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Article

Multifunctional Green Infrastructure in Shrinking Cities: How Does Urban Shrinkage Affect Green Space Planning?

Olivia Lewis *, Sílvia Sousa, and Paulo Pinho

CITTA Research Centre for Territory, Transports and Environment, University of Porto, Portugal

* Corresponding author (olivia.lewis@fe.up.pt)

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Abstract
Despite global urbanization, not all cities have increasing populations. While not homogenous, shrinking cities arguably have different opportunities and challenges for green space than growing cities. This article reports a structured content analysis to investigate how urban green space planning evolved in two case study cities: Buffalo (New York, US) and Porto (Portugal). These cities both underwent shrinkage and suburbanization but with very different green space planning histories. The concept of green infrastructure is used as a lens to analyze green space planning change, specifically focused on multifunctionality. The aim of investigating how objectives and priorities for planning green spaces change during a period of urban shrinkage, and particularly what functions these cities have assigned to green space, showed that, over time, green spaces were expected to produce more ecological functions in both cities, and, particularly in Buffalo, contribute to the economic and demographic outcomes of the city. Overall trends in green space planning appear to have played a role but we find shrinking cities may leverage green space to meet unique needs. These findings contribute to the literature by addressing how shrinkage affects not only vacant areas but also overall green space planning, as well as suggesting that general green space planning studies should consider demographic change as a relevant context factor.

Keywords
green infrastructure; multifunctionality; shrinking cities; spatial planning; urban green space

Issue
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1. Introduction

In the US, 80 cities were identified as shrinking from 1970 to 2010, while 129 of Europe’s cities were shrinking from 1990 or earlier to 2005 (Ganning & Tighe, 2018; Turok & Mykhnenko, 2007). Schilling and Logan (2008, p. 451) wrote that “shrinking cities provide fertile ground for neighborhood-scale and citywide greening strategies that can revitalize urban environments, empower community residents, and stabilize dysfunctional markets.” In recent decades, have shrinking cities focused on planning green space to achieve these ends? There are almost countless possible objectives for urban green space (UGS), many of which relate to shrinking. While often complementary, these objectives can also imply trade-offs. Has the context of shrinkage affected UGS planning in these cities, including or beyond goals for green space that are directly related to urban shrinkage? To answer these questions, this research looks at change over time in municipal planning objectives for UGS in shrinking cities, using a local lens to look at what functions planners expected from UGS in the context of demographic and economic change. By studying the recent past of shrinking cities as socio-ecological systems, our goal is to contribute towards a better understanding of how to reach sustainable future pathways.

1.1. Concepts

1.1.1. Urban Shrinkage

Many authors define shrinkage using population loss, often as the sole dimension. The timeframes used for defining shrinkage vary greatly, from a very short two years to 40 years (Hartt, 2021; Hollander & Németh, 2011; Schilling & Logan, 2008). In addition to population decline, many definitions refer to economic downturn, loss of investment, and structural crisis. Economic decline is thus a common but not ubiquitous dimension (for an example of an exception, see Hartt, 2019). The following definition is widely cited:

> A shrinking city is a densely populated urban area that has on the one hand faced a population loss in large parts of it (for at least 5 years, more than 0.15% annually), and is on the other hand undergoing economic transformation with some symptoms of a structural crisis. (Stryjakiewicz & Jaroszewska, 2016, p. 28)

The literature on shrinking broadly agrees that the context of shrinkage shapes planning responses; however, there are two divergent mechanisms proposed for how this occurs, summarized in Figure 1. Pallagst et al. (2017) posit that the strategies a city creates to cope with shrinkage are directly influenced by that city's perception of shrinkage; for example, a city that accepts shrinkage will adopt strategies such as reducing infrastructure, thus "planning for decline," while a city that aims to maintain its population is either ignoring shrinkage or observing it without acceptance. A different view is that planning strategies are not influenced by the perception of shrinkage in that city: "Each city employs a complicated mixing of a variety of different planning strategies, regardless of whether they have 'accepted' population loss or not" (Heim LaFrombois et al., 2019, p. 8). As is shown in Figure 1, this means perceptions of shrinkage, in terms of acceptance, may or may not be a mediating factor between the situation of urban shrinkage and a city's response strategies.

1.1.2. Green Infrastructure

Green infrastructure (GI) is a recent conceptualization of the role of UGS, defined by Benedict and McMahon (2002, p. 12) as "an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations.'' The concept gained traction alongside the emergence of ecosystem services and socio-ecological thinking in the 1990s and 2000s (Duvall et al., 2018).

