and documented their benefits, focusing on energy-saving functions. They conducted an empirical test to compare annual energy consumption by roof type: without a green roof, covered by turf, covered by shrubs, and covered by trees. The study identified key factors of green roofs as follows: (1) green roofs reduce energy use, (2) modern buildings save energy better, (3) the thicker the soil on the roof, the better the reduction of heat, (4) less dense soil is a better insulator, and (5) the moisture content of the soil affects the extent of heat loss (Castleton et al., 2010).

3.3. Green Streets

Green streets, as an urban greening strategy and green infrastructure in cities, are most commonly used to create green spaces along roads. Essentially, green streets contribute to mitigating urban runoff, reducing heat islands, providing wildlife habitats, and managing stormwater (Church, 2015; Wolch et al., 2010).

For stormwater management, green streets can be a lower-cost solution (Church, 2015). According to Church (2015), green streets and other green infrastructure help enhance the stormwater system.

The Environmental Protection Agency (2014) defines a green street as “a stormwater management approach that incorporates vegetation (perennials, shrubs, trees), soil, and engineered systems (e.g., permeable pavements) to slow, filter, and cleanse stormwater runoff from impervious surfaces (e.g., streets, sidewalks). Green streets are designed to capture rainwater at its source, where it falls. In contrast, a traditional street is designed to direct stormwater runoff from impervious surfaces into storm sewer systems (gutters, drains, pipes) that discharge directly into surface waters, rivers, and streams“ (US EPA, 2015).

Newell, Seymour, Yec, Renteria, Longcore, Wolch, and Shishkovsky (2013) reviewed eight greening programs in seven U.S. cities through

Table 2. Comparison of Urban Greening Strategies

Type	Definition	Scale	Technical Requirements	Cost
Green Wall	A plant system installed on the exterior walls of buildings	Small to Medium	Structural reinforcement, irrigation system, appropriate plant selection	Medium (installation and maintenance costs)
Green Roof	A plant system installed on the roofs of buildings	Medium	Waterproofing layer, drainage system, lightweight soil, plant selection	Medium to High (installation and maintenance)
Green Street	Roads and streets landscaped with trees and plants	Large	Suitable soil and irrigation system, maintenance	High (installation and maintenance costs)
Urban Agriculture	Activities of cultivating food crops within urban areas	Small to Large	Soil management, irrigation system, plant selection	Variable (depends on scale and crops)
Urban Park	Public recreational spaces within cities, including green spaces and recreational facilities	Large	Soil and plant management, irrigation system, recreational facilities	High (establishment and maintenance costs)
Urban Forest	Areas within cities with trees and forests	Large	Soil management, irrigation system, appropriate tree selection and maintenance	High (establishment and maintenance costs)

a sustainability planning framework to evaluate these programs as sustainable strategies. The authors concluded that these greening programs share responsibilities for green infrastructure maintenance and enhancement. Additionally, these programs contribute to managing stormwater issues within the context of sustainable planning (Newell et al., 2013).

3.4. Urban Agriculture

According to the WCED report, urban food growing, as a part of urban agriculture and gardening, provides food accessibility for the urban poor and supports urban development. The main benefits of urban agriculture include health and economic improvements through providing additional income from surpluses and creating new jobs (WCED, 1987).

Community gardens, as one type of urban agriculture, refer to open spaces managed by the local community for various purposes, such as cultivating food or flowers (Guitart, Pickering, & Byrne, 2012; Holland, 2004; Kingsley, Townsend, & Henderson-Wilson, 2009; Pudup, 2008).

Guitart, Pickering, and Byrne (2012) demonstrated three main values of community gardens —crops grown, groups involved, and land tenure —through literature reviews. According to their study, community gardens are used to grow food, operated by non-profit organizations, and owned by the public (Guitart et al., 2012).

3.5. Urban Parks

Pudup (2008) explained that an 'organized garden project' is not only a community garden but also a transformative power of gardening projects for individual and social transformation. The author compared two organized garden projects and assessed each project in terms of their individual, social, political and economic aspects (Pudup, 2008). This study shows that garden projects such as community gardens can be an antidote to social issues when the projects fit each programs' participants.

