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Bridging Disciplines: Inter–Multi–Transdisciplinary Pathways for Sustainable Urban Development in the Western Balkans

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Abstract

Western Balkan cities currently stand at a critical inflection point, characterized by the convergence of intensifying climate and hydrometeorological hazards, acute environmental pollution, and profound demographic imbalances. This article argues that the region's persistent implementation gap—frequently described as being "full of plans but short of traction"—is not primarily a technological deficiency but a structural crisis of knowledge integration and governance. By analyzing the compounding nature of risks, where environmental stressors cascade across interdependent infrastructure systems, the study demonstrates that traditional, siloed policy responses are insufficient. Instead, it posits that achieving urban resilience requires a fundamental shift from technocratic management to inter-, multi-, and transdisciplinary frameworks. Four practical pathways are proposed to operationalize this shift: (1) embedding environmental and social risk assessment into the core of sustainable urban development; (2) integrating service delivery to simultaneously support livelihoods and sustainability; (3) establishing 'frugal' urban observatories that bridge official monitoring gaps with citizen science, providing a resource-efficient counterpart to expensive 'smart city' architectures; and (4) institutionalizing co-production to ground policy in local realities. Ultimately, the paper suggests that by treating integration as a delivery mechanism rather than an academic ideal, Western Balkan cities can transform into "integration laboratories," demonstrating how to govern sustainability transitions effectively under strict fiscal and administrative constraints.

Keywords: Sustainable Urban Development; Urban Climate Resilience; Transdisciplinary Governance; Nature-based Solutions (NBS); Western Balkans

Cities at a convergence point

Western Balkan cities are becoming the places where multiple pressures collide—and where their interactions become visible, lived, and politically consequential. Climate-related shocks and slow-onset stressors are expected to intensify together, with extreme heat, flash floods, wildfire, drought, and landslide hazards worsening and increasingly occurring simultaneously. These compounding hazards matter because infrastructure systems fail as systems: disruptions can

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cascade across transport, energy, food supply, and livelihoods when interdependent networks are stressed at the same time (World Bank, 2024a).

Urban concentration is amplifying these risks. Capital cities in Western Balkans now hold a disproportionate share of national urban populations—approaching half in cities such as Podgorica and Skopje—while many smaller cities are shrinking and losing economic vitality. At the same time, extreme heat days have increased sharply, from only a few days per year in the 1990s to more than 40 days per year on average in the 2010s, intensifying exposure precisely where population density and built surfaces are highest (World Bank, 2024b). The health burden that urban residents carry is already stark. In 19 assessed towns and cities, air pollution is estimated to reduce life expectancy by up to 13–16 months, with nearly 5,000 premature deaths per year directly attributable to air pollution (UNEP, 2022).

At the same time, demographic change is tightening constraints on municipal capacity just as the problem set expands. Rapid population ageing—driven by low fertility and sustained emigration—raises the dependency ratio and increases pressure on social expenditure and health systems over time (OECD, 2021). If the region's cities feel like they are "full of plans but short of traction," part of the explanation sits in governance capacity. The practical work of preparing mature projects, evaluating environmental impacts, and monitoring delivery is often weakest at the municipal level, even when formal compliance frameworks exist (Mildner et al., 2023).

This makes the constraint structural: sustainable, resilient, healthy and inclusive urban development in the Western Balkans is not primarily a technology problem—it is also a knowledge-integration and governance problem.

Why the bottleneck is integration, not information

Evidence is growing across climate risk, pollution, mobility, and sectoral transitions, but it often arrives in disconnected streams. The region's adaptation challenge is clearly framed as one of compounding risk and high costs of inaction, with damages projected to rise sharply without adaptation investments (World Bank, 2024a). Cities across the region score high on composite climate-hazard indices that combine heat, drought, floods, wildfire, and water stress, with most Western Balkan cities falling into high-risk or red-flag categories compared with cities elsewhere in Europe (World Bank, 2024b). These risks, however, are unevenly distributed across capitals, shrinking cities, coastal areas, and mountain basins, meaning that averages hide sharp local vulnerabilities.

What looks like "multiple problems" is often the same system showing up in different forms. Energy systems shape air quality and household affordability; transport choices shape exposure and access; land take and infrastructure form shape heat and flood impacts; monitoring capacity shapes what is visible and governable. The region's own Green Agenda reporting increasingly treats implementation as a coordination challenge—calling for stronger cross-sector collaboration and multi-level governance to accelerate progress and avoid duplication (Regional Cooperation Council, 2025). For example, urban nature-based solutions (NBS) can provide a pathway to cleaner environments and lower carbon emissions, helping cities move toward climate neutrality and circularity over the coming decades (Pearlmutter et al., 2021; Savić et al., 2024).