GI definitions vary, although with general consensus on the concepts of connectivity and multifunctionality (e.g., Duvall et al., 2018; Lennon & Scott, 2014; Pauleit et al., 2019). Authors disagree about whether GI refers only to publicly planned and/or managed green spaces (e.g., Gómez-Baggethun & Barton, 2013) or also private spaces (e.g., Cameron et al., 2012). In this study, UGS is considered as open, vegetated urban space (Hunter & Luck, 2015), while GI is understood as a particular planning approach to green space. This differentiation is summarized as follows:

> The term green spaces can be applied to existing or planned green elements and structures regardless of whether or not they take into account UGI [urban green infrastructure] principles, while UGI stands for a specific perspective on natural areas and other open spaces in urban and non-urban surroundings. (Davies et al., 2015, p. 12)

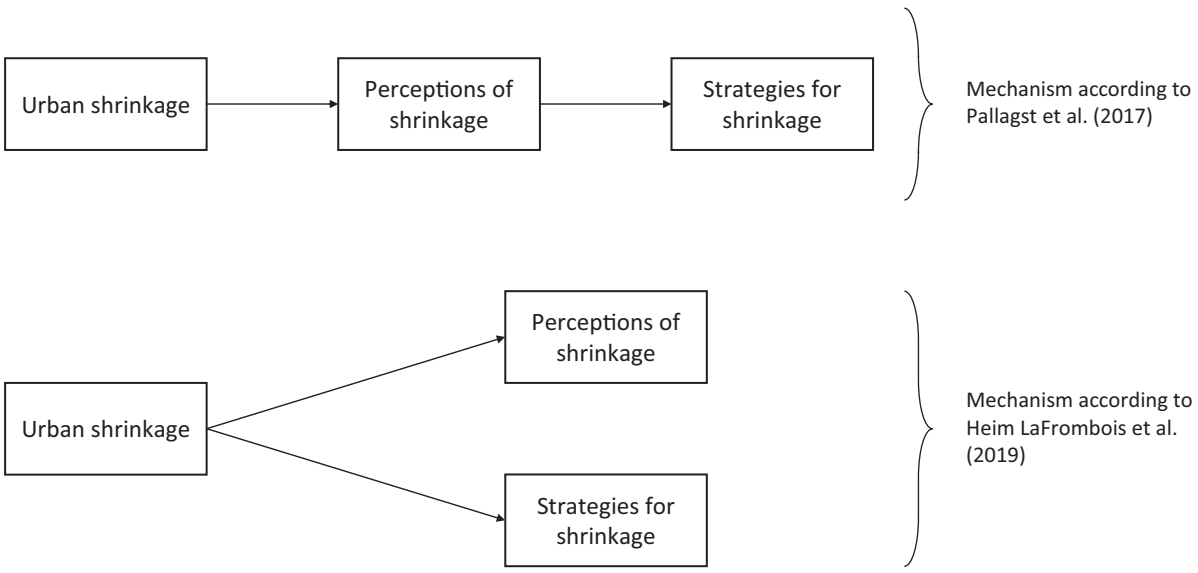

Figure 1. Schematic showing different proposed mechanisms for which the situation of urban shrinkage affects a city's strategies for responding to shrinkage.

The concept of multifunctionality used here is from Hansen and Pauleit (2014, p. 518): "Multifunctionality in GI planning means that multiple ecological, social, and also economic functions shall be explicitly considered…[it] aims at intertwining or combining different functions." Ecosystems are considered to provide functions that may then be considered services, that is, human-beneficial outcomes (Hansen & Pauleit, 2014).

1.2. Scope of the Article

This article sits at the intersection of the two research fields of shrinking cities and GI planning. Shrinking cities present a unique context for GI planning. James et al. (2009) presented five emergent themes for UGS research, namely physicality, experience, valuation, management, and governance. Structuring thinking around these themes reveals that green space in shrinking cities is considerably different than in growing cities (Lewis, in press). For example, shrinking cities often have patchwork landscapes of "occupied structures, abandoned structures, and vacant, formerly occupied land" (Nassauer & Raskin, 2014, p. 2), also conceptualized as "perforation" (Florentin, 2010). However, they do not necessarily have more large-sized green areas (>25 ha) than growing cities (Kabisch & Haase, 2013). Moreover, despite being "green," vacant spaces do not necessarily provide ecosystem services, as this depends on management regimes (Gardiner et al., 2014; Walker et al., 2017). From a resident's perspective, while a greener urban environment could present benefits, there may also be concerns about dangers—actual or perceived—from unmanaged spaces (Gulachenski et al., 2016; Nassauer & Raskin, 2014). Green spaces emerging during shrinkage may not meet the needs and preferences of urban residents (Colasanti et al., 2012; Schetke et al., 2010).

