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SI3 for urban resilience: a human-nature driven paradigm shift

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Abstract

In a world increasingly marked by environmental challenges and climate uncertainties, the urgency for a paradigm shift in our relationship with the planet Earth has never been more evident. The increasing awareness of time running out underscores the immediacy of action necessary to alleviate the impact of human activities on the planet's resources and to address the pervasive effects of environmental issues and climate change. Moreover, as these adjustments unfold, there arises a need to reconsider the foundations of a shared future that is socially, environmentally, and technologically viable, and, consequently, it is necessary to rethink our connections with one another and the broader built environment – encompassing individuals, communities, and societies. This paper contends that the ongoing and forthcoming transformations necessitate a continuous re-evaluation of our common ground to ensure a more sustainable and resilient future for all. Therefore, this research advocates for the implementation of the SI3 framework as a catalyst for this paradigm shift – a framework that integrates inclusive, innovative, and intelligent solutions to foster urban resilience in the face of an evolving world. The imperative need for a transformative change in the way we perceive and interact with our built environment is also addressed through the NBC (nature-based cities) and GIM (green information modeling) models. Likewise, the challenges of dealing with the existing built environment are explored within the SI3 scope, emphasizing the importance of collecting and analyzing data related to space appropriation, daily flows, public space usage, social-spatial dynamics of buildings, and building energy consumption. By synthesizing and understanding this sort of data, the paper argues that cities can be better equipped to adapt, evolve, and thrive in the face of ongoing and future challenges, contributing to a more resilient and sustainable urban future.

Keywords: Paradigm Shift, Urban Resilience, Sustainable Development, Nature-Based Solutions, Green Information Modeling

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Jorge Maia is a landscape architect, who graduated from the University of Évora in 1991. He held a position as a municipal technician at the Famalicão Municipality and coordinated the Project Department, focusing on public space intervention. In 2018, he moved to the Planning Division at Porto Municipality, where he contributed to the revision of the Municipal Master Plan and helped develop the Municipal Ecological Structure. Since the beginning of 2022, he joined the Planning Division at Matosinhos Municipality, balancing the revision of the Municipal Ecological Structure and the development of the Municipal Green Structure with public space projects. He collaborates regularly with various architects on the design of public and private green spaces and in interventions in public spaces as a freelance landscape architect. Some projects in public space intervention include Vila Flor Cultural Center, in Guimarães; Plataforma das Artes, in Guimarães; Urban Park surrounding D. Afonso Henriques' Stadium, in Guimarães; Camões Parking Lot, in Guimarães; Bétulas Urbanization, in Famalicão; Casa de Esmeriz, in Famalicão; D. Jorge Ortiga Square, in Famalicão; Ladário Leisure Park, in Cinfães.

I. Introducing SI3 for urban resilience

Once upon a time, there was a *spaceship called Earth*[1], that became nonoperating...
This dystopian way to introduce this article underlines how urgent a paradigm shift is needed regarding the relations (or lack thereof) we establish among each other and between ourselves and the overall built environment (as individuals, communities, and societies). It is being accepted, recognizable mainly by younger generations, that – most probably – time is running out to address the needed paradigm shift concerning the path we will have to go through to achieve a more balanced tomorrow[2]. There's an increasing perception that immediate action is mandatory to reduce the impact of our daily lives on the planet's resources[3,4] and to mitigate the effects that environmental issues and climate changes are bringing to everyday life all around the globe[5]. It has been noticed that performance deviations in natural systems are being accelerated and they demand adjustments to those new metabolic behaviors. These adjustments are to be felt in the different scales of our lives – from domestic habits to collective liveable patterns. Additionally, the ongoing (or forthcoming) adjustments will lead to the need to think again (and again) about how to set a proper common ground in which we all share a more suitable future – socially, environmentally, and technologically[6].

