THE CREATION OF GREEN ROUTES AS A STRATEGY FOR THE SUSTAINABLE DEVELOPMENT OF THE ATTICA REGION: A MODEL OF HOLISTIC URBAN REGENERATION

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Abstract
This article focuses on the creation of green routes in the region of Attica, with the aim of promoting sustainable development and holistic urban regeneration. Green routes combine environmental, social and economic dimensions to create more resilientand vibrant cities. By integrating natural elements and green spaces into the urban fabric,greenways can enhance the ecological resilience of the area, addressing challenges such as air pollution and urban heat islands. The integration of sustainable practices is fundamental to this approach. Greenways have the potential to improve air quality and reduce temperature levels by expanding green spaces, planting trees and creating water features. These modifications can enhance biodiversity by creating a suitable environment for a wide range of plant and animal species. At the same time, the use of intelligent technology to monitor and manage greenways is vital for their effective operation. The application of technologiessuch as air quality and humidity sensors, as well as water management systems, can guarantee the efficient use of resources and the continuous improvement of the routes.

The implementation of green routes has important social and economic consequences. Some of the benefits that can result include improving the quality of life for residents, creating employment opportunities and boosting property values. Greenways can act as places for recreation and social participation, enhancing social cohesion and fostering a sense of community. Examining initiatives abroad through comparative analysis could provide important insights and best practices that could be used in Attica. Sharing experiences and improvements could enhance the efficiency and effectiveness of green routes, making them more sustainable and adapted to local requirements. In summary, the creation of green routes in Attica can be an effective strategy for sustainable development and urban regeneration. Through a combined approach of environmental, social and economic factors, green routes can enhance the resilience ofthe city and improve the quality of life of its inhabitants, while contributing to the protection and promotion of biodiversity.

Keywords: *Greenways, Sustainable urban development, Climate resilience, Participatory urban design, Smart technologies.*

Introduction

Climate change is a phenomenon that has been a major concern for the planet in recentdecades, as it has an impact on both the natural environment and on humans themselvesand their quality

of life. As a result of this phenomenon, an intense preoccupation with green infrastructure is beginning to be observed in terms of strategic as well as urban planning (Bakali & Chatzigeorgiou, 2022). Cities are in essence dynamic systems that are in constant evolution since both their size and social structures, as well as their geopolitical arrangements and technological systems change through the years (Agudelo-Vero et al., 2011; Kennedy et al, 2007). In 2021, urban population growth has been rapid, with the number reaching 4.4 billion people, and projections for urban population growth up to 2050 are noted at an additional 2.5 billion people, which may lead to a 66% increase in the global urban population (UN ORG, 2021).

This intense and rapid urbanisation leads to the urgent need to study the capacity of urban centres to provide water, energy, food, sanitation and waste disposal, as well as other services such as transport, social infrastructure and employment opportunities for both current and future conditions (Roaf, 2010; Poulaki et al, 2021; Rachiotis & Poulaki, 2024). The solution to this issue is considered to be urban resilience, through which sustainable development can be achieved, which is particularly important for modern spatial planning. Both resilience and sustainability are two concepts, which have at their core both society, economy and environment (Basiago, 1999). The aim of this paper is to study green routes as a primary strategy for sustainable development of the Attica region.

Literature review

Contemporary environmental problems and benefits of urban green routes

The main environmental problems facing urban areas in modern times are large and significant, such as lack of drinking water, inadequate waste management, energy overconsumption and air and soil pollution, as well as pollution from the use of fossil fuels. These problems are most acute in developing countries, where short-term economic objectives conflict with environmental protection. Cities consume huge amounts of natural resources and produce large amounts of waste, putting a strain on the local and global environment.

The urban heat island effect is also an environmental challenge, as is the management of stormwater affected by urbanisation and pollution (Irwin & Brockstael, 2004; McMichael, 2000). During the heat island effect, urban areas are significantly warmer than rural areas due to human activities. The temperature difference is most pronounced at night and in the summer months. The main cause is the change in land surfaces, while energy use is a secondary contributor (Li & Zhao, 2012; Solecki et al., 2005). The heat island can affect precipitation, length of growing seasons, and air and water quality. Mitigation can be achieved through green development and improved urban planning. There are concerns about its impact on climate change, with conflicting research results (Chakraborty & Lee, 2019; Glossary of Meteorology, 2019). Regarding flood risk, according to the World Meteorological Organization (WMO/GWP, 2008), urbanization contributes to an increase in flood risk due to changes in hydrological processes. Increased artificial surfaces, arbitrary building and inadequate infrastructure reduce the capacity of water to be absorbed by the soil, accelerating its accumulation (Johnson et al., 2016; Zhang et al., 2008). Floods cause significant loss of life and property and are among the most frequent natural disasters worldwide, accounting for 43% of recorded events in the last 20 years (Huong & Pathirana, 2013; Myers, 2016).