Furthermore, the situation for planning and management of green space is different in shrinking than growing cities. Shrinking cities often have more land to manage at the same time that population and tax base are decreasing. Finances have been identified as a challenge for planning and management of green space in this context (Florentin, 2010; Keeley et al., 2013). Different management strategies have been suggested, including bottom-up strategies such as community gardening on vacant lots (Lee & Sung, 2017) or participatory management of informal green spaces (Rupprecht, 2017), as well as top-down strategies like fencing and mowing (Morckel, 2017). Various authors have argued that traditional planning approaches are insufficient in shrinking cities (e.g., Galster, 2019; Heck & Will, 2007). However, alternative approaches may be complicated by the "stickiness" of existing institutional systems (Kirkpatrick, 2015, p. 261; Safransky, 2014; Sorensen, 2006). By applying the concept of GI to shrinking cities, we aim to think about the overall system of green space in a shrinking city, including, but not limited to, the topic of vacant land management.

Green space in shrinking cities can be planned and managed with a focus on a number of different ecosystem services and/or amenities (Herrmann et al., 2016). In this article, we focus on objectives for green space planning in terms of multifunctionality. We hypothesize that shrinkage is relevant through two mechanisms: (1) shrinkage motivates planners to produce a particular result (i.e., shrinkage as driver); and (2) shrinkage imposes limitations by reducing resources and increasing governmental responsibilities (i.e., shrinkage as context). This article employs a comparative, longitudinal case study approach. The longitudinal approach enables us to understand the development of these expectations within a city, while the comparative approach enables us to perceive whether these developments are common themes across shrinking cities and also the role of local context. Multifunctionality was investigated by considering the expected functions of green space, as well as how these objectives were related to one another, both in thematic terms and spatially, for example through different land-use types in the plan.

To address the aim of investigating change in green space planning in shrinking cities, with the lens of the multifunctionality concept, this article is based on a content analysis of planning documents from two cities, Buffalo (New York, US) and Porto (Portugal). The analysis is guided by two research questions: (1) What general approach to shrinking is visible in each document? and (2) How have expectations of green space multifunctionality—considering ecological, social/cultural, and economic functions—changed over time?

2. Methodology

2.1. Content Analysis

A directed content analysis of seven planning documents published between 1971 and 2020 was carried out. In the case of Buffalo, two sets of plans were analyzed, each comprising a comprehensive and a land-use plan; for Porto, the strategic reports of three municipal director plans were analyzed. Details of each document are shown in Table 1.

In Buffalo, the 2000s plans were written after a long period in which the city did not update its spatial plans despite much urban change. For Porto, the 2006 *Plano Diretor Municipal* (Municipal Director Plan [PDM]) has been considered "a clear departure from the preceding plans" (Madureira et al., 2011, p. 146). The 2006 and 2020 PDMs were also written after the municipal ecological structure (MES) concept was introduced by Portuguese Decree-Law No. 380/99 of September 22nd, giving a different national context to green space planning.

These types of strategic municipal plans can be viewed as "something more than a mere 'vision statement' but less than a rigid 'blueprint'" (Norton, 2008, p. 436) and are, therefore, a key point of analysis in

Table 1. Overview of the planning documents analyzed.

City	Year	Plan Type	Plan Title
Buffalo	1971	Comprehensive plan	*Buffalo Master Plan*
	1977	Land-use plan	*Buffalo City Plan*
	2006	Comprehensive plan	*The Queen City in the 21st Century: Buffalo's Comprehensive Plan*
	2016	Land-use plan	*Land Use Plan*
Porto	1993	Municipal director plan: Strategic section	*Porto Projecto Cidade Nova: Plano Director Municipal* (Project New City Porto: Municipal Director Plan)
	2006	Municipal director plan: Strategic document	*Plano Director Municipal do Porto—Relatório Setembro 2005* (Municipal Director Plan of Porto—Report September 2005)*
	2020	Municipal director plan: Strategic document	*Plano Diretor Municipal Relatório—Discussão Pública: Setembro 2020* (Municipal Director Plan Report—Public Discussion: September 2020)**

Notes: * Referred to as the 2006 plan, because it was ratified in 2006. ** The public discussion version of this document was analyzed because the final version had not yet been released at the time of analysis.

the overall planning process. The object of this research was the policy focus of the plans and not their quality (Norton, 2008). Various authors have chosen master plans as the object of content analysis; for example, Heim LaFrombois et al. (2019, p. 4) argue that these plans "represent the overall vision of the city and strategies for achieving that vision and incorporate the goals and strategies of other more specific plans," demonstrating their suitability for the questions posed here.

