Working with nature to address the challenges of Small Towns. Evidence from France.

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Abstract
In urban literature and practice, increasing attention is paid to the potential of working with nature in reducing exposure and vulnerability to climate hazards, including floods and extreme heat waves. Still, planners' perspectives on this approach have long been metropolitan and cities centered. This paper aims to surpass territorial hierarchies by considering the specific case of small towns. We apply an ecosystem-based approach to rethink spatial planning practice at the scale of Rives-en-Seine, a small northwestern town in France. An interactive and multidisciplinary workshop methodology was used. The results highlight that while well-designed nature-based interventions can deliver multiple benefits and ensure small-town resilience, their practical implementation will require tools combining ecological engineering and urban and architectural design.

INTRODUCTION

Although the world is becoming urban, not all people living in urban areas live in large cities since many live in small and intermediate towns. Indeed, small and intermediate towns are critical interfaces between 46% of the world population who live in rural areas and 35% who live in cities (Roberts, 2016). Managing the development of small towns that are by-products of rural urbanization is very challenging, particularly with climate change's increasing risks. Like cities, small towns face environmental, social, and economic challenges that increasingly question their resilience and will require them to adapt to a broader range of shocks and stresses (Bush & Doyon, 2019). Specific action plans are, therefore, needed to support their preparedness to face climate change. Instead, little climate adaptation work is currently being developed at the scale of the small towns (Salas Tobón & Barton, 2019). This topic has also received little attention in urban research (Servillo et al., 2017). Studies, however, already

emphasize the need to work with nature to address climate change and biodiversity loss (Seddon et al., 2021). Mainly, scholars called attention to the requirement of "re-embedding" urban areas in their surrounding regions by invoking the "urban bioregion" concept that underpins a co-evolutionary balance between urban centers and their surrounding agri-environmental areas (Fanfani, 2018). In this article, we suggest re-examining the practices of building small towns' resilience by considering Rives-en-Seine in Normandy (France) as a case study. Following Fanfani (2018), we consider this small town a place for "searching for new forms of balance between established communities, the surrounding environment, and the local heritage." Our approach lies in not considering Rives-en-Seine to be limited to its administrative boundary but rather as an ecological unit, where the built environment is embedded in a broader natural system. Thus, we also explore the potential of working with nature when applied within a multiscale approach to improve the living environment and reinforce small towns' resilience and cope with risks such as, erosive runoffs, floods, and heat waves.

LITERATURE AND BACKGROUND

Integrating nature and its multiple ecological systems into the built environment has the potential to build sustainable and resilient patterns of urban living. This ecological planning approach, known as nature-based solutions (or interventions), has gained popularity in a few years as a set of ecosystem-based tools to address a range of societal challenges of climate change, natural hazards, food and water resources security, human wellbeing and health, and economic and social development (La Rosa et al., 2021). For example, Chausson et al. (2020) emphasize how protecting and restoring habitat along shorelines or in upper catchments can protect communities and infrastructures from flooding and erosion, carbon sequestration, and biodiversity. Others focused on green infrastructure (planned interconnected networks of natural and semi-natural areas with other environmental features designed and managed to deliver ecosystem services) role in carbon sequestration, cooling, mitigating air pollution, and offering recreational opportunities as well as health benefits (Monteiro et al., 2020). Moreover, increasing evidence from the literature points to the fact that flood risk management is no more tackled through the sole mean of grey infrastructure (civil engineering protective infrastructure, such as dykes and seawalls). Dong et al. (2017) call even for "greening the grey infrastructure" to ensure the ecological enhancement and urban drainage resilience reinforcement. Besides, Alves et al. (2019) argue that a mix of green, blue and grey infrastructures will likely result in the best adaptation strategy to face climate change. These alternatives tend to complement each other, as while grey infrastructure efficiently reduces flooding risks, green spaces offer additional benefits that grey infrastructure cannot offer (Brink et al., 2016).

Over the past decades, whilst large cities have made significant strides in deploying nature-based interventions for addressing climate change hazards, small towns have been slow to respond, and very little nature-based intervention work has been applied to small towns scale (Salas Tobón & Barton, 2019). Faced with critical budgetary constraints in most cases, climate change adaptation is not a priority in these towns compared to other economic development imperatives, as further explored in the next section. In light of the foregoing, this evidence-based research aims to fill this gap and demonstrate that well-designed nature-based interventions can deliver multiple benefits and ensure the resilience of these small towns.

Case study presentation: Rives-en-seine. A "small town of tomorrow"

In France, an interesting shift is occurring in planning public policies that have long been aimed at the large metropolis. In recent decades small towns that have long remained in the shadow are increasingly considered a critical territorial organization interface. They are the subject of renewed interest from public policy through specific programs, mainly the Small Towns of Tomorrow program. With the goal of securing funding to support local development projects, the small town of tomorrow program is intended for towns with fewer than 20,000 inhabitants that reveal fragility while having a centrality function in the territory.