Urban greenways are a condition that offers a significant set of environmental benefits to large urban centers. Some of these benefits include improved microclimate, as plants have a significant impact on regulating both temperature and humidity (Rachiotis & Poulaki, 2024), and through photosynthesis significant amounts of carbon dioxide are captured, which offsets

the carbon footprint of humans on the environment (WWF, 2009). Networks of urban green infrastructure, such as parks and green corridors, support ecological connectivity and provide habitats for diverse flora and fauna (Liu & Russo, 2021; Zhao et al, 2024a). Other benefits of greenways include heat island mitigation, significant reduction of air and noise pollution, soil retention and aquifer enrichment, along with biodiversity protection (Kiani et al, 2014; Nicol & Blake, 2010). For example, Central Park in New York has been found to reduce temperatures in surrounding areas by 2-5°C, while similar parks in Tokyo have reduced temperatures by 2°C (Xing et al, 2017). Urban greenways also play an important role in both absorbing and filtering solar radiation (Gao et al., 2018; Santamouris, 2014), and what was observed by research by Chen et al. (2014) is that green infrastructure in the city can reduce average seasonal summer temperatures. The role of plants along these routes is also important in reducing air pollution (Wolch, 2014), and their soundproofing properties are also important (Cinderby & Bagwell, 2017; Gozalo et al., 2017; Paker etal., 2012; Zhao et al., 2024b).

In general, green infrastructure is an important space for social interactions forvisitors, as well as a release from everyday life and stress (Thompson et al., 2014; Vanden Berg, 2017). It is also worth noting that they can play an important role in both education and civic culture through the development of educational seminars as well ascultural events. In terms of social benefits, one of the most important is the aesthetic improvement and upgrading of the city's image (Ariane et al. 2005), as well as covering part of the social, cultural and recreational events of cities and improving interpersonal relations of all citizens (Krellenberg et al., 2014). Green streets provide people with more spaces for exercise, relaxation and socialisation, which improves theirquality of life. Stress can be reduced, physical and mental health can be improved, andcommunity cohesion can be enhanced. Residents congregate in these areas, which enhances a sense of belonging and strengthens social ties (Liu et al., 2020; Sturiale & Scuderi, 2024).

Another function of green spaces is their economic benefits, as they can attract both entrepreneurs, who can invest in the area, and tourists. Through greenways, employment is provided in the construction and maintenance of these infrastructure projects, thus boosting local businesses (Rachiotis & Poulaki, 2024). The construction of these infrastructures requires personnel ranging from engineers and environmentalists to construction and maintenance assistants. Greenways contribute to the development of leisure and tourism services; therefore, they can also create jobs in sectors such as tourism and outdoor activities. Among the economic benefits is also thefact that it contributes greatly to increasing the zoning value of both buildings and land, as well as increasing the income tax paid to municipalities (Kiani et al., 2014; Rachiotis & Poulaki, 2024). According to a study conducted in Sydney, residential properties neargreenways experienced an increase in value of about 6%, providing economic benefitsto property owners and the local property market.

Urban resilience: definition and strategies to promote it

Resilience, as a concept, is characterized by a multitude of definitions, but at the core of the concept is the capacity to both respond and adapt, and to evolve as a result of different forms of stress and risk (Hassler & Kohler, 2014). The simplest definition of urban resilience, however, is in essence the capacity that a city has to absorb various disturbances while maintaining both its functions and structures (Holling, 1973; Levine et al., 2012; Li & Zhao, 2012). Another definition is that of Carpenter et al. (2001, citedin Desouza & Flanery, 2013), according to which urban resilience indicates the ability that systems have to increase their capacity for adaptation and learning. Also, through a report by the Global Forum regarding Urban Resilience and Adaptation, a resilient city is defined as a city ready to absorb and recover from shocks and stressful conditionswhile maintaining its core functions as well as its

own identity (ICLEI, 2015).

Regarding strategies to promote urban resilience, Mahmood (2023) argues that resilient strategies should include preparedness, perseverance, innovation and adaptability in order to be able to respond to crises. These strategies should be flexible and adaptable to the needs of each city, based on local priorities (Mahmood, 2023). Meerow (2016) also highlights the importance of people in resilience, noting that citizens and organisations involved in planning are crucial to the success of strategies. What she argues is that it is worth considering who benefits from resilience and who may be harmed (Meerow et al, 2016). Another study is that of Sapountzaki (2007), who suggests that social resilience should be considered as a mechanism that can transfer vulnerability from one social actor to another, arguing that individual and collective resilience may come into conflict. Assessing the systemic linkages between communities and risks is critical to resilience. Planning should focus on reducing vulnerability for all and maintaining individualized resilience within the broader common interest (Sapountzaki, 2007).

