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Urban resilience in post-industrial urban landscapes: necessity or destiny?

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Abstract

Resilience thinking has become a core issue in urban planning and development. This has been based on the increasing impacts of modernization and its ecological, socio-cultural, and economic consequences, especially in post-industrial cities. This chapter will focus on urban resilience, and more specifically resilience to climate change. By doing so, the paper aims to stress the conditions of post-industrial cities as regard with resilience to climate change, considering that these cities are somehow specific contexts in respect with exposure, vulnerability and (adaptive) capacity. The chapter compares some current limitations of urban resilience-linked strategies adopted in two European post-industrial cities, i.e. Liege (Belgium) and Oulu (Finland). The conclusions will outline some possible avenues for research on resilience to climate change in post-industrial cities.

Keywords: urban resilience, urban planning, climate change, adaptation, post-industrial cities

1. Introduction

Our societies are increasingly aware of the manifold risks they are faced with and especially those risks related to societal modernization (Beck, 1992; Giddens, 1990) and its environmental consequences. Accordingly, a number of policies have been proposed to

reduce the level of risks and hazards generated by human activities at the international, European and national level. Significant international efforts have hence been directed towards reducing our GHG emissions, protecting biodiversity or safeguarding human health, i.e. a series of domains faced with increasing impacts on the environment and the population. Quite significantly, uncertainties about the likely outcomes of some processes are increasingly considered as an important element to be addressed during decision-making. This led to the consideration for the precautionary principle as a landmark approach when developing new policies, products, or services at the European level (European Parliament, 2016).

Our societies are more and more inclined to adopt a double-edged strategy as regard with risk management, by combining mitigation and adaptation policies. One the one hand it consists in reducing likely hazards through prevention measures declined along the "avoidance, reduction and compensation" tryptic (Pelta, Bas & Guillet, 2023). When uncertainties remain too critical, a precautionary approach should be adopted to as to avoid potential harmful effects. On the other hand, our societies must prepare for significant disasters and/or disruptions, through coping and reconstruction strategies (EUCRA, 2024; Tye & Giovannettone, 2021). This dual approach is at the center of the last IPCC report (IPCC, 2022), which proposed an integrated framework to address climate risks. In the meantime, the Sendai Framework for Disaster Risk Reduction had already set up clear targets for the adoption of policies along the three dimensions of disaster risk (exposure to hazards, vulnerability and capacity, and hazard's characteristics) in order to prevent the creation of new risk, reduce existing risk and increase resilience (UNDRR, 2015).

As an increasing share of the population is now living in cities (UN, 2022), risk mitigation and adaptation policies are especially relevant for urban inhabitants and environments. The

concentration of social, economic and spatial vulnerabilities in cities, combined with the presence of significant natural and man-made hazards within cities requires shifting from a piecemeal reactive hazard mitigation approach towards a more comprehensive resilience thinking (Masnavi et al., 2019). This explains the integration of urban resilience as a priority sustainability objective in the Sustainable Development Goal 11 oriented towards making "cities and human settlements inclusive, safe, resilient and sustainable" (UN, 2022). In this context resilience can be understood as *"the capacities of societies, communities and individuals or a social-ecological system to deal with adverse consequences and the impacts of hazard events"* (Birkmann, 2013). In this chapter we will focus on urban resilience, rather than resilience at large, and more specifically urban resilience to climate change. By doing so, the paper aims to stress the conditions of post-industrial cities, considering that these cities are somehow specific contexts as regard with both exposure, vulnerability and adaptive capacity.

The first section is dedicated to defining urban resilience and identifying relevant conceptual framework to address this issue. It will outline the method adopted in the chapter as regard with urban resilience in post-industrial cities, largely based on a socio-ecological systems (SES) approach. The following section presents key challenges faced by post-industrial cities in the field of urban resilience. We will then compare present limitations of urban resilience-linked strategies adopted in two European cities, i.e. Liege (Belgium) and Oulu (Finland). This will help us to reflect about the road travelled and yet to travel as regard with an effective implementation of these policies in post-industrial cities. The last section is conclusions, in which we will outline some possible future avenues for research and collaboration in this field.

