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Dynamic decision trees for building resilience into future eco-cities

Ioan M. Ciumasu *

ECONOVING International Chair in Eco-Innovation, REEDS International Centre for Research in Ecological Economics, Eco-Innovation and Tool Development for Sustainability, University of Versailles Saint Quentin-en-Yvelines, 5-7 Boulevard d'Alembert, bâtiment d'Alembert — Room A301, 78047, Guyancourt, France

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ABSTRACT

Intensifying global urbanization and environmental changes bring about the imperative of sustainable urban development and decisions upon inescapable pressures and risks, but knowledge integration between disciplines is a limiting contextual challenge. This paper proposes a reformulation, in terms of urban risk management, of an earlier developed ontological scenario generation method. The procedure consists of several steps: (i) identification-and-prioritization of main pressures, (ii) paired discussion of pressures using four-cell matrices, (iii) re-visit of the pressures' priority order, (iv) articulation of short-listed pressures as decision-making questions, and (v) generation of scenarios via "yes/no" responses to each question, in their order of priority. In this article, the method feeds upon the general context described in recent multi-disciplinary urban studies and public strategic plans in the city of Iasi (Romania), to propose a formal procedure for enabling the acceleration of productive decision making towards city sustainability. Answering three top priority questions, namely "Implement a business-friendly and efficient governance system?", "Develop a resource management system?", and "Carry out a human capital accelerator strategy?" results in a 4-scenario set: *Receding City*, *Wanting City*, *Promising City*, *Inspiring City*. The scenarios are discussed in terms of systemic risks at the end of post-communist transition and beginning of the socio-economic convergence with Western Europe.

1. Introduction

1.1. Urban sustainability and the accumulation of systemic risks

Cities are creativity hubs [1], "growth machines" for their hinterlands [2] and commercial nodes within the world network of interconnected cities [3,4], as well as a pressure in its own right upon the environment [5]. Unsurprisingly, many students and makers of sustainability regard the future of humanity as inextricably bound up with cities and urban living [6]. A sustainable city, often called 'eco-city', is definable in terms of the relation between the city inhabitants and the surrounding natural ecosystems. For example, Breuste and Qureshi define the sustainable city as "an ecologically healthy human settlement modeled on the self-sustaining resilient structure and function of natural ecosystems" and "an entity that includes its inhabitants and their ecological impacts" [7]. Nonetheless, in the transition to sustainability, cities cannot act in isolation; instead, cities undergo a process of transformation from an essentially local identity to a double, local-and-global identity [8]. In the multi- and trans-disciplinary terminology of sustainability studies, cities cannot be sustainable per se because they are at the same time dependent on their local context – notably the local ecosystems' 'carrying capacity' expressed as 'ecosystems goods and services' – and on their capacity to access global resources via their exchange possibilities within the global networks [9].

Although many urban communities have begun to recognize the imperativeness of, and engage on, a transformative course of action and have begun to integrate recommendations from foresight exercises, the process of decision making usually involves trade-offs and arrangements which seek avoidance of

* Tel.: +33 139 255163, +33 638 189639; fax: +33 139 255157.
E-mail addresses: ioan.ciumasu@uvsq.fr, Ioan.M.Ciumasu@alumni.tum.de.

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controversy within the given context. The consequence is that true evolutions towards sustainability are often hampered and the outcomes are rather conservative [10–12]. The theory of transition management describes such situations in terms of socio-technical landscapes and regimes which are resistant to (niche) innovations, except when regime/landscape crises require new solutions for new needs [13,14]. Thus, crises and emergencies appear to be both symptoms of unsettled problems and opportunities for change and improvements. The sustainability goal however is truly fundamental [5,9,11], and it requires modifications in the socio-technical landscape; hardships on the pathway of transformative innovations are only commensurate with this aim.