According to Hassler and Kohler (2014), the existence of a resilience framework with common standards and rules may help reduce inconsistencies in strategies. Resilience is based on integrity, coordination and self-improvement (Folke et al., 2004). As the UN Habitat report (2015) suggests, an effective resilience strategy is directly related to political stability, the existence of strong government structures, integrated public-private partnership and strategies of long-term planning. Widavsky (1988) (cited in Hassler & Kohler, 2014) points out that anticipatory strategies, although frequent, often increase vulnerability due to the uncertainty of threats, while resilient strategies aim to deal with the unexpected.

Good practices in green infrastructure management

By conducting a comparative analysis with international green and infrastructure projects, it is possible to gain valuable insights into the effectiveness and innovation of these projects, which can be used to optimize and adapt them to local conditions (Amin, 2023; Kim, 2020; Lindsey, 2022):

1. **The High Line in New York, United States**

The High Line is an elevated green corridor created on an old railway line, turning it into a popular park. In addition to incorporating architectural and natural elements, the project has helped increase property values in the area by 10-20%, boosting tourism and attracting new businesses. The High Line is an example of successful urban regeneration through green infrastructure.

2. **Promenade Plantée in Paris, France**

The Promenade Plantée, built on a former railway line, is considered a pioneering green project that seamlessly integrates the urban environment with the natural world. This initiative promotes social unity and creates green recreational areas in densely populated urban areas (Lindsey, 2022).

3. **Superkilen in Copenhagen, Denmark**

Superkilen is a public space that integrates sustainable infrastructure and cultural elements from different nationalities, promoting social cohesion. The project has been designed with the involvement of the local community and has enhanced the quality of life of the residents. The incorporation of innovative design elements and the use of green infrastructure enhance the multicultural integration of the area (Amin, 2023).

4. **Cheonggyecheon - Seoul, South Korea**

This urban regeneration project, which included bringing the Cheonggyecheon underground river back to the surface, serves as a model for restoring natural features in urban areas. The redevelopment of the area had a significant impact on the local economy and social cohesion, as it significantly reduced the temperature in the area, attracting thousands of visitors daily and enhancing ecological resilience (Kim, 2020).

5. **Faelledparken, Copenhagen, Denmark**

Fælledparken is one of Denmark's largest parks, with a focus on sustainable urban development. It offers sports facilities and smart infrastructure, and has become a meeting point for the community, enhancing social inclusion and health (Andersen, 2021).

The evaluation of these initiatives shows that green initiatives, when developed with social and economic aspects in mind, offer many advantages. The knowledge gained from these initiatives can be applied to the development of the green routes under consideration in Attica, which will improve public health, promote economic growth and enhance biodiversity by boosting property values and tourism.

Technologies for the effective management of green routes.

The application of smart technologies to monitor and manage green routes is growing rapidly, integrating solutions such as sensors, IoT, data networks and artificial intelligence (AI). These technologies enhance biodiversity, monitor air quality and green spaces, and improve the user experience. IoT sensors record real-time environmental data such as air quality, humidity and temperature. With this data, it is possible to monitor ecosystem health and make timely maintenance decisions. In addition, biodiversity monitoring systems using infrared and cameras record the activity of animals and plants, providing valuable information for conservation (Ahmadet al., 2023).

Artificial intelligence (AI) and machine learning (ML) analyse the data collected, providing predictive models to help make decisions. These systems can predict future environmental changes, highlighting problems such as air quality degradation and biodiversity loss, while supporting the maintenance needs of greenways. Data from sensors and other sources are stored and analysed in cloud-based management platforms. These platforms allow managers to access critical information on environmental conditions and biodiversity in real-time, enabling immediate decision-making for the management and maintenance of greenways (Huchler, 2023; Nasenisafavi & Huang, 2020).

Smart watering systems use soil moisture sensors to automatically activate watering only when necessary, saving water and avoiding overuse. Also, the use of smart lighting that adjusts based on the presence of people or natural conditions improves energy efficiency and safety on greenways. The following *IoT* technologies are central to the management of greenways (Korkou, 2023):

1. Environmental monitoring sensors: measure factors such as CO2 and particulate matter (PM2.5, PM10) and send real-time data via the cloud for analysis and processing. This data helps with plant and site maintenance.
2. Smart watering systems: They adjust the water supply according to the needs ofthe plants, saving water resources and avoiding excessive consumption.
3. Motion and population sensors: They monitor human activity on greenways, allowing for better design and safety of spaces, as well as adjusting maintenancebased on usage (Coutts & Hahn, 2015).
4. Data management networks and platforms: data from sensors are collected andprocessed, creating integrated systems for monitoring and managing green routes. These platforms

are based on cloud computing and provide real-time updates for maintenance or interventions.