As a result, policy implementation becomes a coordination challenge rather than a technical one. Plans exist in abundance, but the absence of cross-sectoral, multi-level integration makes it difficult to translate them into investments that address compound risks rather than isolated symptoms.

The case for inter-, multi- and transdisciplinarity

Urban form, emissions, and environmental stress are tightly coupled. Cities that expand outward in low-density patterns generate higher $PM_{2.5}$ and CO_2 emissions from both transport and residential energy use, while more compact cities perform better on air quality and carbon intensity. At the same time, green cover declines as cities grow, reducing natural cooling and pollution absorption precisely where exposure is rising (World Bank, 2024b). These patterns link land-use planning, energy systems, transport, public health, and ecosystem management into a single system. Air pollution and climate change share sources; waste mismanagement contributes to methane emissions, fire risk, and local toxicity; housing quality determines vulnerability to both heat and cold. Polluted air shows why integration is non-negotiable. Pollution sources range from thermal power generation and industrial facilities to traffic emissions, mining and household heating, with seasonal variation and city-specific mixes that demand different combinations of energy, housing, transport, and health interventions (UNEP, 2022). Another example is related to urban mobility. Transport systems in many cities fail to provide adequate capacity and service quality, contributing to congestion, air pollution, and unequal accessibility—while the absence of coherent policy and investment frameworks keeps cities stuck in incremental responses (World Bank, 2024c).

No single discipline can capture these interactions, and no single agency can manage them alone. In this context, transdisciplinarity becomes a necessity rather than an aspiration. Local authorities, utilities, civil society, and residents hold critical knowledge about how systems actually function on the ground—where heat accumulates, where waste is burned, where transport fails, where energy poverty bites. Co-producing knowledge with these actors strengthens both the accuracy of diagnosis and the legitimacy of solutions (Mildner et al., 2023). Gathering the perspectives of key stakeholders and local population before implementing solutions, such as NBS, increases their effectiveness and supports efforts to address climate change, biodiversity loss, and growing pressures on water and food resources (Megyesi et al., 2024). This approach should be included in decision-making processes to develop climate-sensitive urban services that are place-based, people-centric, and facilitate planning towards green, resilient, and inclusive cities (Milošević et al., 2022).

Data gaps—and frugal pathways to smarter governance

A recurring constraint is not simply "lack of data," but inconsistent monitoring, fragile maintenance financing, and uneven analytical capacity. Urban environmental monitoring is particularly underdeveloped despite being central to adaptation and public health. Most Western Balkan cities lack dense, locally calibrated observations of temperature, humidity, heat stress, precipitation, and urban surface conditions, even though heatwaves and pluvial flood effects are becoming dominant climate risks (Milošević et al., 2023; Arsenović et al., 2023; Allen et al., 2024; Tošić et al., 2025). These risks do not affect urban populations evenly: poorer households, informal neighborhoods, and elderly populations are far more exposed because of housing quality, location, and limited access to cooling, green space, and healthcare. Air-quality reporting across the region also highlights inconsistent data due to station maintenance financing gaps and the absence of certified calibration laboratories and air-quality modelling capacity—limitations that compromise trend analysis and targeted policy design (UNEP, 2022).

Most Western Balkan cities still lack integrated data that links environmental hazards with population characteristics, health outcomes, and service access, making it difficult to identify who is most at risk and to design targeted interventions. Without exposure and vulnerability mapping, investments in resilience risk protecting infrastructure rather than people. Thus, rather than just importing an expensive "smart city" model built on dense proprietary sensor networks, the Western Balkans context points toward frugal, layered observatories: strengthen fit-for-purpose official monitoring, targeted low-cost deployments where decisions require granularity, use crowdsourcing and citizen science, and harmonize reporting for comparability and learning.

Practical pathways where integration can move the needle

What, then, would integration look like as an urban practice—not just an academic preference? Four practical pathways are provided below and visualized in Figure 1.

1. Resilient Cities Start with Smarter Development. In Western Balkan cities, heatwaves, floods, droughts, and air pollution already affect who stays healthy, who finds work, and which neighborhoods continue to attract investment. These pressures will intensify for future generations if today's planning ignores them. Sustainable development therefore requires that urban growth, housing, and infrastructure decisions be guided not only by short-term economic returns but by where people are most exposed and vulnerable. Integrating environmental and social risk into urban development helps protect today's residents while preventing tomorrow's costs from being passed to future generations.

2. Deliver urban services in ways that support both livelihoods and long-term sustainability. Energy, water, housing, transport, waste, and healthcare are the everyday foundations of prosperity and wellbeing. When these services are planned in isolation, cities waste resources, deepen inequality, and increase environmental damage. Coordinated service provision—such as cleaner heating, efficient buildings, reliable public transport, and safe public space—allows Western Balkan cities to reduce pollution and climate stress while improving affordability, access to jobs, and quality of life. This is how economic growth, social inclusion, and environmental protection can reinforce rather than undermine each other.

