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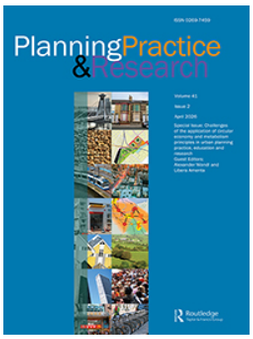

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Alexander Wandl & Libera Amenta

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EDITORIAL

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Challenges for the application of circular economy and urban metabolism principles. Towards circularity in urban planning practice, education and research

Cities are complex adaptive systems shaped by overlapping crises, including climate change, the energy transition, biodiversity loss, resource constraints, and widening social divides. These pressures play out spatially, in competition for land, demands on infrastructure, and questions about the quality of the built environment. Circular economy and urban metabolism approaches have become prominent responses in policy, practice, and education, but as circularity has moved from concept to implementation, it is timely to ask what it produces in spatial terms. Which planning instruments and governance arrangements make circularity work in practice, and where does it remain a generic ambition? This special issue brings together papers examining cases of circularity governance and policy together with education-focused reflections to examine how the principles of circularity and urban metabolism are applied, and where their use is still debated or not fully developed in planning practice, research, and teaching.

In its application, circularity has evolved from a niche policy idea into a mainstream agenda that shapes how institutions, firms, and cities address multi crises. The term has travelled and evolved, giving rise to adjacent notions such as green, bio- or reuse economies and extensions such as urban circularity, circular society, and regenerative economy. However, its promise has remained constant: to decouple prosperity from material throughput, with a primary aim of sustainable development.

Initially, under the industrial economy framework, national policy dominated the discussion. However, cities began to play a crucial role, advancing circular visions and strategies at the beginning of the 2010s. Although there is substantial research on urban and territorial metabolism, it has become clear that circular economy research and practice often adopt footloose approaches that ignore space and context (Verga & Khan, 2022) and that the predominant circularity concepts are not well suited to spatial planning and urban design (Williams, 2019). Moreover, advancing circularity requires assessing the impacts of circular initiatives beyond material flows, considering governance and public awareness, and focusing on broader social and spatial consequences rather than solely on waste and resource efficiency (Dąbrowski *et al.*, 2025).

In the meantime, more city-focused frameworks for implementing circular solutions have been introduced, including the Circular Cities and Regions Initiative's (CCRI) methodology for implementing circular solutions (EC, 2025). Even so, the CCRI methodology only recognises spatial planning and urban design as having a role in citizen engagement. Meanwhile, many cities discover that *space* itself is scarce: locations with the right infrastructure and socio-spatial configuration for circular production and behaviour are limited, confirming that the circular transition requires explicit spatial guidance (Hausleitner *et al.*, 2022; Van den Berghe *et al.*, 2024).

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Bortolotti *et al.* (2023), in this issue, provide evidence that over the last decade, a spatial turn in circular economy (CE) research is recognisable. The literature review identified two clusters of research (explained on p. 6) one foregrounds environmental economics and urban planning, with the aim of 'improving coherence around the understanding and use of the concept of CE and the multiple Rs' and providing contextual insights into how CE is interpreted in planning documents across Europe and what this implies for 'impacts, benefits and challenges . . . at the neighbourhood and city-scales'. Another cluster of research connects transition studies with urban and landscape design, highlighting the 'institutional and social embeddedness' of sustainability trajectories. This body of research addresses 'the lack of understanding of the social dimensions crucial for the legitimacy and the adoption' of circularity, while also stressing the 'absence of spatial analysis' in many urban-metabolism studies and advocating its development to support spatial planning and design explorations. Together, this work links CE concepts to spatial governance, legitimacy and the analytic capacities required for place-based action.

Responding to this need for a shared spatial language, Wandl *et al.* (2026) present the Delft Scales-to-Aspects Circular Built Environment model, building on two years of interdisciplinary work foregrounding the spatial, multiscale and cross-disciplinary nature of circularity and offering a shared canvas for research, education and collaboration. It 'intentionally introduces the transition's spatial and temporal levels' (p. 3).