5. Smart lighting: smart lighting automatically adjusts to the presence of people or natural conditions, reducing energy consumption and improving safety at night.
6. Drone Monitoring: drones can be used for surveillance and monitoring of largegreen areas and trails. These systems offer the opportunity for aerial inspections, providing data on plant condition, animal presence and potential soil erosion (Štrbac et al., 2023).
7. GIS (Geographic Information Systems): GIS systems allow the mapping and analysis of data related to green routes. Information collected from IoT sensors, drones and other means can be integrated into a GIS to provide a clear picture of environmental conditions such as routes, biodiversity and infrastructure quality (Misbari et al., 2023).
8. Participatory Management Platforms: through crowdsourcing applications and platforms, users of green routes can participate in their management by reporting problems such as the destruction of infrastructure or the presence of pollution. This type of technology enhances the interaction between the community and local authorities, facilitating the maintenance and managementof routes (Sturiale & Scuderi, 2019).

Overall, the use of smart technologies on greenways improves functionality, promotes sustainability and saves resources, making green spaces more efficient and ecologically friendly. Artificial intelligence (AI) systems play a key role in monitoring and managing greenways, processing big data from IoT sensors, cameras and data networks. By analyzing this data, AI systems create predictive models, helping managers make more accurate and efficient decisions for maintaining ecosystems and infrastructure. The operation of AI systems involves several stages (Thompson & Green, 2020):

1. Data Collection: IoT sensors installed on the greenways collect real-time information on air quality, temperature, humidity and biodiversity. The data is transferred to centralized servers via cloud platforms (Jiang et al., 2021).
2. Data processing: data is analysed through AI and machine learning (ML) algorithms that identify trends, such as changes in air quality or weather conditions, and predict future situations (Liu & Jay, 2021.
3. Predictive Analysis: with ML techniques, AI can predict when watering is needed or detect anomalies such as low air quality so that automatic action can be taken (Suárez et al., 2024).
4. Automated Decision Making: AI systems can automatically activate watering systems or adjust lighting based on environmental conditions, improving energy efficiency (Jena & Utete, 2024).
5. Learning from Historical Data: AI systems improve over time, learning from data and increasing the accuracy of models, helping to improve management practices (Chen et al., 2022).

This process leads to significant optimization of the operation of green routes and reduction of environmental impacts through intelligent management of natural resources. Regarding the advantages of AI in green routes, these are as follows (Ahmad,2023):

1. Automated Management and Maintenance: AI reduces the need for human intervention by automating functions such as watering and lighting. Intelligent watering systems adjust watering based on real data, such as soil moisture, reducing water waste.
2. Accurate Decisions:Thanks to ML algorithms, AI systems predict future environmental situations and maintenance needs, allowing managers to make timely proactive decisions, avoiding crises (Shao et al., 2021).
3. Sustainable Development and Reducing Energy Costs: Intelligent AI-controlled lighting systems adjust light intensity based on human presence and conditions, reducing energy

consumption and costs. AI-adapted heating and cooling systems also help reduce energy footprints.

4. Biodiversity monitoring: AI monitors biodiversity through sensors and cameras,recording the activity of animals and plants. This helps to maintain ecosystemsand protect species in urban areas (Anderson & Gough, 2022).
5. Efficient Data Management: AI systems manage huge volumes of data from IoTsensors in real-time, providing managers with detailed information on environmental conditions and enabling better management.
6. Improving the User Experience: AI systems can improve the user experience ongreenways by providing personalized information, such as the best routes for hiking or biking, depending on weather or traffic conditions (Hussain & Mishra,2020).

These advantages make AI an important tool for the sustainable development and improved operation of green routes. By using these technologies, greenways become more functional, sustainable and efficient, while enhancing eco-efficiency and user experience.

Methodology

The purpose of the study was to investigate the role of green routes in the Region of Attica as a means of promoting sustainable urban development and holistic urban regeneration. The research also analyzed examples of good practice from other cities abroad, with the aim of providing concrete guidelines for the design and implementation of these routes in Attica. By studying successful models of urban regeneration and green infrastructure, the study proposed concrete measures that will help to better manage natural resources and improve sustainable development in the region.