2. Defining urban resilience

Resilience is a contested idea that can be understood in various ways (Grove, 2018). While *engineering resilience* refers to a single state equilibrium to which a system would ideally revert after a disruption (Hollnagel, 2014), *ecological resilience* rather considers that the pre-existing situation is not necessarily where natural ecosystems will or should tend to fall back to after a major disruption (Folke et al., 2004). This is even more the case in *socio-ecological resilience* frameworks that consider a mutual adaptation of societies and ecosystems after a disaster (Simmie & Martin, 2010). Adopting a socio-ecological systems (SES) approach, Meerow (2016, p. 39) defined urban resilience as *"the ability of an urban system–and all its constituent socio-ecological and socio-technical networks across temporal and spatial scales–to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity."*

The SES framework acknowledges the importance of considering various temporal and spatial scales to adequately address urban resilience. It suggests that structural adaptations of urban systems may be required to address these challenges, thereby stressing that the pre-existing urban condition should not necessarily be considered as an optimum. This framework further stresses the intricate intertwining between sustainability and resilience issues, considering these as two sides of a same coin rather than opposite or independent political agendas (Marchese et. al., 2018). It further calls for a radical transformation of the city, encompassing both social, spatial and environmental disparities, instead of concentrating on its sole technical components (Kim & Liu, 2016; Ribeiro & Pena Jardim Gonçalves, 2019).

Based on this approach, we will consider the specific challenges post-industrial cities are faced with according to three dimensions: i) exposure to hazards and risks; ii) socio-economic vulnerability and spatial justice; and iii) adaptive capacity through institutional and governance mechanisms.

As regard with the comparison of the resilience policies adopted by two post-industrial cities, we applied the 5Ws framework proposed by Meerow and Newell (2019) to the cases of Liege (Belgium) and Oulu (Finland). This framework helps to effectively structure the analyze along a multi-dimensional matrix that considers both actors, scales, motivations, and main issues addressed by the plan. By doing so this evaluation matrix considers both the process and substantive nature of resilience policies.

3. Why are post-industrial cities so desperately in need of a resilience agenda?

3.1.Exposure to hazards and risks

When considering exposure to hazards, post-industrial cities are usually characterized by a close proximity to coast, waterways and rivers, which was key to their blooming in the XIXth and early XXth century. Coastal locations and/or water courses were indeed essential for the transport and logistics, especially of heavy loads and raw materials. The relation between industrial areas with water courses was usually built upon pre-existing settlement patterns which, until the industrial revolution, favored access to water as a means for distributed energy production, navigation and craftmanship, for cleaning and waste disposal (Guillerme, 1983). The industrial revolution greatly accelerated the expansion of existing cities and, in some cases, led to the emergence of new towns in strategic locations. It basically means that most of these cities are currently exposed to flooding, especially in the perspective of climate

change, either due to their proximity to the sea as industrial harbors (Rotterdam, Bilbao, Hamburg) or main water courses, may these be “natural” or “artificial” (Liege, Sheffield, Emscher City Region).

Besides this long-term expansion along coasts and waterways, post-industrial cities are usually characterized by a severe soil sealing related to the presence of large residential areas, production spaces, storage areas, access roads, … (Haase & Nuissl, 2007). The productive rationale inherent to early industrialization did not leave much room for natural or recreational areas in urban planning. Therefore industrial cities were and, thus, post-industrial cities are characterized by a low green space availability and a relatively high artificialization rate. Such a soil sealing obviously contributes to the Urban Heat Island, both through the capture of radiative energy within the built environment, combined with the heat released by buildings and industrial activities and the lack of cooling related to evapotranspiration.

By contrast the proximity to waterways may play a positive role in resilience strategies, as it may help to reduce heat island effect and the concentration of brownfield sites may support the development of ecosystems connected with water. Reconversion of vacant industrial land towards resilient urban spaces, through nature-based solutions, may contribute to the development of green infrastructures, at the city or agglomeration level (Preston et al., 2023).

3.2.Socio-economic vulnerability and spatial justice

Industrial areas are highly vulnerable to climate change due to the concentration of critical infrastructures nearby hazard zones, and the dependency chains characterizing most industrial complexes (Luiijf & Klaver, 2021). By nature, industrial production is highly dependent on

logistic chains, energy networks and production facilities that may themselves be at risk. As a series of industrial activities are still reliant on waterway transportation, drought and low water conditions may themselves constitute a disruption risk. Altogether it means that the intrinsic vulnerability of these areas is here multiplied by extrinsic dependencies, a situation that is common to most urban areas but especially acute in post-industrial cities.