3. Build frugal, transparent urban data systems to guide fair and effective decisions. Meeting today's needs without harming tomorrow requires knowing where problems and progress actually lie. Yet many Western Balkan cities lack reliable local data on air quality, heat, infrastructure performance, and social vulnerability. Frugal urban observatories that combine public data, low-cost sensors, and citizen reporting can provide the evidence needed to prioritize investments, track whether policies work, and ensure that resources are directed to the communities that need them most. Good data is not just about technology—it is also about accountability to both present and future residents.

4. Make co-production the backbone of urban sustainability. The transition toward more sustainable cities will only succeed if it reflects local realities and builds public trust. Municipal governments, scientists, businesses, and communities all hold knowledge that matters. In Western Balkan cities, where institutional capacity is often stretched, co-producing solutions—such as climate adaptation plans, nature-based projects, and service improvements—helps ensure that policies are practical, socially fair, and environmentally effective. Involving people in shaping their cities strengthens democracy today while creating more resilient and inclusive urban futures for the next generation.

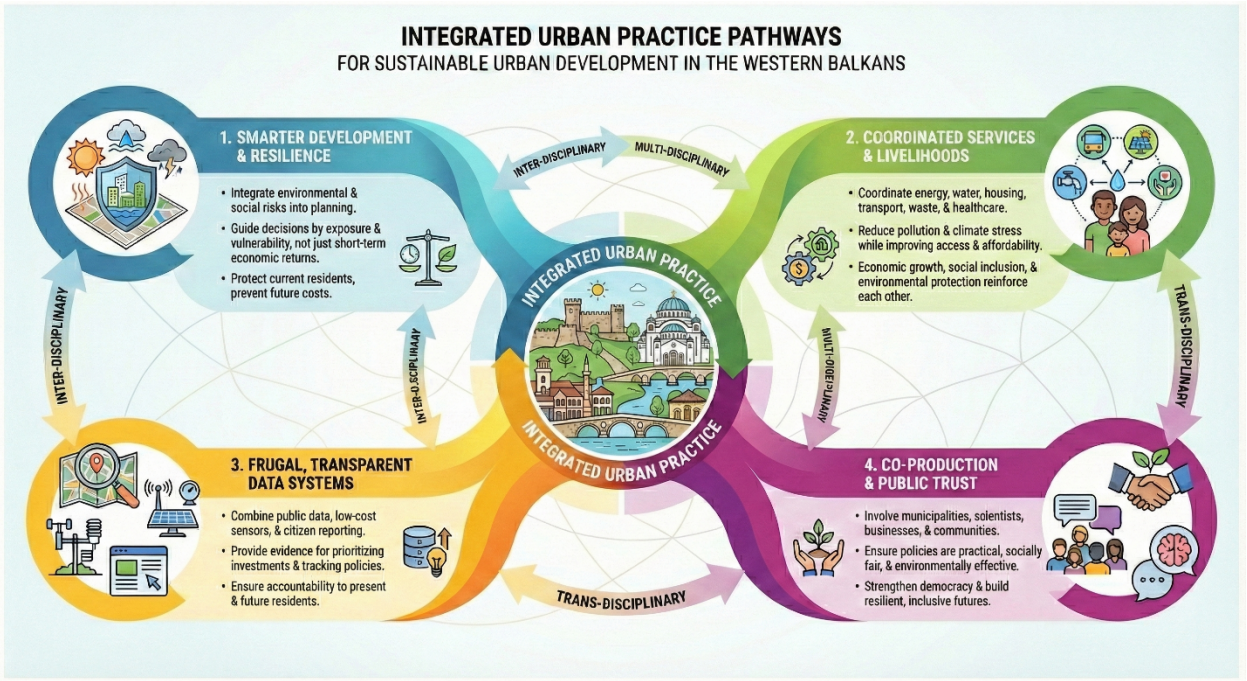

Figure 1. Conceptual framework for sustainable urban development in the Western Balkans. *Note: The graphical representation of this framework was developed by the author with visualization assistance from Google Gemini*

Conclusion: Western Balkan cities as "integration laboratories"

Western Balkan cities are not short of strategies or technical pilots; they are short of integration capacity—the ability to connect risk, health, mobility, energy, land, and monitoring into coherent governance that can deliver, learn, and adjust under tight fiscal and administrative constraints. Because hazards are compounding, infrastructure is interdependent, and health burdens are immediate, the cost of staying siloed is rising. If inter-, multi- and transdisciplinary approaches are treated as delivery tools—paired with frugal, reliable data ecosystems—Western Balkan cities can become "integration laboratories" that demonstrate how to govern sustainability transitions under constraint, rather than waiting to become idealized "smart cities" first.