Existing research on urban shrinkage and GI has employed content analysis, including qualitative, context-oriented approaches (Grădinaru & Hersperger, 2019; Heim LaFrombois et al., 2019; Kim & Tran, 2018; Sousa, 2019), which were similarly applied here. Specifically, directed qualitative content analysis was used (Hsieh & Shannon, 2005). For the first research question, about the general approach to shrinkage in each document, plans were analyzed for content related to past shrinkage, population projections, and goals around shrinkage, as well as inductively for other relevant factors. For the second research question, the plans were analyzed for content relating ecological, cultural, social, and economic functions to green spaces. As Escobedo et al. (2019) highlight, the intended outcome of terms like GI and ecosystem services are more important than the terms themselves; we, therefore, chose to focus on what is conceptually covered by GI and multifunctionality and not only what was labeled as "green infrastructure," "ecological services," and so on.

2.2. Case Studies

A diverse case selection method was used to choose two case study cities of (currently) similar size and shrinkage pattern, with diverse UGS planning histories (Seawright & Gerring, 2008). Selecting a limited number of case studies is intended to meet calls for in-depth, comparative case study research in shrinking cities (e.g., Heim LaFrombois et al., 2019).

Buffalo, located in Western New York, next to Lake Erie, has a land area of approximately 104.6 km^2 (City of Buffalo & Office of Strategic Planning, 2016). Buffalo has been labeled a "quintessential rustbelt city" (Silverman et al., 2015, p. 4). From a peak population of 580,123 in 1950, Buffalo's population steadily declined to 261,310 residents in 2010 (Manson et al., 2021; Silverman et al., 2015). As shown in Figure 2, a slight resurgence in population was visible in the last decade, with the 2020 census reporting 278,349 residents (Manson et al., 2021).

The city was formed as a trading post on Buffalo Creek, on land traditionally of the Haudenosaunee Confederacy (Szczepaniec, 2018). It grew throughout the 19th century as a transit point and manufacturing center connecting the eastern seaboard and the grain-producing states of the Midwest (Kowsky & Olenick, 2013). The American park movement was born at the same time Buffalo was growing. This movement came to Buffalo around 1870, following a citizens' petition for a public, waterfront park; the noted landscape architect Frederick Law Olmsted visited Buffalo in 1868 and formed the basis of a three-part park scheme, connected by a number of parkways (Kowsky & Olenick, 2013). This "revolutionary" system of parks and parkways formed the basis for a Buffalo parks system that still exists today (Eisenman, 2013).

From 1950, population decline began in Buffalo, driven mainly by manufacturing jobs shifting out of the Rust Belt region and, later, suburbanization (Knight et al., 2018). Simultaneously, its share of regional population decreased, as did wealth: Median household income rose only 4% from 1950 to 2010, compared to 88% nationally (City of Buffalo & Office of Strategic Planning, 2016). A "rather broad neighborhood downgrading pattern" was observed from 1970 to 2010 (Delmelle, 2015, p. 5). Knight et al. (2018, p. 5) write that:

> Buffalo holds a reputation as a shrinking city that is characterized by issues of chronic vacancy,

> abandonment, and segregation. Yet, the success of its established neighborhoods and several revitalizing areas (notably downtown)…are giving rise to claims of a citywide resurgence.

In 2016, the city reported almost 12% of its land was vacant (City of Buffalo & Office of Strategic Planning, 2016).

Porto is an old port city in Northern Portugal, located where the Douro River meets the Atlantic Ocean. It covers 41.4 km^2. The city's peak population was 327,368 in 1981; this declined to 231,828 by 2021 (Statistics Portugal, 1984, 2021b). It is part of the Porto Metropolitan Area and can be considered a regional employment hub (Direção Municipal de Urbanismo et al., 2015). Some recent population growth is visible according to annual estimates but was not visible from the decennial censuses of 2011 and 2021 (see Figure 2).

Porto was identified as the most strongly shrinking city in Portugal from 1981–2011 (Alves et al., 2016). It was characterized as undergoing metropolitan shrinkage with urban sprawl (Sousa, 2010); from 1991 to 2011, the metropolitan area grew by 9% while the city proper shrank by around 21%, indicating a strong suburbanization process (Guimarães et al., 2016). Post-1981 population loss has been attributed to high housing prices and declining housing conditions and characterized by urban sprawl and city-center population loss (Alves et al.,