I.1. Imagining a human-nature-driven paradigm shift

Suppose one imagines a paradigm shift in how individuals, communities, and societies live between themselves and the built environment, toward a better-balanced relation between artificial (infra)structures and natural systems. In that case, it will be acceptable that the paradigm shift will also be expandable to the way cities must embody the challenges brought by this paradigm shift. Cities, as the common ground of people's everyday lives, but also as one of the human inventions that bring more stress to the planet's natural systems[7], need to accommodate solutions that won't address the referred paradigm shift as ''business as usual''. These are solutions to boost resilience within the built environment – concerning the growing scarcity of natural resources, and the increasingly extreme weather events (shaping

1. Buckminster Fuller. *Operating Manual for Spaceship Earth* – 1st edition in 1969 (Lars Muller Publishers, 2008).
2. Ozge Yalciner Ercoskun, *A Paradigm Shift towards Urban Resilience* (IGI Global, 2014).
3. Peter Newman, Timothy Beatley and Heather Boyer, *Resilient Cities: Overcoming Fossil Fuel Dependence* (Island Press, 2017).
4. Ingemar Elander, Brendan Gleeson, Rolf Lidskog and Nicholas Low, *Consuming Cities: The Urban Environment in the Global Economy after Rio* (Routledge, 2000).
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6. Simon Bibri, *Advances in the Leading Paradigms of Urbanism and their Amalgamation: Compact Cities, Eco–Cities, and Data–Driven Smart Cities* (Springer, 2020).
7. United Nations, *Report on the United Nations Conference on the Human Environment* (United Nations, 1972), https://www.un.org/en/conferences/environment/stockholm1972

more devastating natural hazards) – and to address a wide range of environmental risks affecting people's urban life. It is commonly accepted that urban resilience[8] is a key factor within the paradigm shift process. In this article, this idea is attached to a stronger bond between urban resilience and the different levels involving everyday life, technological advances, and public urban policies[9]. Everyday life because the paradigm shift demands a new living culture (meaning, a less selfish culture) – with a new consumption culture (e.g., circular economy; consumption with less waste; longer life-cycles for dairy products and utilities; the 3R strategy (to reduce; to reuse; to recycle), a new mobility culture, etc.). Technological advances set on comprehensive and contextual data and digital immersion can suppress the short range of cities' "smartification" (mostly based on a simplistic and technocratic "sensorization" of the cities[10] that, instead of "smartness"[11], bring intelligence to everyday life – i.e., meaningful technology[12]. Public urban policies, because the paradigm shift stands for the collective construction of the built environment, i.e., urban resilience is not due to ad hoc solutions. Instead, it demands the creation of an inclusive common ground, structured on collaborative planning approaches that will drive the urbanization process to a point where the built environment and its (infra) structures converge in a synergic way with the natural green system and blue system[13].

A human-nature-driven paradigm shift must pursue inclusive, innovative, and intelligent solutions (socially, environmentally, and technologically) for urban resilience – which, in this article, will be called SI3 for urban resilience.

II. The contribution of NBC and GIM towards the human-nature-driven paradigm shift

The title of this article tends to suggest that its focus is on urban resilience. However, the main goal is not to discuss what urban resilience is about because, as Meerow, Newell, and Stults (2016) mentioned, the concept of urban resilience is still to be set in a very clear framework[14].

8. Octavio Castillo, Valentina Antoniucci, Enrique Márquez, Margarita Nájera, Alberto Valdiviezo and Mariana Castro, *Urban Resilience: Methodologies, Tools and Evaluation – Theory and Practice* (Springer, 2022).
9. Zaheer Allam, Didier Chabaud, Catherine Gall, Florent Pratlong and Carlos Moreno, *Resilient and Sustainable Cities: Research, Policy and Practice* (Elsevier, 2022).
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13. Judy Bush and Andréanne Doyon. *Building Urban Resilience with Nature-based Solutions: How Can Urban Planning Contribute?* (Elsevier, 2019).
14. Sara Meerow, Johua Newell and Melissa Stults, "Defining Urban Resilience: A Review", *Landscape and Urban Planning* 147 (Elsevier, 2016): 38–49. https://doi.org/10.1016/j.landurbplan.2015.11.011