Study Objectives:

1. **Analysis of sustainable practices:** Examining the use of green routes to improve air quality, reduce temperatures and enhance biodiversity.
2. **Implementation of smart technologies:** Study the technologies used to monitor and manage green routes.
3. **Impact on society and the economy:** Assess social and economic impacts,such as job creation and increased property values.
4. **Comparison with international projects:** comparative analysis with similar international projects to assess efficiency and innovation.

Research Questions:

1. What are the main environmental challenges facing Attica and how can they beaddressed through the development of green routes?
2. What are the social and economic benefits of the implementation of green routesin the region of Attica and in general?
3. Which technologies are necessary for effective management of green routes?
4. How do the green routes in Attica compare with similar projects in other cities?
5. What policies and incentives are needed to encourage the use of green routes bythe local community and investors?

The research methodology was based on an extensive literature review and the use of keywords such as: "green routes", "sustainable urban development", "ecological resilience", "biodiversity", and "Attica", in order to identify relevant studies and examples of international practices. The search was conducted on databases such as Google Scholar, Scopus, and ScienceDirect, which provide access to reliable sources for academic articles and studies on

sustainable infrastructure and urban development. The analysis focused on evaluating good practices from cities internationally that have implemented green routes and compared these examples with the current situation in the Region of Attica.

The delimitations and limitations of the research on green routes in Attica relate to several factors:

1. Geographical limitation: the study focused on the Region of Attica and its municipalities, such as Athens and other urban and peri-urban municipalities. This geographical limitation limited the possibility of drawing general conclusions for other regions of Greece or abroad, as environmental, social and economic conditions may vary considerably from region to region.
2. Need for Intersectoral Cooperation: The success of implementing green routes depends on effective cooperation between local and regional authorities, citizens, private actors and environmental organisations. Lack of coordination and administrative complexity in Attica may delay or limit the implementationof these strategies.
3. Budget and funding constraints: Greenways require significant funding for implementation and maintenance. Although European and national funding instruments such as the NSRF are available, limited resources may prevent thefull implementation of the proposed green infrastructure.

Case study results: Region of Attica

Particularly in the municipalities of Attica with extensive construction, such as the municipality of Athens, there is a significant lack of green spaces. The mental and physical health of residents is negatively affected by the limited opportunities for outdoor activities and social interaction in these areas. The creation of interconnected parks and green corridors can create new recreational spaces and enhance citizens' health. These trails can be utilized for social events, hiking, thus providing residents with healthier and more sustainable environments (Amin, 2023; Lindsey, 2022). The municipalities of the Attica region face serious flooding problems during periods of heavy rainfall as a result of increased urbanisation and the cementing of natural lands. The risk of flooding can be mitigated by implementing green corridors incorporating natural materials such as bio-permeable soils (e.g. rain gardens) to manage precipitation.These pathways can act as natreduceorption systems in Attica, allowing water to infiltrate into the land and reducing the risk of flooding (Anderson & Gough, 2022).

The destruction of natural ecosystems and the reduction of biodiversity have been the consequences of extensive building in Attica. Species loss is a consequence ofthe insufficient natural habitats available in urban areas for plants and animals. Greenways can act as ecological corridors that facilitate animal mobility and plant propagation by connecting scattered natural areas. This helps to develop more resilient urban ecosystems and improve biodiversity (Misbari et al., 2023; Štrbac et al., 2023).

In particular, the municipality of Athens has a specific resilience strategy for 2030, which aims to create a green and affordable city through the support of environmental infrastructure within the urban fabric (Resilient Athens, 2019). One of the strategies on which the resilience programme focuses is climate issues, with a focus on adaptation to climate change. In general, climate change is beginning to be perceivedas a cross-cutting issue, which directly depends on various sectors that it affects, such as water transport and management, land use, energy and resource consumption, as wellas the social and economic assessment of its impacts and actions to prevent or mitigateit (Resilient Athens, 2019).

The Athens Resilience Strategy is organised around four central axes that reflectthe desired future state of the city. Each axis includes specific objectives which, in turn,are accompanied

by specific actions that work together to realise the overall vision (Resilient Athens, 2019). Among the 44 planned actions, those that focus on climate change stand out. These are divided into two categories: actions that aim to reduce greenhouse gas emissions (mitigation) and actions that adapt the city's infrastructure towithstand new climate challenges (adaptation). Some of these actions, such as urban regeneration, include both elements. The second pillar focuses almost exclusively on climate change, with the aim of creating mitigation and adaptation plans. It also includes development projects, such as improving the city's energy, food and management systems. The actions aim, among other things, to create natural infrastructure such as green zones and better manage them to enhance the natural environment and promote the quality of life of residents. The third axis focuses on preparing the city for future crises, while the fourth deals with the regeneration of derelict areas and the linking of green spaces with cultural sites. There are also actions related to improving governance and social cohesion, mainly at the neighbourhood level (Resilient Athens, 2019).