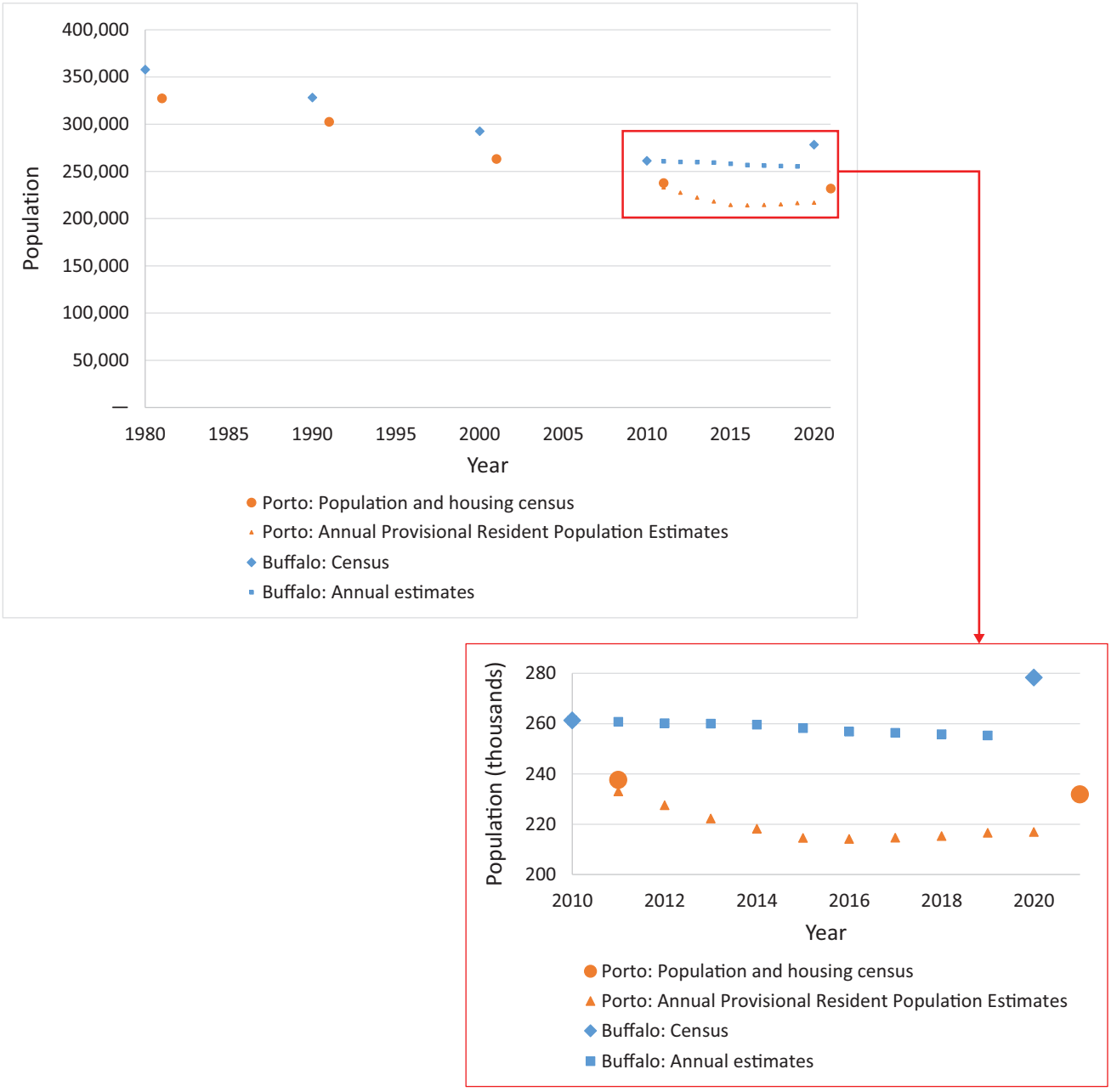

Figure 2. Population in Porto and Buffalo (main: 1980–2021; inset: 2010–2021). Source: Authors' figure based on data from Manson et al. (2021), Statistics Portugal (1984, 2007, 2021a, 2021b), and US Census Bureau (2020).

2016; Sousa, 2010). Further relevant factors, identified by local stakeholders, include suburban housing construction, location of jobs in the metropolitan area outside the city center, and car-friendly policies (Ferreira et al., 2020). Residential vacancy and unemployment exceed national averages but vary strongly across the city (Direção Municipal de Urbanismo et al., 2015).

Recently, new pressures, characterized as "tourist-driven functional gentrification," have become evident in Porto (Varady & Matos, 2020, p. 2). These include private building rehabilitation and housing pressures along with an influx of new businesses (Fernandes et al., 2018). Both tourism and student influx have led to a crisis of housing affordability, forcing lower-income families out of the city's historic core (Varady & Matos, 2020). Overall, an exceptionally fast, intense, internationally driven gentrification is described (Fernandes et al., 2018; Sousa & Rodriguez-Barcón, 2021; Varady & Matos, 2020).

Porto's green space cover varies strongly across its parishes, from 46.8% in the east (Campanhã), to only 26.05% in the central/eastern area (Historic Center and Bonfim; Graça et al., 2017). This, however, does not correspond to green space quality, with the western and southwestern parishes having higher quality green spaces (Graça et al., 2017). A comparative assessment of Porto's land cover from 1892 and 2000 concluded that "Porto did not follow the growing concern [visible in other European cities] for the preservation of its urban green structure as an integrated and coherent system" over the 20th century; in this time period, its green area dropped from over 75% to 30% (Madureira et al., 2011, p. 148).