Verbiest et al.'s (2024) contribution demonstrates, through two case studies of the regeneration of Belgian industrial parks, how socio-spatial visualisations can translate generic circular agendas into site-specific opportunities, thereby mediating between policy ambitions and local spatial realities. Presenting an alternative to 'generic circularity toolboxes with limited consideration of site-specific contexts' (p. 1) often used in practice.

Amenta (2025) extends this translation work by distilling six place-based principles, 'systemic action, inclusive governance, proximity, reuse of local resources, porosity, and time/ecology' (p. 7) that turn circular ambitions into concrete spatial strategies for reconnecting overlooked urban areas as productive ecological infrastructure. According to Verbiest *et al.* (2024) and Amenta (2025), circularity only works when general agendas are turned into practical, context-specific strategies using visualisations and design-driven approaches.

De Martino et al.'s (2025) work extends the spatial reading of circularity by exploring the complex relationship between the port and the city of Naples from a landscape perspective. Naples' land – sea threshold has been reframed as a circular environmental infrastructure and employing scenario-based design, aligned with maritime spatial planning, to reconnect port operations, public access, and coastal ecologies.

These design-led contributions sit alongside papers that test how circularity is incorporated successfully or not – in planning instruments and governance. The paper by Varjú and Óvári (2024) presents, in a refreshingly honest way, how, in the case of Pécs, Hungary, despite long-standing commitments to circularity, fragmented competences, centralised governance, and market distortions, can prevent cities from turning dispersed elements of circularity thinking in plans into an operational strategy. Amenta et al.'s (2025) work underlines how circularity and resilience approaches can contribute to define non-negotiable development paths for multi-risks exposed environments, ensuring an improved socio-ecological equilibrium through their operationalization, as in the

case of the Municipal Plan of Sant'Anastasia in the South of Italy. Scenarios including circularity principles have been constructed through engagement with local stakeholders.

In van Schaick's paper (2024), the special issue presents a review and reflection on one of the first regional spatial circularity strategies to be developed. This paper shows how the Province of South-Holland advances the spatial dimension of the circular transition through a design-led strategy bridging policy silos. However, it also reveals institutional vulnerabilities in doing so. One notable aspect of the genesis of this *South-Holland Spatial Circularity Strategy* is that it was tested in a regional design studio at Delft University of Technology. 'Two years' worth of students' projects and the involvement of specialists from the province Zuid-Holland provided the necessary confidence to start the real-life regional design process for a spatial circularity strategy in Zuid-Holland' (van Schaick, 2024, p. 10). A long tradition of situated education and regional design in relation to circularity (Wandl *et al.*, 2019), combined with a clear strategy for integrating circularity into architecture and urbanism education (Ioannou *et al.*, 2022), provided a solid foundation for this endeavour.

These reflections bring us to another focus of this Special Issue: How do we teach circular and inclusive critical ways of thinking and visioning about circularity? Bortolotti *et al.* (2024) reports on an interdisciplinary circular city studio at IUAV University in Venice, evidencing both the potential and the limits of transferring urban metabolism data into multiscale design proposals and thus clarifying what planning education can realistically deliver at this stage, demonstrating that, even in committed curricula, translation from analysis to spatial design is still hard. In her educational practice review, Wuyts (2024) shows how social fiction workshops help planning students surface values, positionalities, and questions of inclusion when imagining circular and metabolic futures, thereby linking circularity to social justice in planning education. She is adopting a post-humanist perspective that considers not only humans but also animals, plants, and other beings and matter.

While this special issue is largely Europe-centred, Zhu *et al.* (2026) provide a valuable counterpoint from Guangzhou: a neighbourhood-scale, community-anchored regeneration project that mobilises low-cost circular practices in the public realm and building stock. Read alongside recent studies that document bottom-up circular food-system loops in Chengdu's urban villages (Lin *et al.*, 2025) and participatory toolkits for the circular regeneration of older residential areas (Li *et al.*, 2025). It highlights a gradual shift from policy-led circularity to more locally grounded implementation in China. At the same time, national programmes such as the 'waste-free city' remain predominantly macro-oriented in both their objectives and instruments (Zhou, 2024).