The new Athens Regulatory Plan 2021 (Law 4277) played an important role in the organization of the green grid in the Attica region./2014), according to which it seeks both the promotion and the creation of *"routes of cultural timelessness"* through the organization of cultural walks, as follows from Article 15, as well as the implementation of a *"green arc"* through the connection of the center of Athens with the mountainous areas surrounding it through the implementation of appropriate interventions, as follows from Article 19. What is also sought, according to Article 30, is the development of sustainable mobility through the development of a metropolitan transport network for both pedestrians and cyclists.

There are several municipalities in the Attica region for which a plan of green routes is being developed, including the municipality of Fylis and the municipality of Ag. Regarding the green routes of the municipality of Fylis, it has been proposed to create sidewalks and roads with gentle traffic mainly in central points, in order to give priority to pedestrians and make the city center more livable, as well as the creation ofa bicycle path, marking a circular route within the municipality (Tzortzi et al, 2019). Regarding the municipality of Ag. Anargyroi-Kamatero, what is proposed for the implementation of the green routes is the creation of roads and sidewalks of gentle traffic mainly in central points, the realization of studies of the municipality in the places where the pedestrianization takes place and the creation of a bicycle path, moving in a circular way within the municipality as an extension of the existing one (Rachiotis & Poulaki, 2024; Tzortzi et al., 2019):

In general, Attica has in recent years focused on many important green projects aimed at improving the quality of life of its residents and promoting sustainable development. These projects incorporate sustainable infrastructure, the creation of green spaces and the enhancement of the ecological resilience of the region. More specifically, some of the major green projects in Attica are as follows:

1. Redevelopment of the Falirikos Ormos: This project aims to create a large parkthat will connect the sea to the city, while improving the environmental resilience of the area, offering flood protection and new recreational infrastructure. The Region of Attica announced the European Funding of € 370 million. € for the construction of the Metropolitan Park of 541 acres in Faliro Bay, something that puts back on track the implementation of the major project that had remained unfinished, which is largely due to the efforts of the current Regional Authority.
2. Stavros Niarchos Park: the Stavros Niarchos Foundation Cultural Centre is a model of modern green development, covering an area of 210,000 sq.m. and offering recreational and sports facilities using sustainable practices.
3. Redevelopment of Panepistimiou Avenue: As part of the "Great Walk of Athens" project, sustainable mobility was promoted by planting trees and creating greenroutes that enhance the possibility of walking, while reducing traffic congestionin the centre of Athens.

4. Park Tritsis: One of Attica's largest urban parks, it offers natural wetlands, education and recreation, and is a model of sustainable urban development.
5. Redevelopment of Gazi and Kerameikos: This area has been regenerated through green urban development projects, enhancing social cohesion and creating spaces for cultural and community events.
6. Redevelopment of Omonia Square: The recent renovation of the square, with a fountain and green infrastructure, has enhanced the aesthetic and functional value of the area, making it pedestrian-friendly (Senosiain, 2020).
7. Lycabettus redevelopment: The aim of the project is to protect the natural environment, create more green routes and enhance recreation while respecting the ecosystem (Kendal, 2023).
8. Redevelopment of Elaionas: The regeneration of this industrial area includes the restoration of natural elements and the creation of green spaces, looking forward to a sustainable integration into the urban fabric.
9. Redevelopment of Agios Panteleimon Square: Seeking to increase green spaces in one of the most densely populated areas of Athens, promoting social inclusion and environmental upgrading.
10. Green metro corridors and cycle paths: Extending cycle paths and planting greenery along the metro will help improve sustainable mobility and reduce pollution.
11. Gudi Park: One of the largest parks in Athens, where upgrading projects include greenways and biodiversity conservation (Liu et al., 2020).
12. Urban vegetable gardens: In areas such as the Municipality of Athens and Peristeri, vegetable gardens have been developed to promote sustainable agriculture and social cohesion.

The region of Attica can learn important lessons from international examples. Projects that combine green infrastructure with a social and economic dimension have multiple benefits, such as improving the quality of life, increasing property values and attracting tourists. With proper adaptation and planning, Attica can create green routes that enhance biodiversity, promote public health and strengthen the local economy.