As regard with socio-economic vulnerability and spatial justice, post-industrial cities are usually characterized by a concentration of vulnerable inhabitants, in terms of revenue, household composition, origin, language, in selected areas of the cities (Buck et al., 2021). Urban segregation is partly inherited from industrial development, which promoted the location of lower quality housing nearby production sites (Lejeune et. al., 2016). When this situation is reproduced over time, it may lead to a higher exposure of lower revenue inhabitants to climate hazards, may it be heat wave or flood risks (Poussard et. al., 2021).

In general, environmental inequalities are strengthened by poor housing conditions, with more renters, living in non-insulated, hard to ventilate buildings (Barton, 2009). The combination of these factors may expose their dwellers to higher temperature in the summer. Highly exposed areas may lack accessible green space where to escape from housing conditions, a situation that is partly inherited from the industrial revolution.

3.3.Adaptive capacity through institutional and governance mechanisms

The adaptive capacity of post-industrial cities is highly dependent on their ability to steer multi-level governance systems so as to foster solidarity and shared values (Kozina et al., 2021). These governance systems include various municipality offices and a diverse set of

public and private actors, to address the challenges faced by large urban/industrial systems, spanning over extended functional urban areas. This typically implies a revised balance of power as regard with private actors, more accustomed to preserve their decision space against any form of external interferences.

In order to create and maintain adaptive capacity, local participation and citizen engagement are needed (Horlings et al., 2021). However, involving the local population in the decision-making process is both an urgent need and a real challenge, given the lack of experience and limited political resources of inhabitants living in deprived areas (Lejeune & Teller, 2016). It may imply to deploy significant efforts to effectively build upon the cultural diversity characterizing these places. Besides language and cultural barriers, public participation should be designed to build trust between citizens, public administrations, and non-governmental organizations.

Inclusiveness and empowerment strategies are hence consubstantial to any form of resilience policy in post-industrial cities (Uyttebrouck et. al., 2023). Ideally, empowerment strategies should not be restricted to preparation and preparedness phases but cover the reconstruction and long-term adaptation phases. These should go hand-in-hand with a renewed ‘culture of risk’, anchored in a place-based narrative about how to handle new climate conditions, that is shared by institutions, private actors, citizens and community groups (Krauß & Bremer, 2020).

4. Resilience policies in two post-industrial cities: there is still a long road to travel

Our understanding of present challenges faced by post-industrial cities as regard with resilience policies will be based on a comparison between two cities, i.e. Liege (Belgium), a 195 000 inh. city and Oulu (Finland) 205 000 inh. Both cities have a strong industrial past, mainly oriented towards steel production and coal extraction in Liege, tar and pulp and paper fish processing in Oulu. They witnessed a significant economic reshuffle since the early 1980ies, built upon biotechnology, precision manufacturing and logistics in Liege; telecommunications and high-tech industries in Oulu. Liege and Oulu are both involved in long term urban regeneration strategies, oriented towards improving their residential attractiveness. There are still substantial differences between these two cities, as Liege kept losing inhabitants over the last decade while Oulu succeeded in retaining and attracting new inhabitants, especially from middle income groups.

Both cities are faced with significant resilience challenges as will be exposed through the following two tables (table 1 and 2). Quite significantly, none of these two cities has formally adopted a “Resilience Plan” explicitly termed as such, and/or a plan based on an established resilience framework, as for instance the City resilience Framework – CRF (Arup, 2016). Liege and Oulu were not part of the 100 Resilient Cities (100RC) initiated by the Rockfeller Foundation, a program that was mainly gathering global cities (Sabatier & Reghezza-Zitt, 2021). Pittsburgh, Glasgow, Belfast, Manchester and Rotterdam were amongst the few preeminent postindustrial cities selected to be part of the 100RC initiative.

As Liege and Oulu did not have an explicit “Resilience Plan”, we hence decided to focus on recent and specific policy documents for building this analysis. The selected plans are

indicative of recent orientations as regard with adaptation to climate change. They deserve a specific attention in terms of orientations for the future and are very relevant as regard with the local framing of the main stakes and expected actions related with urban resilience.

In the case of Liege, adaptation to climate change is presently splintered along a myriad of documents and policies, either adopted at the municipal or the regional level. The city recently adopted a “Plan Canopée” (Ville de Liege, 2022 ; Ville de Liege, 2023) , i.e. Canopy Strategy, which is conceived as part of the Local Climate Plan (Ville de Liege, 2021).
The City of Liege already witnessed significant climate disruptions, a first one in the summer 2020, with the heat wave and related stress for affected populations, and a second one in July 2021 during the Bernd Flood event.