Rives-en Seine is a small town in the Seine Valley of Normandy (northwestern France). The Seine River has long been considered a significant development axis for the Paris metropolis, offering an extensive river and seaport. Rives-en-Seine is also located at the heart of the natural regional park, the Boucles de la Seine Normande, and has the peculiarity of being a newly born town from the merger in 2016 of Caudebec-en-Caux (mostly urbanized), Villequier, and Saint Wandrille-Rançon (primarily rural) (Figure 1). Each of these municipalities has a recognized history and cultural and natural heritage, making it challenging to build a common identity for the town.

The Seine is a central and common element in the residents' everyday life as the connection to the river has even given its name to the new municipality. The landscape and its ecological elements, including the wooded hillsides, the forest, the rivers, and the wetlands, are also robust markers of this small town and have the potential to form a true shared identity. Over centuries, however, Rives-en-Seine has not been able to escape the spatial transformations that have affected the entire territory of the Seine Valley. These include excessive drainage of wetlands and their conversion to urbanized and agricultural areas, soil artificialization, natural habitat destruction, and biodiversity. Recent IPCC Normandy (2021) publications foresee extreme risks linked to climate change, including increased heatwaves, increased river levels, runoffs, low groundwater recharge, and water quality deterioration.

Moreover, the agricultural areas of the plateaus are threatened by land management pressure and intensive farming practices, as well as the lack of vegetation, which further compounds runoff risks. Rives-en-Seine is clearly vulnerable to climate change, particularly the flooding risk from the rising level of the Seine River. Our approach, therefore, lies in considering the Seine catchment area as the urban bio-region within which it is relevant to study "small towns of tomorrow".

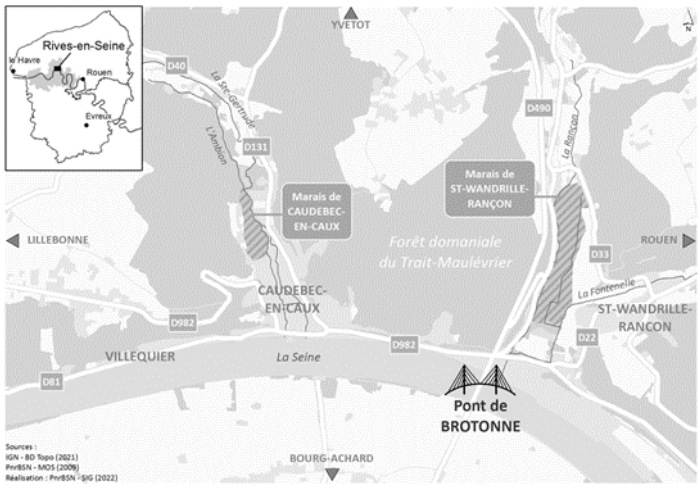

Figure.1: Localization of Rives-en-Seine's three urban entities Caudebec-en-Caux, Villequier, and Saint Wandrille)

METHODOLOGY

As previously stated, this paper applies an ecosystem-based approach to spatial planning practices. Accordingly, the methodology is grounded in an interactive group workshop involving the students and the professors of two institutions: the National School of Architecture of Normandy and the Earth and Life Sciences Polytechnic Institute UniLaSalle (Rouen Campus), as well as other local stakeholders, including, the regional natural park of the Boucles de la Seine Normande and the public establishment for land management.

During a week, students were immersed in Rives-en-Seine, where they started by conducting a socio-ecological assessment of the town. This involved first a scoping phase in identifying the goals of ecosystem enhancement and threats to their achievement. Second, a risk analysis of the whole area spanning the three municipalities was performed. Interviews were also conducted with major stakeholders involved in the town's ecological restoration projects (watershed management agency …) and urban planning. Focus groups were organized with residents to understand their perception of ecosystem services that nature-based interventions could bring and their overall perspective on the local development project of Rives-en-Seine.

RESULTS

The results put forward a range of nature-based interventions as suggested by the workshop methodology.

Reinforcing the ecological corridors in the town's centre as support for urban uses

Natural habitats are highly fragmented in Rives-en-Seine due to the compounded artificialization of public spaces. New green spaces can be created in the main square of the town centre Caudebec-en-Caux to improve soil infiltration performance, reduce rainwater-runoff, and direct the excess water during rainy periods to groundwater recharge. Beyond its ecological interest, greening public spaces (which is overall positively perceived and accepted by local inhabitants) contributes to the urban micro-climate regulation and a better organization of the space use (restaurants, farmers' market, etc.). Greening public spaces also contributes to rebalancing the space share between cars and pedestrians to establish safe paths for soft modes and daily leisure activities. Finally, it is interesting to consider the role of various actors in the territory to associate the ecological function of green spaces with the urban functions of the grey and blue infrastructures as structuring resources for Rives-en-Seine.

