Going Green: Blue-Green-Cycling Networks as Effective Tools for Sustainable Development in European Cities

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1 Introduction

Contemporary cities face increasingly complex, dynamic, and multidimensional challenges that cut across environmental, social, and spatial domains. Environmental threats include climate change, biodiversity loss, groundwater depletion, flash floods, pollution, and urban smog. Social challenges involve declining quality of life, deteriorating public health, limited access to green areas, mobility exclusion, socio-spatial segregation, and inefficient public services. Spatial pressures stem from the rising costs of maintaining expanding infrastructure, the degradation of urban landscapes, car congestion, and suburban sprawl (Jha et al. 2013, Bilska 2016). Addressing these issues requires not only reactive mitigation of negative impacts but also proactive strategies that strengthen resilience, adaptive capacity, and the ability to sustain well-being under conditions of crisis and uncertainty (Montgomery 2021). The resilient city is not merely one that survives disturbances but one that leverages them to adapt and improve (Drobniak 2013, Czachor 2019).

One promising approach to urban resilience is the integration of blue-green infrastructure (BGI) with cycling networks, forming blue-green-cycling networks

(BZCNs). These networks connect natural ecological systems with active mobility infrastructure, diversifying urban functions and enhancing ecological, social, and economic sustainability (Garrard et al. 2018, Bruntlett & Bruntlett 2021). European initiatives such as London's All London Green Grid (ALGG), Milan's Cambio Plan, Lyon's Les Voies Lyonnaises (LVL), and Leipzig's Grüne Ring exemplify different strategies for designing and implementing such systems. This study analyzes these case studies, identifies and categorizes the planning tools applied, maps them against the United Nations Sustainable Development Goals (SDGs), and evaluates the effectiveness and potential of BZCNs as instruments of urban planning and resilience building.

2 Methods

The study employed a comparative case study approach, combining document analysis and literature review. Policy documents, municipal strategies, and relevant academic and professional literature were examined to identify tools used in the selected projects. Four European cities were selected for their diversity in scale, governance, and planning traditions: London, Milan, Lyon, and Leipzig. Each case reflects a distinct trajectory of integrating natural systems with cycling infrastructure.

The research process involved three main stages. First, project instruments were extracted and systematized across categories such as technical solutions (e.g., cycle highways, river-valley routes), governance frameworks (e.g., metropolitan strategies, inter-municipal cooperation), and social instruments (e.g., inclusivity, participatory planning). Second, these tools were categorized into six domains: society, economy, safety, infrastructure, environment, and strategy. Third, the tools were mapped against relevant SDGs, notably SDG 3 (Good Health and Well-being), SDG 9 (Industry, Innovation, and Infrastructure), SDG 11 (Sustainable Cities and Communities), SDG 13 (Climate Action), and SDG 15 (Life on Land). This process allowed for a comparative evaluation of the contributions of BZCNs to resilience and sustainability.

3 Results

The comparative analysis demonstrates that while the underlying principle of linking ecological systems with cycling infrastructure is shared, the emphases differ across cases. London's All London Green Grid, introduced in 2012, integrates existing river valleys, open spaces, green corridors, and peri-urban land-

scapes into a metropolitan ecological framework. Cycling infrastructure appears as a secondary component, mainly enhancing accessibility to green assets (Transport for London 2012). The strength of ALGG lies in its systemic vision and integration into the London Plan, though its relative neglect of transport functions limits its transformative mobility impact (Greater London Authority 2021).

Milan's Cambio Plan, unveiled in 2021, exemplifies a mobility-driven approach. It plans 750 kilometers of new rapid cycling routes across the metropolitan region, prioritizing transport efficiency, economic resilience, and social inclusivity. The project leverages natural features while embedding cycling in regional mobility planning, supported by safety measures and infrastructural innovation. Cambio demonstrates the power of cycling as both a transport solution and resilience-enhancing measure when linked with ecological and social objectives (Città Metropolitana di Milano 2021).

Lyon's Les Voies Lyonnaises, evolving from the Réseau Express Vélo launched in 2020, is an ambitious yet context-sensitive plan focusing on cycling safety and comfort. By 2030, the city aims to deliver a coherent network of cycle highways, linking parks and river valleys while improving green quality. Its strength lies in technical and legal innovations that foster everyday cycling, positioning it as a replicable model for mid-sized metropolitan areas (Métropole de Lyon 2021).

Leipzig's Grüne Ring, initiated in the 1990s, represents a pioneering landscape-based approach. It connects forests, rivers, and recreational landscapes through a circular ecological and cycling corridor at the regional scale. Unlike the other cases, it is rooted in inter-municipal cooperation and long-term landscape governance, strengthening ecological continuity and cultural identity while encouraging active mobility. Its integration of ecological, cultural, and mobility goals highlights the role of BZCNs in regional resilience (Stadt Leipzig 2020).

Cross-case analysis shows that environmental integration is a common denominator, while social inclusivity is most explicit in Milan and Leipzig. Strategic governance instruments are dominant in London and Leipzig. Infrastructure and safety measures feature prominently in Milan and Lyon. Economic considerations are strongly embedded in Milan's framework, while cultural identity is emphasized in Leipzig. Collectively, these initiatives demonstrate multiple pathways toward resilience.

Mapping against SDGs confirms that BZCNs support global sustainability agendas. All four cases advance SDG 11 by creating sustainable, inclusive cities. Climate adaptation strategies, including flood mitigation and reduced car dependency, address SDG 13. Health and well-being (SDG 3) benefit from active mobility and access to green space. Biodiversity and landscape preservation (SDG

15) are prominent in London and Leipzig. Infrastructure innovation (SDG 9) is particularly evident in Milan and Lyon's cycling highways.

4 Discussion and Conclusion

The findings underline the multifunctionality of BZCNs as planning instruments. They provide simultaneous benefits across environmental, social, infrastructural, and economic domains, diversifying urban resilience strategies. London demonstrates the potential of embedding cycling within ecological planning but risks underemphasizing mobility. Milan illustrates the transformative capacity of cycling networks at the metropolitan scale, though ecological integration requires vigilance. Lyon offers a technically robust, safety-oriented model adaptable to mid-sized cities. Leipzig highlights the significance of long-term governance, landscape management, and cultural identity.

The alignment with SDGs reinforces the global relevance of BZCNs, linking local urban initiatives to broader sustainability frameworks. However, imbalances persist: many projects privilege infrastructure and safety while underplaying economic, cultural, or governance aspects (Kazmierczak & Carter 2010). Comprehensive planning should therefore strive to integrate all categories of tools systematically.

In conclusion, BZCNs are an effective instrument for enhancing resilience and sustainability in urban and regional contexts. Their success depends on systemic approaches, adaptive governance, and cross-sectoral collaboration. The European cases analyzed here confirm that BZCNs not only mitigate current urban challenges but also proactively prepare cities for future uncertainties. Further comparative research and practical experimentation are needed to refine methodologies, strengthen governance frameworks, and maximize alignment with SDGs.

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