Established along the model of Lyon, Liege’s Canopy Strategy has been proposed to enhance the green cover in the city, considering that it had a key role to play as regard with the Urban Heat Island effect and the protection of biodiversity. The Canopy Strategy has been transposed in a planning guidance that restricts the cutting of existing trees and defines compensatory measure when a project implies tree cutting. Besides this, the guidance defines targets for tree planting for project developed in parcels of more than 500 m2. These targets are defined for each neighborhood. It should be stressed that the elaboration of the Canopy Strategy is still under process at this time and the implementation plan should be further refined in the months/years to come.

Similarly, in the case of Oulu, there is no specific resilience strategy for the city. However, the idea of resilience is included in many governance policies, such as educational planning and business planning. In respect the climate change, which is the focus for resilience

strategies in the chapter, the City Strategy for Oulu 2030 (Oulun kaupunki, 2022) is probably the most relevant, as it involves a specific section on carbon neutrality policy for 2035.

There has been a study focusing on the resilience of the city of Oulu by the urban developers' perspectives (Häkkänen, 2022). The study was based on ten interviews with urban planners. According to the results the planners considered resilience as an important issue and as a success factor for the city. According to the results, the resilience of the city of Oulu is formed by a leadership, attitudes towards ongoing and future change, collaboration and networks and the flow of information, and human and customer centered orientation in governance. By focusing on these issues resilience could be better rooted in the city's culture and operational environment (Häkkänen, 2022).

Table 1	**Liege Canopy Strategy**
Who?	• The resilience strategy of Liege is mainly based on a collaboration between city authorities and scientific experts (Issep). • The population has not been directly involved in the design of the strategy, which is largely based on a mapping of the Urban Heat Island (UHI) effect in Liege, combined with satellite picture classification and field surveys to assess the spatial distribution of trees and green areas in the city. • The strategy has been presented during workshop gathering NGOs representatives at the end of the process. • Private developers have not been directly involved in the elaboration of the Canopy plan, even though they have a role to play in the implementation of the strategy, especially through the greening of existing surfaces and the compensation mechanisms. • Low income groups have not been explicitly involved in the process even though the diagnostic highlights that the tree coverage and access to green spaces is far from being equally distributed in the city.
What?	• Urban Heat Island is the main perturbation considered in the strategy. • The resilience strategy does not address flood risks, forest fires or low water conditions, even though these are important hazards faced by the city. Flood risk is mainly considered as a stress for the tree canopy. The expected effects of tree planting on reducing water run-off is not quantified in the document. • The strategy is mainly oriented towards green open spaces (and lack of such spaces) as well as building densities through the assessment of Urban Heat Island. • Roads and infrastructures, and the likely impact of heat waves upon the economic sector are not addressed in the policy. The policy does not consider cascading effects.
When?	• The focus of the project is on rapid onset disturbances, especially heat waves. The project does not consider the long-term impacts of climate change upon urban heat island. • Slow-onset changes like the impact of climate change upon biodiversity and health of ecosystems are considered in the document. Heat stress may lead to an evolution of adapted species and will typically require more maintenance for trees (watering and pruning).

	• The resilience strategy is both oriented to present and future generation, through the consideration of a wide spectrum of ecological services, including carbon storage by trees.
Where?	• The boundaries of the strategy are strictly delineated within the administrative of the city, even though these limits do not match with those of the urban agglomeration. • As the preliminary analyses provide fine-grained spatial information about the disparity of the green coverage, the regulation specifies tree planting targets adapted to the different neighborhoods of the city. These targets are applicable to new developments only. • Compensation mechanisms proposed in the regulation are not identifying any priority in terms of tree planting when trees are suppress in the framework of a project. • Defined as such there is a risk that compensation mechanisms will prioritize "easy to plant" areas rather than those areas characterized by a significant deficit in green spaces.
Why?	• The main goal of the strategy is to address citizens expectations as regard with greening the city, combined with an in-depth analysis of ecosystem services. • The strategy has been designed through explicit references with the "Plan Canopée" adopted by the city of Lyon. • The main focus of the plan is oriented towards effective outcomes in terms of socio-economic services. Process is quite marginal at this stage, even though it is a known limitations as regard with the implementation of such a plan and especially the greening and unsealing of built structures.