References

Allen, M. J., Arsenović, D., Savić, S., & Nikitović, V. (2024). Mortality risk during heatwaves: An evaluation of effects by heatwaves characteristics in Serbia. *Geographica Pannonica, 28*(4), 284-293. https://doi.org/10.5937/gp28-52729

Arsenović, D., Lužanin, Z., Milošević, D., Dunjić, J., Nikitović, V., & Savić, S. (2023). The effects of summer ambient temperature on total mortality in Serbia. *International Journal of Biometeorology*, *67*(10), 1581-1589. https://doi.org/10.1007/s00484-023-02520-5

Megyesi, B., Gholipour, A., Cuomo, F., Canga, E., Tsatsou, A., Zihlmann, V., Junge, R., Milosevic, D. & Pineda-Martos, R. (2024). Perceptions of stakeholders on nature-based solutions in urban planning: A thematic analysis in six European cities. *Urban Forestry & Urban Greening*, *96*, 128344. https://doi.org/10.1016/j.ufug.2024.128344

Mildner S-A, Bories T, Sass M, Engstrom A, Neumann-Wengler S., & Gordon-Forbes, D. (Eds.). (2022). *GreenAgenda for the Western Balkans. The Road Toward Effective and Sustainable Implementation*. AspenInstitute Deutschland e.V. ISSN 2940-4169. *Available at: www.aspeninstitute.de/wp-content/uploads/Green-Agenda-for-the-Western-Balkans_2023.pdf*

Milošević, D., Dunjić, J., Stojsavljević, R., Žgela, M., Savić, S., & Arsenović, D. (2023). Analysis of long-and short-term biometeorological conditions in the Republic of Serbia. *International Journal of Biometeorology*, *67*(6), 1105-1123. https://doi.org/10.1007/s00484-023-02482-8

Milošević, D., Middel, A., Savić, S., Dunjić, J., Lau, K. & Stojsavljević, R. (2022). Mask wearing behavior in hot urban spaces of Novi Sad during the COVID-19 pandemic. *Science of the Total Environment*, *815*, 152782. http://dx.doi.org/10.1016/j.scitotenv.2021.152782

OECD (2021). *Multi-dimensional Review of the Western Balkans: Assessing Opportunities and Constraints, OECD Development Pathways*. OECD Publishing, Paris, https://doi.org/10.1787/4d5cbc2a-en.

Pearlmutter, D., Pucher, B., Calheiros, C. S. C., Hoffmann, K. A., Aicher, A., Pinho, P., Stracqualursi, A., Korolova, A., Pobric, A., Galvão, A., Tokuç, A., Bas, B., Theochari, D., Milosevic, D., Giancola, E., Bertino, G., Castellar, J. A. C., Flaszynska, J., Onur, M., ... & Nehls, T. (2021). Closing Water Cycles in the Built Environment through Nature-Based Solutions: The Contribution of Vertical Greening Systems and Green Roofs. *Water, 13*(16), 2165. https://doi.org/10.3390/w13162165

Regional Cooperation Council. (2025). *2024 report on the implementation of the Green Agenda for the Western Balkans Action Plan (GARI). Available at: https://www.rcc.int/pubs/218/2024-report-on-the-implementation-of-the-green-agenda-for-the-western-balkans-action-plan-gari*

Savić, S., Krstić, H., Šećerov, I. & Dunjić, J. (2024). Decreasing the energy demand in public buildings using nature-based solutions: Case studies from Novi Sad (Republic of Serbia) and Osijek (Republic of Croatia). *Energy, sustainability and society*, *14*(1), 23. https://doi-org.ezproxy.library.wur.nl/10.1186/s13705-024-00455-2

Tošić, I., da Silva, A.S.A., Filipović, L., Putniković, S., Stošić, T., Stošić, B. & Đurđević, V. (2025). Extreme precipitation events in Novi Sad during the period 1961-2020. *Geographica Pannonica*, *29*(3). 10.5937/gp29-57395

United Nations Environment Programme (2022). *Air pollution in the Western Balkans: Key messages for policymakers and the public.* Available at: https://www.ccacoalition.org/resources/air-pollution-western-balkans-key-messages-policy-makers-and-public

World Bank. (2024a). *Country Climate and Development Report: Western Balkans 6 background note—Adapting to a changing climate: The case for urgent action.* Available at: https://documents1.worldbank.org/curated/en/099092624072026025/pdf/P179205-f9cb3642-1bdb-4724-93c6-deec380abe55.pdf

World Bank. (2024b). *Reshaping Cities: Readying Cities in the Western Balkans for a Changing Climate*. World Bank. Available at: https://www.worldbank.org/en/region/eca/publication/reshaping-cities-readying-cities-in-the-western-balkans-for-a-changing-climate

World Bank. (2024c). *Western Balkans Urban Mobility Initiative: Summary report.* Available at: https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099060624074022601