Between the call for this special issue and its publication, geopolitical conditions have shifted markedly, reshaping the policy arguments for a transition to a circular economy. The COVID-19 pandemic had already exposed vulnerabilities in global supply chains and strategic dependencies early on. Russia's full-scale invasion of Ukraine in 2022 further underlined Europe's exposure to external shocks and the territorial consequences of energy and materials security. Since then critical raw materials have become increasingly geopoliticised. China has expanded the use of export controls and licensing requirements for a range of strategically important minerals and related technologies, highlighting how concentrated supply can translate into political and economic leverage. In the United States, the return of a Trump administration in 2025 led to a more openly transactional and unilateral approach to trade and foreign policy, reinforcing uncertainty

about multilateral cooperation. Taken together, these shocks have shifted circularity from a sustainability aspiration to a question of resilience, strategic autonomy, and, often less recognised, the spatial distribution of costs and benefits.

Against this backdrop, Van den Berghe *et al.* (2024, p. 31) anticipated a 'unique opportunity to leverage the circular economy as a strategy to reduce dependencies and enhance economic, social, and ecological resilience' (p. 31). They argue that the shifting geopolitical situation will increase circular-economy governance focused on localism and regionalism, thereby shifting attention to specific territories and the responsible planning authorities. It becomes clear who is responsible and who will be the winners and losers of the transition towards a circular economy. The future challenge for spatial planners in policy discussions is not simply to accommodate the loudest spatial claims, but to facilitate deliberation on the pros and cons of the transition to a circular economy and its trade-offs, and synergies with the multi-transitions we face at present. Moreover, we should ask what this means for the socio-spatial configuration of our cities and regions. As Remøy and Wandl (2022, p. 129) state, 'spatial planning and urban design in Europe will have to deal with environmental and social challenges, which we have not dealt with for half a century'. This is largely because Europeans have spent the past decades offshoring industrial and waste management activities outside of Europe, shifting significant social and environmental risks and damages to other parts of the planet. In doing so, we have avoided a serious sustainability debate and put our strategic autonomy at risk.

The authors' critical reflections on the first decade of the twenty-first century indicate a significant spatial turn in the discussion of circularity. However, we can also conclude that despite experimentation and initial attempts at circular spatial strategy making, local and regional authorities struggle to integrate circularity principles into spatial economic strategies and urban and regional development plans. One reason for this is that principles of spatial circularity have only recently been introduced in planning and design schools and have not yet been systematically embedded in planning instruments, teaching courses, and academic programs. The articles in this special issue offer encouraging examples of how circularity is penetrating planning and urban design education and spatial planning practice, despite challenges. Nevertheless, the contemporary geopolitical changes have reinforced increasing competition for land use and the vulnerability of international supply chains, as demonstrated by initiatives such as the European Union Critical Raw Materials Act of 2024. The consequence will be heightened debate and conflict about how we use the territory and plan and design urban and rural change. Spatial planners and urban designers should be at the heart of societal discussions on how to address the challenges of meeting physical resource demands whilst enhancing environmental quality and liveable places. This will sharpen the debate about land use and development choices. Spatial planners and urban designers are well placed to clarify trade-offs, identify synergies, and translate circular ambitions into spatial strategies that protect liveability and environmental quality.

Finally, it is worth asking whether the circular economy should be framed, as it often is, as an additional demand on already scarce space, or if, conversely, its potential lies instead in its capacity to integrate objectives that are already central to planning across housing, mobility, climate action, and economic development. Many planning principles are inherently circular. Spatial planning and urban design have long aimed to limit land take, to optimise the use of existing assets, to promote multifunctionality, to close urban metabolic loops, and to reconcile economic activity with environmental and social

constraints. Therefore, the circular economy does not introduce fundamentally new goals but rather offers a contemporary framework to reinforce and align long-standing planning ambitions and urban design principles.

Author contributions

Both Authors Alexander Wandl (A.W.) and Libera Amenta (L.A.) substantially contributed and agreed to the final version of this Introduction to the Special Issue. Specifically, Conceptualization, A.W. and L.A.; Writing – Original Draft Preparation, A.W. and L.A.; Writing – Review and Editing, A.W. and L.A.

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Alexander Wandl
Faculty of Architecture and the Built Environment, Department of Urbanism, Delft University of Technology
A.Wandl@tudelft.nl http://orcid.org/0000-0003-1163-0529

Libera Amenta
Department of Architecture, University of Naples Federico II
http://orcid.org/0000-0002-0885-2326