Urban parks have been a subject of many studies for a long time. Many studies have been designed to verify their positive and negative impacts on cities. To verify the role of urban parks in urban areas, many studies focused on three primary benefits: economic, social and environment (Stringer et al., 2006; Wolch et al., 2014). Three main benefits of urban parks can link to the framework of sustainable development directly. For example, the economic benefits of urban parks represent their impacts on increasing property values (Tajima, 2003), tax revenue and jobs (Stringer et al., 2006; Wolch et al., 2014). For social benefits, urban parks contribute to improve health, enhance social interaction and ameliorate social inequity (Barbosa et al., 2007; Chiesura, 2004; Ulrich, 1981; Ulrich et al., 1991). Lastly, environmental benefits of urban parks include improving biodiversity, providing wildlife habitat and managing stormwater (Chiesura, 2004; Tajima, 2003).

3.6. Urban Forests

Urban forests refer to all publicly and privately-owned trees and stands of remnant forest (Nowak & Dwyer, 2007; Nowak et al., 2010; Nowak, Noble, Sisinni, & Dwyer, 2001) and are a part of ecosystems that affect the quality of urban life. Urban forests as the biggest greening strategy for an urban area can contribute environmental quality, well-being and provide providing eco-services for people. Many benefits and functions of the urban forest come from the urban forest structure such as number of trees, sizes, species composition and location (Nowak et al., 2001).

Dwyer, McPherson, Schroeder and Rowntree (1992) assert that urban forests contribute various benefits to cities, such as a pleasant, healthful and comfortable environment to live. According to their study, as effective planning for an urban area, the urban forest has to be considered for its contributions of trees. They explained the benefits for the urban forest in two dimensions: (1) environment, (2) social dimensions. For the physical and biological en-

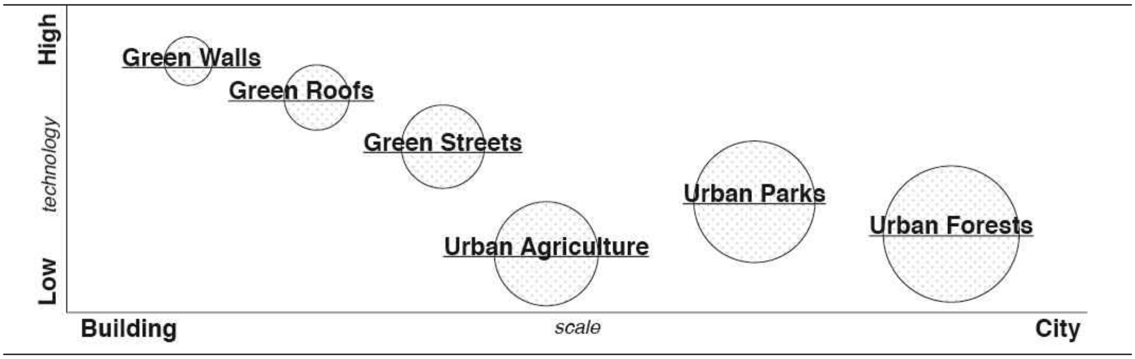


Figure 3. Scale of urban greening strategy

vironment, the urban forest contributes to energy and carbon dioxide conservation, at almost nine million tons per year. Trees in an urban forest contribute to improving air quality and reducing the costs associated with poor air quality. Urban forests also help reduce runoff, flooding damage, and stormwater treatment costs. Additionally, they provide noise reduction and various ecological benefits. In terms of social benefits, urban forests offer health and psychological benefits, societal advantages, increased real estate values, and support local economic development (Nowak, Noble, Sisinni, & Dwyer, 2001).

4. Urban greening strategies

An urban greening strategy can be used as a tool for sustainable development in shrinking cities for the following reasons: (1) the benefits of an urban greening strategy align with the three goals of sustainable development, (2) vacant lands and infrastructure in shrinking cities can be repurposed to generate meaningful value using an urban greening strategy, and (3) urban greening strategies minimize environmental costs and maximize environmental value for the future.

First, the three purposes of sustainable development can be satisfied by the three benefits of an urban greening strategy. Sustainable development aims to balance economic, equity, and environmental goals (Campbell, 1996; Wiechmann, 2008). Campbell (1996) identifies green, profitable, and fair as key concepts to resolve conflicts between planning goals and achieving sustainable development. Many scholars agree on the benefits of urban greening strategies, such as reviving the local economy, improving social interactions and social equity, and providing wildlife habitats (Holland, 2004; Nowak & Dwyer, 2007; Tyrväinen & Miettinen, 2000; Wolch et al., 2014). These studies demonstrate the potential of an urban greening strategy as a tool for sustainable development.