As such, the sort of "yet-to-be set" definition of urban resilience needs to be grounded in the advocated paradigm shift referred to until this moment, i.e., a paradigm shift stepping away from what can be called as "ego-urbanism" and, instead, tracking inclusive, innovative, and intelligent solutions. Therefore, the purpose of the human-nature-driven paradigm shift, set on SI3, is to contribute to achieving urban resilience with higher standards rooted in nature-based cities (NBC)[15].

One can say urban resilience is often attached to a certain degree of complexity concerning the relations between the context, scale, configuration, and the systems of the built environment[16,17,18], set on the idea that the urban system should behave as a complex adaptive system[19,20], framed by social, ecological, metabolic[21], and circularity perspectives. In addition, it is also possible to associate urban resilience with the equilibrium between the urban systems and the natural systems (blue system; green system; biodiversity; etc.), alongside adaptation and permanent readjustment of all systems to changes in time and scale. When targeting the notion of complexity and adaptation[15], the layers addressing both should include *i*) governance networks, *ii*) networked material and energy flows, *iii*) urban infrastructure and urban form, as well as *iv*) socioeconomic dynamics. In this article, it is proposed to add three more topics: *v*) retrofitted innovation, *vi*) synergetic collaboration, and *vii*) meaningful intelligence. The correlation between these seven topics can contribute to achieving higher resilience standards, for instance, regarding local resources management, minimum water usage, energy efficiency, waste reduction, and life cycle equilibrium (either natural or artificial ones), putting architecture and urban planning under a systemic perspective highlighting metabolic processes associated to ways of living and its spaces, buildings, and cities. It is important to recognize the importance of eco-friendly design propositions based on zero-carbon approaches[22] and passive systems for urban resilience. Paving the way for NBC is to follow a track where urban resilience comes from testing context-based knowledge[23].

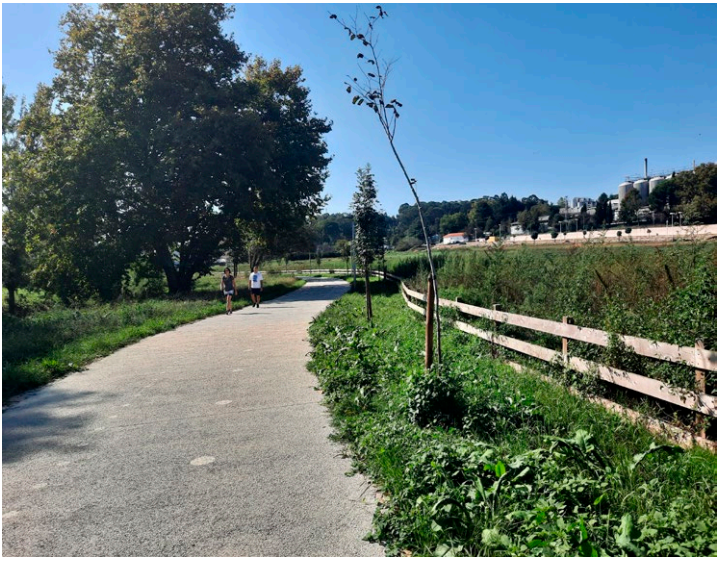
15. Timon McPhearson, Nadja Kabisch and Niki Frantzeskaki. *Nature-Based Solutions for Cities* (Elgar, 2023).
16. Michael Batty, "The Size, Scale, and Shape of Cities", *Science* Vol. 319, Issue 5864 (February 2008): 769-771. DOI: 10.1126/science.1151419
17. Peter Allen, *Cities and Regions as Self-Organizing Systems Models of Complexity* (Routledge, 1997).
18. Michael Batty and Y. Xie, "From Cells to Cities". *Environment and Planning B: Planning and Design*, 21, 7, (1994): S31-S48, https://doi.org/10.1068/b21S031
19. Ombretta Romice, Sergio Porta and Alessandra Feliciotti, *Masterplanning for Change: Designing the Resilient City* (Routledge, 2020).
20. Nikos Salingaros, *Principles of Urban Structure* (Vajra Books, 2014).
21. Nektarios Chrysoulakis, Eduardo Castro and Eddy Moors. *Understanding Urban Metabolism: A Tool for Urban Planning* (Routledge, 2015).
22. Deborah Heinen, *Climate Governance and Urban Planning Implementing Low-Carbon Development Patterns* (Routledge, 2022).
23. Aly Abdel Razek Galaby and Amal Adel Abdrabo. *Handbook of Research on Creative Cities and Advanced Models for Knowledge-Based Urban Development* (IGI Global, 2020).