Rethinking the urban plant strategy

The current plant strategy in Rives-en-Seine includes primarily species that are not adapted to their environment. Therefore, promoting a better interaction between plants and their environment is necessary. Besides, most of the green spaces in Caudebec-en-Caux are subject to a very intensive management strategy: bushes are continuously cut, lawns are mowed, and spontaneously growing plants are regularly pulled out. Although maintenance is necessary, the current management approach impedes the development of diverse flora in the town. Green space management intensity should be reduced to encourage spontaneous ecological processes and promote urban biodiversity. Creating so-called "laissez-faire" areas in the interstices of the town, where vegetation will serve as a miniature hotspot of urban biodiversity, can also play an effective environmental communication and education role among Rives-en-Seine inhabitants. The urban plant community supports human well-being partly owing to its role in constructing place identity while reducing the heat island effect.

Containing erosive runoff from agricultural plateaus to protect urbanized areas

Rives-en-Seine is located between multiple agricultural areas. It expands throughout the high plateaus, where several hydrological disorders cause frequent erosive runoff episodes. Interestingly, agricultural practices on the plateaus strongly influence the

hydrographic structure of the watershed, as the way vegetation is spatially distributed along the slopes is an essential factor for decreasing runoffs.
A strategy of planting hedges in these agricultural areas can effectively increase soil fertility while limiting erosive events and the costs of repairing damage caused by flooding and landslides. In addition, hedgerows planted along agricultural plots can serve as an ecological corridor for multiple herbaceous species. Farmers also have a significant role in containing the risk of erosive runoff in Rives-en-Seine: spatial reorganization of crops, reintroducing grasslands in farms, agricultural practices change toward sustainability, and small hydraulic infrastructure implementation are all possible solutions that require farmers to cooperate to maximize ecological benefits and minimize risk exposure.

Valuing wetlands as everyday public spaces

Wetlands' size and connectivity are essential to maintaining local biodiversity, species distribution, and water quality in Rives-en-Seine. Therefore, sustaining functional connectivity between wetlands and marshes should receive special attention. A restoration plan for these areas would benefit from a landscape approach that considers habitat connectivity within the more expansive surrounding areas, including urbanized areas. This will help limit the erosion of amphibian populations already threatened by habitat loss due to climate change. Moreover, a comprehensive wetland management strategy for Rives-en-Seine should consider the dynamics of these areas, particularly in Caudebec-en-Caux and Saint-Wandrille, where urbanization is expanding into water-saturated and flood-prone valley areas during extreme rainfall events. Thus, developing a network of wetlands crossing Caudebec-en-Caux to the Seine can play a crucial role in promoting the migration of species from marshes (located in the north) to wetlands (located in the south). Finally, it is necessary to promote the appropriation of these spaces by the inhabitants through their promotion as educational spaces and walkways developed to communicate the multiple ecosystem services offered by wetlands and their ecological management.

Regreening waterways improves biodiversity and the quality of public spaces

As stated previously, the Seine is a structuring element of the landscape and activities in Rives-en-Seine. The morphological restoration of the river and other water streams crossing urban areas has been long dominated by civil engineering practices (dyking, concreting, etc.). Even if it represents an effective solution to protect properties and people against flooding, grey infrastructure causes watercourses discontinuity and aquatic ecosystems impoverishment. Besides, soil artificialization coupled with the absence of vegetation that currently characterizes the Seine banks does not favor the development of adequate ecological habitat nor prevents fish from finding refuge in these areas. Nature-based intervention that may underlie the restoration project can be considered by allowing the stream to erode the banks in areas that are least

vulnerable to flooding or by developing flood expansion areas using riparian wetlands to allow the stream to overflow. It is hence relevant to develop public spaces along the water streams, which could be temporarily restricted in case of flooding. Once again, for the development of riverbanks, it is possible to combine grey infrastructure with green infrastructure by using wooden structures and greening specific segments by planting native species.

CONCLUSION

Small-town are rooted in local specificities and existing territorial capital. Our research suggests that this scale matters when thinking ecologically, as focusing on large metropolitan areas runs the risk of ignoring the uniqueness of small towns and the natural environment in which they are embedded.

Our results confirm the hypothesis that small towns could be a laboratory of urban resilience by experimenting with alternative development processes and tools. These towns are more suitable than large cities for transdisciplinary approaches, notably by involving citizens in the change process and finding innovative ways to unite different actors' efforts and capacities. Mainly, citizens' involvement at the small-town scale is believed to be more efficient in helping create a platform to support nature-based solutions and ensure transformative adaptation processes. Moreover, Rives-en-Seine case study reinforces an idea against the conventional wisdom that, although small towns are very dependent on larger cities, they also have their own territorial trajectories. Therefore, a research approach to small towns has to consider the dual challenge of focusing on their environmental and natural resource capital while positioning them relative to their bio-regional embeddedness.

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