As described, while Buffalo and Porto are both medium-size port cities that underwent suburbanization-driven shrinkage, they have very different structural and green space histories. Buffalo, although dense by US standards, has approximately 2,700 residents/km^2, while Porto is more than twice as dense, with around 5,600 residents/km^2. Buffalo's system of Olmsted parks and parkways structured the green space of the city, making it "the premier example" of parks and parkways planning (Kowsky & Olenick, 2013, p. 20), while Porto had a privately driven development (Oliveira & Pinho, 2008) that resulted in fragmentation of the city's green structure in the 1900s—according to Madureira et al. (2011), unusually so in the European context. The two cities can thus be considered interesting extremes from a green space perspective, while at the same time maintaining a size, geographic type, and shrinkage history that makes comparison possible.

3. Results

3.1. Approach to Shrinkage

The first research question asks what general approach to shrinking is visible in each document. As shown in Table 2, all four plans from Buffalo acknowledge ongoing population decline, and regrowth is clearly expected with concrete population predictions in the first three. Only the 2016 plan has a different outlook, presenting a general goal for regrowth but without a concrete prediction for future population; this plan is also unique in its broader focus on the drivers of shrinkage. The three more recent plans clearly show the assumption that the city's policies and plans can affect population outcomes, although the 2016 plan is less direct, focusing on creating "conditions" for growth rather than growth itself.

Table 2. Approaches to urban shrinkage as seen in municipal planning documents from Buffalo and Porto.

Plan Title	Framing of Past Situation	Population Projections/Expectations	Goals	Other Relevant Points
Buffalo Master Plan (1971)	Acknowledges population loss over past 25 years (City Planning Board & Division of Planning, 1971, pp. IV–12); economic shrinkage and shrinking tax base due to suburbanization (City Planning Board & Division of Planning, 1971, pp. I–6)	Regrowth expected by 1980; planning population figure set at 500,000 (City Planning Board & Division of Planning, 1971, pp. IV–12)	—	—
Buffalo City Plan (1977)	Acknowledges ongoing declining population	Population assumed to be close to 400,000 by 2000 (Division of Planning, 1977, Ch. III, p. 5)	—	Assumption that policies and planning will reverse trends in the city (Division of Planning, 1977, Ch. IV, p. 22)

Table 2. (Cont.) Approaches to urban shrinkage as seen in municipal planning documents from Buffalo and Porto.

Plan Title	Framing of Past Situation	Population Projections/Expectations	Goals	Other Relevant Points
The Queen City in the 21st Century: Buffalo's Comprehensive Plan (2006)	Acknowledgment of declining population	Assumption that population decline will stop by 2020 and regrowth will then occur (Office of Strategic Planning, 2006, p. 9); specifically, 0.5% annual growth from 2010 to 2015 and 1% from 2015 to 2030 (Office of Strategic Planning, 2006, p. 66)	—	Assumption that policies and planning will affect the population outcome (Office of Strategic Planning, 2006, p. 9)
Land Use Plan (2016; Buffalo)	Acknowledges population decline	—	General goal for regrowth: "Create the conditions for Buffalo to regrow again." (City of Buffalo & Office of Strategic Planning, 2016, p. 2)	Focuses not only on suburbanization as driver but also on broader changes (related to modes of transportation and national economy) that affected Buffalo (City of Buffalo & Office of Strategic Planning, 2016, p. 6)
Project New City Porto: Municipal Director Plan (1993)	—	—	—	Notes a lack of adequate demographic projections for planning at the Planning Unit (sub-municipal) level (Câmara Municipal do Porto, 1993, p. 33)
Municipal Director Plan of Porto—Report (2005)	Acknowledges population decline from 1981 to 2001 (Câmara Municipal do Porto, 2005, p. 19)	—	—	Mentions very high population density and historical overcrowding in the city center (Câmara Municipal do Porto, 2005, pp. 21, 121) as well as the importance of considering city use for employment and study as well as residence (Câmara Municipal do Porto, 2005, p. 215)

Table 2. (Cont.) Approaches to urban shrinkage as seen in municipal planning documents from Buffalo and Porto.