Context-based-based knowledge is a) to know environmental conditions, b) to engage with territorial systems, c) to manage landscape resources, d) to structure integrated urban forms, e) to assemble contextual typologies, f) to use local materials and building techniques, and g) to create embodied living spaces. The path between empirical experience and adaptive pragmatic know-how, grounded in a synergetic methodology, demands formalizing traditions of everyday social practices to shape architecture and urbanism based on mining contextual data and its records through time and space (climate, resources, comfort standards, population, socio-economic performance, etc.) and aggregating it as useful information towards urban resilience. This comprehensive approach to urban resilience also needs to boost what can be called "green data" – nourishing a kind of "green information modeling" (GIM). The relevance of what is known as greening the cities[24] (see figures 1 and 2) in the context of environmental crisis and climate changes will force spatial planning and urban planning focusing on the diversity of the built environment[25], in which monitoring and evaluation of "green data"[26] will increase awareness and attention towards the environment, ecology, and Nature[27]. This aim, if not based on constant data verification from different sources and continuously monitored, will hardly have processing scope over the diversity of cross-information to be considered within the GIM framework. To this end, the relevant role that data can play in this correlation is increasingly evident, revealing how useful deepening GIM can be. The integrated, systemic, and incremental (re)construction of the "green" in the urbanization process[28] is as important as that of buildings, infrastructures/streets, inclusive public spaces, equipment, and public services. SI3 are set on the diversity of NBC and the vitality of GIM, mediated by human-nature-driven urban resilience.

III. SI3 addresses metabolic urban spaces in the existing built environment

So, can historical buildings or old urban areas be inclusive, innovative, and intelligent?
From a practical perspective, implementing SI3 can represent a challenge when dealing with the existing built environment. Charters, recommendations, and laws have been executed to protect historical sites and landscapes guaranteeing their future to the next generations[29]. For instance, historic centers or heritage buildings represent the human capacity for evolution

24. Jurgen Breuste, Martina Artmann, Cristian Ioja and Salman Qureshi. *Making Green Cities: Concepts, Challenges and Practice* (Springer, 2023).
25. Giuliano Dall'O, Alessandro Zichi, and Marco Torri, "Green BIM and CIM: Sustainable planning using Building Information Modelling", in *Green Planning for Cities and Communities*, ed. Giuliano Dall'O (Springer, 2020), 383-409.
26. Jaymie Scotto, Sean Farney, Bill Kleyman, Philip Marangella, Brad Meissner, Dean Nelson, M. Reali-Elliott, Karimulla Shaikn, Braham Singh, and Wes Swenson. *Greener Data: Actionable Insights from Industry Leaders* (URB Book, 2022).
27. Rob Roggema, *Nature Driven Urbanism* (Springer, 2020).
28. Susannah Hagan, *Ecological Urbanism: The Nature of the City* (Routledge, 2015).
29. Dimitra Babalis, *Urban Heritage in Times of Uncertainty* (Altralinea Edizioni, 2019).