Table 2	**City Strategy for Oulu 2030**
Who?	• The strategy for Oulu is mainly based on a collaboration between city authorities, regional government actors and consultants. The strategy was preceded by Sustainable Energy and Climate Action Plan (SECAP) of Oulu under the Covenant of Mayors (CoM) in 2018. • Planning process did not include local participation. • There are various ecological, infrastructural, socio-economic variables and measurements for the implementation. The measurements and goals are not spatialized but mostly in average figures and targets. • The strategy has been presented to the City Council in 2022 for approval.
What?	• The strategy is an overall development plans for the city that integrates several sub-strategies and planning documents. • The specific carbon neutrality policy section has three goals: (1) Climate change mitigation and adaptation; (2) Sustainable urban structures: and (3) Close to nature city. All these goals have their own sub-aims with measures and targets. • Resilience aspect is implicit in the Climate change mitigation and adaptation goal which aims to examine the impacts of climate change to the city. • The strategy does not address adaptation but mainly mitigation measures, nor it does not indicate the risks of climate change. • The strategy includes specific targets for green spaces, natural areas, and inhabitants' satisfaction to green spaces, public transportation and cycling infrastructure, for example.
When?	• The strategy has the focus for implementation for the years of 2022-2025, except the carbon neutrality aim is for 2035. • For the climate change mitigation there is a starting level defined but annual decrease of carbon emissions is not defined which makes it difficult to evaluate how realistic the strategy is.
Where?	• The strategy is for the entire city. However, it is contextualized in the regional governance structure, and also representatives from regional governance have participated the strategy making (especially its background policies) • While most of the mitigation and sustainable urban structures goals are 'in average' in the city, the green spaces and close to nature indicators, especially, have locational information and targets. • Risks and adaptation issues are not spatialized.

Why?	• Carbon neutrality goal 2035 is based on the government's legally binding target that makes municipalities responsible of the neutrality. • The strategy aims to create environmentally awareness inhabitants that would lead to sustainable decisions, co-operation, decisions, and actions in the city.

As can be seen from the two tables, both cities are still far from having articulated a comprehensive action plan addressing the different dimensions of urban resilience and effectively prioritizing local adaptation measures required to reduce the impacts of climate change. Liege's Canopy Strategy is clearly oriented to adaptation, when the City Strategy for Oulu keeps being mostly driven by mitigation mechanisms. Part of the divergences between these two strategies is related with the absence of a comprehensive strategy articulating mitigation and adaptation.

In both cases, the approach keeps largely being expert-led, with few if any direct involvement of the local population, especially the low-income groups that are known to be especially vulnerable to climate change. Stakeholder engagement appears more developed in Oulu than in Liege, especially through the involvement of business groups. Even though these two cities are characterized by a postindustrial trajectory, the involvement of the private sector and the consideration for the opportunities and risks specifically related with the economic decline of some economic sectors is insufficiently developed. The potential contribution of brownfield sites and large economic estates in climate adaptation measures is hardly taken into consideration at this stage.

These two strategies are insufficiently spatialized, either at the scale of urban streets, blocks and neighborhoods. They lack clear intermediate targets to monitor the progress of implementation. Transition risks induced by an inadequate implementation of policy targets is not yet properly articulated in either of these two policies.

5. Conclusion

This paper outlined some of the specific difficulties faced by postindustrial cities as regard with climate change. It may be argued that postindustrial cities are inherently resilient, as they were faced with severe economic disruptions in the 1970ies and 1980ies, and did somehow "reinvent themselves" so as to keep on attracting residents, investment and businesses. Adaptation to climate change hence constitutes a new challenge for these cities, whose economic reconversion is still in progress. A better articulation between urban resilience and economic attractiveness agendas is certainly a relevant option for these cities, even though the existence of lock-in effects should never be underestimated.

The comparison of the strategies adopted in Liege and Oulu reveals that these two cities are still a long way towards articulating a comprehensive resilience plan, addressing both process and expected outcomes, at different urban scales and involving all potentially affected stakeholders. The two cities are somehow paradigmatic in the divide between overtly mitigation- (Oulu) and adaptation-led (Liege) resilience policies. This divide that can be explained by the existence of limited financial and human resources, the proper trajectory of the cities and their experience with large disruptions related with climate change. Still such a divide is certainly not sustainable over the long term, as mitigation and adaptation are both required to address climate risks.

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