Plan Title	Framing of Past Situation	Population Projections/Expectations	Goals	Other Relevant Points
Municipal Director Plan Report—Public Discussion (2020)	Refers to a "slight recovery in the resident population…in recent years" (Câmara Municipal do Porto, 2020, p. 16)	—	A clear goal to reverse population loss: The first of its seven strategic objectives is to "promote conditions for living and well-being of the population, reinforcing residential activity and creating conditions for the demographic recuperation of the city" (Câmara Municipal do Porto, 2020, p. 37)	Questions whether slight ongoing population growth could continue without supporting policies and acknowledges increased housing costs and "socio-spatial segmentation" (Câmara Municipal do Porto, 2020, p. 16)

Porto's documents show a different approach; in the 1993 report, population loss is not acknowledged. The 2006 report acknowledges the city has gone through two decades of population loss (1981–2001); however, there is no clear demographic objective, and population loss is also framed in terms of historical overcrowding, as well as emphasizing city users beyond residents. The attitude of the 2006 PDM towards shrinkage was characterized as "indifferent" by Sousa (2019). The 2020 report does not set clear demographic objectives, but the first of its strategic objectives is "creating conditions for the demographic recuperation of the city" (Câmara Municipal do Porto, 2020, p. 37); similar to Buffalo, the role of the city is framed as creating conditions for population growth.

In no instance in either city is ongoing population decline or stabilization at a lower population level framed as a desirable objective.

3.2. Multifunctionality

3.2.1. Buffalo: 1970s

In Buffalo's 1970s plans, green space planning falls under Recreation and Open Spaces (City Planning Board & Division of Planning, 1971, p. 47; Division of Planning, 1977, Ch. V, p. 7). These plans listed few ecological functions. The 1971 plan describes that "programs to eliminate pollution and improve ecological relationships will be supported" (City Planning Board & Division of Planning, 1971, pp. III–4). The Tifft Farm Reservation also had the primary goal of wildlife preservation; it was planned to "contain a 75 acre wildlife sanctuary where no public access will exist" (Division of Planning, 1977, section V B–1.32), illustrating excluding humans from an environmental protection area. However, recreation and leisure were strong themes for UGS, demonstrating an emphasis on social function, as shown by the inclusion of green space in Recreation and Open Spaces. The 1977 plan details recreation functions, with local-use parks expected to provide passive uses and increasingly active recreation in larger parks (Division of Planning, 1977, Ch. 5, pp. 2–3).

Green spaces were also considered a means to attract or retain residents. Among 10 ways of attracting or retaining residents, Buffalo's 1971 plan lists two green space factors. The first is "the improvement of open spaces in the city," showing that open spaces, presumably including green spaces, are considered a desired feature for residents (City Planning Board & Division of Planning, 1971, pp. IV–11). The second describes people's "increasing desire for an urban environment for permanent residence and more distant open areas for recreation, instead of a suburban compromise" (City Planning Board & Division of Planning, 1971, pp. IV–11). This indicates a perceived separation between green space and urban environments. The plan also refers to green space providing relief from the urban environment (City Planning Board & Division of Planning, 1971, Ch. V, pp. 50, 65).

In economic function, a trade-off is framed as necessary between economic development goals and green space. In 1971, Buffalo had been losing population for approximately 20 years. However, the master plan does not show concern about excess green space, but rather how to deal with perceived inevitable development pressures on the small amount of open space available in a dense, developed city: "The temptation to use park land for expressway routes, school sites, and other public or private developments can be very great" (City Planning Board & Division of Planning, 1971, Ch. V, p. 44). Priority is given to planning foreseen expansion and expressways, with the policy that recreation areas should be sited where they are "not likely to hinder various expansion

programs, and not in the path of a foreseeable expressway" (City Planning Board & Division of Planning, 1971, Ch. V, p. 11). It is assumed that some existing sites will need to be replaced (City Planning Board & Division of Planning, 1971, Ch. V, pp. 44, 46). Green spaces are essentially framed as counter to development and must, at best, be involved in trade-offs.

In multifunctionality terms, these plans show an approach of different spaces for different uses: Parks, for example, are for social use, whereas the wildlife preserve is conceptualized as a sanctuary without public access. Green and grey infrastructure are not framed as compatible but rather as requiring trade-offs, and priority is given to siting green spaces away from areas potentially required by grey infrastructure. The desire to avoid a "suburban compromise" indicates that the city frames many of the functions of green space as deliverable outside the urban context, although it appears that the social functions delivered by parks of different scales are considered compatible with the urban environment.