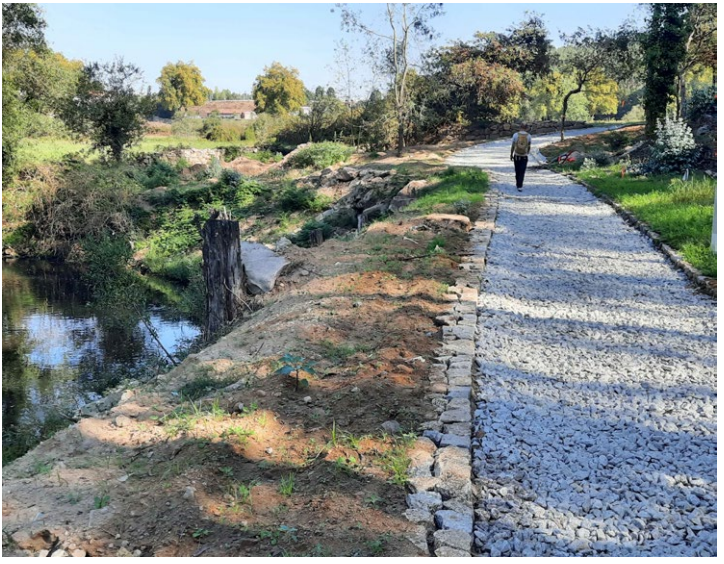


Fig.1 Leça River Ecovia, in Matosinhos

Fig. 2 Continuation of Leça Green Corridor construction, in Matosinhos, with the requalification and natural consolidation of the Leça River banks, and extension of the Ecovia.

and adaptation throughout history. Heritage is a mutable concept in constant change and adjustment to the geographical context, the cultural base, and the contemporary paradigm (likewise, it can be considered that urban resilience is a mutable concept). It is also a broad idea that comprehends not only the material, the structure, or the shape, but also the know-how, the vernacular practices, and the cultural background. In the last decades, UNESCO has enhanced the intangible values of heritage, highlighting the importance of social principles, traditions, and local knowledge. This constant dialogue, between past and present — when imagining a resilient future[30] — requires a flexible, multi-layer, and inter/transdisciplinary approach where strategic and responsible urban rehabilitation and adaptive reuse play a significant role.

Culture is a crucial tool for promoting diversity and creativity in a society[31]. Heritage conservation policies, in which traditional knowledge is emphasized, create a sense of belonging and respect towards different communities[32]. Linking individuals and heritage through digital tools is an emerging practice. It is also a powerful source of information. Digital technology allows different interactions between both and engages higher participation levels from individuals and communities. The way cities or historical centers are lived or understood has changed. There is a lack of belonging, resulting in a less attached society to its past or cultural values. Now, more than ever, switching the mindset to a less self-centered society and a more cooperative community is vital. A humanized urban space, where participatory approaches are the core of the decision-making processes, and the respect for heritage as something to learn from and to intelligently evolve, can increase comprehensive and contextual urban resilience stages. Meaningful technology and retrofitted innovative tools, associated with tangible and intangible heritage[33] in a synergetic methodology, can bridge people and the existing built environment.

Working on the existing built environment, to boost its urban resilience through SI3, is to address higher metabolic standards in the cities, related to its urban densification, urban rehabilitation, urban activities, urban social-spatial dynamics, urban form, and natural systems. This approach implies strengthening overall eco-urban qualities. For this, it is necessary to suppress myopic

30. UNESCO. *Urban Heritage for Resilience: Consolidated Results of the Implementation of the 2011 Recommendation on the Historic Urban Landscape* (UNESCO, 2023).