It is clear that the implementation of the above, as well as the development of a smart city in this context, requires the existence of a Digital Policy, which is characterized by a set of actions aimed at promoting the use of ICT and opening up new channels of communication. Therefore, what this policy involves is, in principle, the adaptation of the internal services of the municipality, such as payroll, civil registers and databases, through the adoption of digital documentation and digital signatures. Another included action is the improvement of municipal services offered to citizens through the municipal web portal and the Digital Service Centre. One of the most important actions is clearly that of the Smart City, which concerns the development of the use of information technology at public level. Its realization requires a combination of three activities, which are interrelated. The first of these is the creation of a single Wi-Fi network through which all the neighborhoods in the region will be connected online. The second is to introduce broadband networks wherever possible, while the third is to introduce sensor-based monitoring systems. In order to make the above possible, it is necessary to support citizens through participatory processes, such as for example app development marathons, research and development workshops, open school activities and small digital workshops (Resilient Athens, 2019).

In order to promote sustainable development in Attica, a holistic urban regeneration model is proposed, with the following main axes:

1. Creating connected green infrastructure: Connecting green spaces such as parks and squares through greenways improves biodiversity and quality of life, while reducing

temperatures and improving air quality.
2. Sustainable mobility: The creation of cycle paths and pedestrian walkways linked to public transport reduces dependence on cars and promotes the use of clean forms of transport.
3. Green economic zones: Strengthening the green economy through specific zones that support sustainable entrepreneurship will attract investment and create jobs.
4. Protecting biodiversity: Restoring natural ecosystems, such as wetlands and forests, is important for biodiversity protection and environmental resilience.
5. Smart technologies: The use of technologies such as IoT sensors and drones tomonitor air quality and resources will improve the management of green infrastructure. Technologies already in use are IoT (Internet of Things) sensors, a technology already used in some green regeneration projects in Attica to measure air quality and pollution levels. Also, many greenways and parks are already using automatic watering systems linked to moisture sensors in the ground to manage water consumption in the most efficient way. This allows for reduced water waste and better maintenance of vegetation, especially in the summer months. The use of AI and machine learning can enhance the predictive analysis of data collected by IoT systems. These systems can predict when maintenance or watering is required, as well as identify areas at risk of damage due to environmental factors. This technology is not yet widely used in Attica but could significantly improve efficiency in managing green infrastructure. Furthermore, smart lighting infrastructure that adjusts intensity according to the presence of people or weather conditions can reduce energy consumption and enhance safety on greenways. This technology is still limited in use in Attica and could be extended more widely to public spaces. Finally, the integration of stormwater management systems, such as bio-permeable materials and rainwater storage systems, is critical for flood and water management in Attica. Although some examples exist, full adoption of these technologies is still in itsearly stages.
6. Urban farming: Promoting urban agriculture through vegetable gardens will contribute to food self-sufficiency and social cohesion.
7. Renewable energy sources: The energy efficiency of buildings and the use of renewable energy sources are critical elements for reducing emissions and green growth (Corlett & Hatchwell, 2023).

For Attica Region, the priority for green projects focuses on strategies that address major environmental and urban challenges. Based on the projects already planned, the following projects are considered critical:

1. Regeneration and Integration of Urban Parks
The Region of Attica is focusing on the interconnection and integration of large urban parks, such as Tritsis Park, Areos Field and Attica Park. This strategy aims to create green routes that will improve accessibility to green spaces and help reduce temperatures in densely populated areas.

2. Green Cultural Routes
The creation of green cultural routes linking archaeological sites, parks and areas of high cultural interest is promoted. These projects have already started in areas such as Kallithea, Alimos and Paleo Faliro, with funding from the NSRF.

3. Major Urban Renewal
Projects such as the redevelopment of the Faliriko Ormos are a priority, as they aim to transform the area into a sustainable green and recreational zone, in order to tackle flooding,

improve the quality of life and enhance biodiversity (https://patt.espa2127.gr/)

4. Sustainable Mobility
The creation of networks of cycle and pedestrian paths to facilitate sustainable mobility is an important priority.

5. Urban Regeneration Programme in the Centre of Athens
The redevelopment of Panepistimiou Avenue and other areas of the city centre are strategic priorities aimed at improving sustainable urban development, with an emphasis on green zones and pedestrian spaces.

Policies and incentives to encourage the use of green routes by the local community and investors.

To encourage the use of green routes by the local community and attract investors, specific policies and incentives are needed to promote sustainable development and citizen involvement. The following are the key policies and incentives that are needed:

1. Awareness and Education Campaigns
Informing and educating citizens about the benefits of green routes is crucial to promote their use. Local authorities can organise awareness-raising campaigns on the environmental and social value of these projects, encouraging the active participation of local residents. Also, introducing programmes in schools that reinforce environmental education can contribute to the long-term adoption of green practices by young people (https://www.espa.gr/el/Pages/ProclamationsFS.aspx?item=6523).