Second, the challenges of vacant lands in shrinking cities can be an opportunity to move toward sustainability through an urban greening strategy. Increasing vacant lands is a significant challenge in shrinking cities (Hollander et al., 2009; Mallach, 2017; Reis et al., 2016), as it is the most visible sign of shrinkage and a cause of other challenges, such as population loss. Transforming these lots into urban green spaces helps remove the causes of other challenges and provides ecosystem services to local residents. Additionally, this approach can increase adjacent property values (Wachter, 2004). Overall, an urban greening strategy addresses the challenges of shrinking cities by adding greenery to vacant lots.

The last and most powerful benefit of an urban greening strategy as sustainable development is the environmental benefits. Despite the economic and social benefits of a greening strategy focused on people and their use of green spaces, environmental benefits provide advantages not only to people but also to nature. Biodiversity, wildlife habitats, and improved air quality are commonly verified as environmental benefits of an urban greening strategy (Dwyer et al., 1992; Nowak et al., 2001). Stormwater management, reduced runoff, and the mitigated heat island effect also contribute to energy cost savings for cities (Castleton et al., 2010; Church, 2015; Fernandez-Cañero et al., 2013). The environmental benefits of an urban greening strategy are a key factor in sustainable development.

Lindsey (2003) examined the sustainability of urban greenways in Indianapolis using Berke and Conroy's six criteria (Table #). Berke and Conroy (2000) explore six principles of sustainable development: harmony with nature, livable built environments, place-based economy, equity, polluters pay, and responsible regionalism. Based on these principles, Lindsey developed an empirical framework to evaluate the sustainability of urban greenways (Lindsey, 2003).

For these reasons, an urban greening strategy as sustainable development can help solve the challenges of shrinking cities and create additional value. Essentially, the three benefits of an urban greening strategy align with the three principles of sustainable development. The urban greening strategy can also be a key solution for vacant properties. Lastly, an urban greening strategy provides ecosystem services to cities. For example, a greening strategy that replaces abandoned lands with green spaces can help retain stormwater, provide green and open spaces, and reduce runoff.

5. Conclusion

Shrinking cities have experienced population loss and economic depression linked to the spatial transformation of urban area in terms of vacant lands. Due to their unique features, shrinking cities require sustainable development. A restructuring of industry, demographic and economic dynamics, development for shrinking cities can lead to sustainability. At the same time, one of the important challenges, legacy infrastructure, can be a chance to revive the local economy, generate healthy environment and ameliorate social inequity. In this regard, this study investigated the greening of transportation infrastructure as a tool of sustainable development in shrinking cities.

Green space utilization in shrinking cities necessitates distinct strategies due to their unique characteristics and environmental conditions. In these cities, which face population decline and increased vacant land, the emphasis is on repurposing underutilized spaces and developing diverse green areas. Vacant lots can be transformed into community gardens and urban farms, enhancing the city's visual appeal and providing opportunities for urban agriculture. Additionally, the available land at the urban periphery allows for creating large parks and natural reserves, supporting regional biodiversity and offering recreational opportunities. By understanding these distinctions, urban planners can design green spaces that enhance residents' quality of life and address environmental challenges.

This study accentuated the importance of sustainable development in shrinking cities based on economic, social equity for blighted areas and improving the environment. Shrinking cities need for economic improvement since those cities stopped growing. Shrinking cities also have to solve inequity since urban shrinkage fosters social inequity. They also should consider environmental costs and benefits for the next generations. For those reasons, sustainable development which balances the economy, equity and the environment are needed for shrinking cities.

One of the limitation in this study is its reliance on literature review and theoretical discussions, without concrete empirical research results. Incorporating empirical data to verify the economic, social, and environmental impacts of the proposed green space utilization strategies would significantly enhance the assessment of each type's effectiveness.

This study also demonstrated various types of greening strategies to understand what and how those strategies impacts shrinking cities. Urban greening strategies contribute to generating economic, social and environmental benefits, and those benefits fit three principles of sustainable development. Shrinking cities can use an urban greening strategy to achieve sustainable development.

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