Essentially, in the nowadays' *knowledge-and-innovation*-based economy, urban decision making is dependent upon an operationally integrated understanding of a large number of disciplinary views, social or technical urban studies, each with their own language and interpretation of a sustainable city [15]. This is often an underestimated encumbrance, which typically results in progress being arrested early on during eco-city programs and developments. In fact, we are currently facing a situation in which, despite the existence of academically respectable efforts to bring together the full range of expert views upon cities [16], our cities are far behind the recognized goals of sustainable cities. Unaccommodatingly, the price of renewing urban infrastructures is on the rise, and local (as well as national) budgets are restricted in most developed countries due to the economic crisis and debt conundrum, which puts governance systems in situations of intrinsic vulnerability. Add to this the unfolding environmental crisis, and it becomes conspicuous that the emergence of the urban sustainability goals and policies overlap with the older practice of risk management; this reality is palpable within the climate change mitigation and adaptation negotiations and plans. Worryingly, the number of natural disasters, economic losses caused by them, and the number of people affected by them are increasing faster than the risk reduction capacity [17,18]. In a recent review, Morss et al. [19] have summarized four main critical needs related to extreme weather: (1) reducing vulnerability; (2) enhancing adaptive capacity, including flexibility in decision-making; (3) improving the usability of scientific information in decision making; (4) "understanding and addressing local causes of harm through participatory, community-based efforts formulated within the larger policy context".

In a cross-disciplinary analysis on how cities' are responding to climate change risks and hazards, Solecki et al. [20] have identified three areas of overlap and potential working-together between the fields of disaster risk reduction (DRR) and climate change adaptation (CCA): (1) extreme event likelihood: hazards, risks and uncertainty; (2) event impact parameters: exposure, vulnerability, and equity; and (3) societal responses to extreme events: adaptive capacity and resilience. Nonetheless, such interdisciplinary attempts only highlight how far we are from a truly transdisciplinary understanding of city sustainability and urban risk management.

Climate change is perhaps the most evident environmental change to which communities will have to respond [12], but one should not forget that climate is only one component of the human-environment relation. In a recent analysis focused on urban adaptation to climate changes, Funfgelt [21] has identified four thorough difficulties faced by urban risk managers: (1) true understanding of the emerging scientific information about climate change hazards and their impact on cities; (2) true understanding of how broader socio-economic processes influence urban vulnerabilities; (3) operational integration of information about climate risk and vulnerability into local planning processes and development agendas; and (4) a dearth of suitable governance frameworks for climate risk management in cities.

In short, the current situation in terms of urban disasters at the global level arguably reflects (a) city unsustainability, associated with (b) a fundamental incapacity of science as a whole to provide an integrated knowledge base for sustainability making. Current merging efforts between disciplines are encouraging, but they are still very much a "work in progress". The pressing issue is that we do not have much time to wait — the fact that eco-city projects have not yet produced real breakthroughs means that cities are steadily accumulating in-built vulnerabilities. Since environmental problems are aggravating, problems harden or become wicked – more complex and less tractable – and local crises are becoming more frequent and more damaging.

Globally, the multiplication of local crises suggests that we may be entering an era of concatenated global crises [22]. Therefore, the outcome of sustainability experiments must be double-sided, i.e., develop both resilience and managerial capacity for emergency situations [23]. The accumulation of global issues related to population, food, water, energy, climate change, and environment in general calls seriously into question the business-as-usual approaches of economic development and urban management, and raises the perspective of a "perfect storm" in the international policy discussions [6,24–26]. We not only need to provide technological and social innovations for sustainable development, but we need to innovate fast.

1.2. Obviating the epistemic conundrum of urban sustainability

In the community of experienced students of cities, question marks arise now whether – after decades of inertia and rather unfavorable political contexts – we are in the situation of finally making the big steps towards the sustainable city, a new type of community for the 21st century, or rather writing the obituary of the eco-city idea [27].

Epistemic difficulties associated with the lack of a unified theory of sustainability (or, for that matter, a unified theory of urban systems) are not an exception in the current era of fast change and pervasive knowledge fragmentation. In addition, despite substantial advances in formulating global policy options in terms of global scenarios, cities are rarely able to translate this into meaningful scenarios at their scale and type of discussion. Local communities need to overcome concrete difficulties related to both downscaling and availability of reliable local data. These, together with the local biophysical and social-economic peculiarities, pose a major challenge for city managers and stakeholders [12,28]. In this complex context, science is called upon to evolve towards multi-disciplinarity and time-efficiency [29]. Postmodern managers in general find themselves in situations in which they cannot rely on science to integratively conceptualize contexts and thoroughly understand a given problem, but