2. Strengthening Public Transport and Sustainable Mobility
To encourage the use of green routes, there must be direct and easily accessible connections to public transport. Integrating green routes into the public transport network, with cycle paths, pedestrian walkways and links to metro and bus stations, will facilitate their use by residents.

3. Financial Incentives for Investors
Investors can be encouraged to develop green projects and participate in regeneration through tax incentives, subsidies or financial instruments from the state and the EU, such as the NSRF. Subsidizing sustainable green infrastructure investments could boost private and business involvement, as investments in sustainable urban development are associated with higher returns due to increased property values and attracting tourists(https://tkm.tee.gr/).

4. Participatory Design Programmes
The active participation of residents in the design and management of green routes is important for their success. Through participatory planning, local communities will be able to express their needs and feel that these projects are responsive to their priorities and concerns. This can encourage continued use of trails and community adoption of green spaces.

5. Improving Safety and Accessibility
Safety is a key factor in attracting users to green routes. Good lighting, safe routes for pedestrians and cyclists and police surveillance to protect citizens must be ensured. Improving accessibility for people with reduced mobility will also increase the use of the routes by a larger proportion of the population.

6. Development of Public Events and Activities
Greenways can become vibrant spaces if they regularly host public events such as open- air markets, festivals and sports activities. This will attract residents and create a vibrantspace that will promote the sharing of public space (https://xronikadramas.gr/prasines- diadromes-greenways-kai-o-rolos-toys-sto-astiko-perivallon/).

7. Integration of the parks of Attica
The aim of the current Regional Authority, led by Nikos Hardalias, is within the five- year period 2024-2029 to utilize every available resource, on the basis of a holistic design, to upgrade the metropolitan green spaces, in order to return them to the citizensas they should be: Open, safe, usable, fully accessible public spaces for recreation, sportand socialization, based on the best practices of all advanced Western countries. Placesthat can host cultural, artistic and social activities, which will be a reference point not only for local economies and communities, but also for the hundreds of thousands of visitors who choose Attica as a destination every year.

In this context, the integration of the large urban and peri-urban parks of Atticathat are under the jurisdiction of the Region is planned through green routes - routes that will have as final destination the Green and Sustainable Attica (https://www.ot.gr/2024/06/16/epikairothta/xardalias-prasines-diadromes-gia-viosimi- attiki/).

Conclusions - Future Recommendations

Urban resilience is emerging as a fundamental factor for the survival and prosperity of modern cities. Ever-increasing challenges, such as natural disasters, social inequalities and environmental changes, make it necessary to adopt strategies that enhance the resilience and capacity of cities to recover from crises. The social dimension of resilience should not be overlooked. Cities that promote social cohesion and active citizenship are better able to face challenges. Empowering local communities through education and information creates a support network that can be mobilized in times of need. Citizens who are active and involved in their communities feel a greatersense of responsibility for the well-being of their city, thus enhancing the resilience ofthe urban environment.

The adoption of smart technologies on green routes offers many advantages, such as the ability to monitor air quality, temperature and other environmental parameters. Through data collection, cities can optimize infrastructure maintenance andreact more quickly to potential threats. This innovation is not only about technology, but also about resource management strategy, offering ways to save and develop sustainably. The creation of green routes in the Attica Region is an important step towards sustainability and urban resilience. These trails offer opportunities for environmental education, recreation and physical activity, enhancing the health and well-being of residents. In addition, they promote residents' connection to nature, whichis critical for mental and physical well-being.

The implementation of such initiatives is not only imperative for the current situation, but also essential to ensure a sustainable and resilient future. Collaboration between public bodies, private organizations and civil society will be crucial to the success of these strategies. With the right support and coordination, cities can becomemodels of resilience and sustainability.

Future extensions of the research on green routes in Attica can focus on variousareas that will enhance sustainable urban development and broaden the applications andbenefits of green infrastructure. Future research could examine how smart networks of sensors and monitoring systems can contribute to better management of resources (e.g., water, energy) and maintenance of green infrastructure.

Also, a participatory process in the design and maintenance of green routes is important

for their sustainable use. Research can focus on how local communities can be more actively involved in decision-making on the development and management ofgreenways. In addition, studies could examine the impact of social cohesion and the adoption of greenways by different social groups. Future research could focus on the economic analysis of greenways, looking at how their creation and maintenance affects the local economy. This could include assessing the impact on property values, job creation, and the promotion of tourism in urban areas. These directions offer a rich opportunity to enhance scientific knowledge and practical application in upgrading Attica's green infrastructure and promoting more sustainable and resilient urban development.

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