31. Muhammad Kamran, "*Role of Cultural Heritage in Promoting the Resilience of Linear/Critical Infrastructure System with the Enhancement of Economic Dimension of Resilience: A Critical Review*". International Journal of Construction Management, 22:7 (2020): 1345-1354, https://doi.org/10.1080/15623599.2020.1711493

32. Katia Fabbricatti, Lucie Boissenin and Michele Citoni, "Community Resilience: Towards New Approaches for Urban Resilience and Sustainability", *City Territ Archit* 7, 17 (Springer Open, 2020), https://doi.org/10.1186/s40410-020-00126-7

33. Morato *et al.*, "Traditional Knowledge and Intangible Cultural Heritage for Climate Change Adaptation", in *Intangible Cultural Heritage and Traditional Knowledge for Urban Resilience*, eds. J. Morato, C. Arias, and F. Trabanino (Springer, 2020), Resilient Cities, Vol. 2.

and selfish perspectives about urbanism[34, 35]. Instead, structured human–nature–driven data is mandatory (water management and self–sufficiency of cities, energy management, and decarbonization, food production, reduction of the city's carbon footprint and self–sufficiency, urban acupuncture, the continuous landscape (i.e., the natural *continuum*), etc.). For instance, about urban rehabilitation, the collection and analysis of data concerning space appropriation, daily flows, types of use of public spaces, social–spatial dynamics of the building, building energy consumption, etc., configure a broad set of holistic knowledge that puts in evidence how cities "pulse" and what makes its urban life move.

As for buildings, and the sort of urban life they provide, technological/digital advances (in terms of surveying, monitoring, and evaluation) open up the possibility of moving forward with interventions that improve energy performance, and expand/change their uses[36] without jeopardizing their heritage value – reinforcing the 3R strategy and promoting the circular economy.

IV. Closing remarks on operating a metabolic–built environment

Working with and on the existent built environment, to consolidate its urban resilience, means working with local individuals and communities. Social/community engagement requires a wide range of inclusive and innovative approaches and methods, in which the contribution of co–creation data and procedures, based on meaningful intelligence approaches, are relevant in collaborative processes for human–nature–driven ways of life and its metabolic everyday places, with renewed and representative meanings. Active and plural citizen participation – set on the empowerment of diverse individuals and the engagement of communities, with, for instance, in–person methods, artistic manifestations, story–telling initiatives, tactical endeavors, collaborative mapping approaches with mobile digital devices (with technological platforms with real–time online access and shared editing) – makes urban resilience better grounded on people's needs.

When addressing the problem of humanizing the city[37], one of the most discussed issues is the need to make urban spaces more user–friendly, inclusive, and representative. Advancing towards the intelligent humanization of the built environment requires the integrated

34. Shomon Shamsuddin, "Urban in Question: Recovering the Concept of Urban in Urban Resilience", *Sustainability* 15, 15907 (2023): 1–18. https://doi.org/10.3390/ su152215907.
35. Gisela Oliveira, Diogo Guedes Vidal and Maria Pia Ferraz, "Urban Lifestyles and Consumption Patterns", in *Encyclopedia of the UN Sustainable Development Goals: Sustainable Cities and Communities*, ed. Walter Leal Filho, Pinar Gökçin Özuyar, Anabela Marisa Azul, Luciana Brandli and Tony Wall (Springer, 2019), 851–860.
36. Remoy Hilde, *Building Urban Resilience through Change of Use* (John Wiley, 2018).
37. Baharash Bagherian, *Human Centric Urban Innovations* (URB Books, 2023).

articulation of different urban and natural systems and knowing how to embrace the ongoing transformations in the currently practiced ways of life (e.g., both in terms of family structures and their domestic spaces, as well as work contexts between the physical and digital).

To deliver metabolic urban spaces (set on nature-based solutions (NBS)[38] in the existing built environment (performing it as an NBC) demands that the GIM must be intrinsically linked and interconnected with everyday places (urban and natural ones) and with human activities – where inclusive, innovative, and intelligent solutions (SI3) can play a relevant role in the urban resilience of the "spaceship Earth"[1] – keeping it operating for future generations. It is up to us this won't be a utopia.

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