3.2.2. Buffalo: 2000s

The 2006 plan defines GI comprehensively, dividing it into three "layers": formally protected, not formally protected, and potential GI (e.g., parks, transportation buffers, and vacant residential land, respectively; Office of Strategic Planning, 2006, pp. 49–50). The actual term "green infrastructure," however, is only briefly used, with seemingly different meanings, in these plans (see City of Buffalo & Office of Strategic Planning, 2016, pp. 2, 38; Office of Strategic Planning, 2006, p. 102). In these plans, many ecological functions are expected from UGS, including "providing wildlife corridors, urban habitat, support for biodiversity, and more" (Office of Strategic Planning, 2006, p. 49). Notions of ecological restoration and repair are visible; the 2016 plan has an objective to "repair the environment" and references "legacy environmental challenges" and "remediating prior environmental damage" (City of Buffalo & Office of Strategic Planning, 2016, pp. 36, 38). Providing access to protected areas is seen as a means of education and connection to nature, leading to a feedback loop that ensures the protection of natural sites (City of Buffalo & Office of Strategic Planning, 2016, p. 38). The 2006 plan includes different recreational functions as a main characteristic of parks. However, tension is noted between passive and active recreation uses (Office of Strategic Planning, 2006, p. 44). The plan also newly frames UGS as a cultural asset in the city. In 2006, Buffalo listed parks as a city asset in the historic architecture category (Office of Strategic Planning, 2006, p. 36). UGS is also considered a means of attracting people to the city. The plans directly link UGS to quality of life and amenity function (Office of Strategic Planning, 2006, p. 72). Open spaces are viewed as pull and retention factors, "important assets for any place seeking to attract and retain residents" (City of Buffalo & Office of Strategic Planning, 2016, p. 40). These resources are also expected to draw tourists (Office of Strategic Planning, 2006, p. 98). The document describes how a new park on the East Side "would also help attract visitors and new investment to this part of Buffalo" (Office of Strategic Planning, 2006, p. 92). However, UGS is also a means to serve existing residents. Regional assets, including waterfronts, parks, and parkways are seen to:

> Help create a quality of life for residents in the city and throughout the region that makes Buffalo a special place to live, work and play. They provide meaning and purpose to the daily lives of residents. They should not be understood only as economic assets. (Office of Strategic Planning, 2006, p. 16)

Compared to earlier separations of economic development and green space, the 2000s plans have a clearly different vision. UGS is framed as a competitive asset that can help drive the economic regeneration of Buffalo. The 2006 plan states that "great parks in good order will be a crucial element in any strategy to turn the city around" (Office of Strategic Planning, 2006, p. 44). Investment in parks is listed as one means of restoring population growth (Office of Strategic Planning, 2006, p. 9). UGS is considered a key factor in Buffalo's regeneration: "By building on our cultural assets, increasing the economic base…and enhancing the green environment, we are confident that we can reestablish Buffalo's position of greatness in the nation and the world" (Office of Strategic Planning, 2006, p. IV). The plan emphasizes the historic parks and parkways system as well as the waterfronts (Office of Strategic Planning, 2006, p. 15). It also frames UGS as important for companies, stating: "New and existing enterprises should respect and benefit from the green setting that a restored river and buffer zone will provide" (Office of Strategic Planning, 2006, p. 75). Importantly, all of these "assets" are seen as important in an urban competitiveness strategy (Office of Strategic Planning, 2006, pp. 21, 89). Economic function is also assigned to UGS by acknowledging that vacant lots can potentially add value to adjacent properties, with a range of uses that includes "community gardens to urban agriculture and forestry" (City of Buffalo & Office of Strategic Planning, 2016, p. 38).

In this set of plans, social multifunctionality reappears as a theme and tension is noted between different activities within parks. However, parks are also vested with additional functions; the Olmsted parks in particular are considered to have cultural and economic importance and be a means of drawing people and investment to the city. Earlier separation between wildlife preservation and social functions is replaced with a synergistic notion that protected areas can also serve to educate and connect residents with nature. The plans briefly describe that waterfronts, parks, and parkways are not "only" economic assets but also provide quality of life for residents; whether these two functions are considered synergistic or whether trade-offs are implied is not

fully clarified. The overall function of GI is now not limited to formal green spaces as in earlier plans. Vacant lots are also considered, primarily being mentioned here in terms of adding economic value to neighboring properties. To some extent, it appears that green spaces are expected to "do it all," simultaneously fulfilling the needs of existing residents, attracting new residents, attracting investment, and providing a host of ecological functions.

3.2.3. Porto: 2006

In Porto, no "GI" type concept is visible in the 1993 PDM and minimal discussion of expected functionality for UGS appears; hence, this analysis focuses on the 2006 and 2020 PDM reports.

The 2006 report includes the concept of MES, introduced by national Decree-Law No. 380/99 of September 22nd. The concept is explained as "an evolution of urbanistic thought increasingly concerned with questions of sustainability, protection of natural heritage, waterways, fragile ecosystems, risk areas, etc." (Câmara Municipal do Porto, 2005, p. 93), showing emphasis towards ecological benefits. Porto's 2006 report includes rehabilitating public space and the built environment as one of the five main strategic objectives of the plan, adopting a systemic (i.e., multifunctional) view of ecological and landscape resources (Oliveira & Pinho, 2008). Providing access to natural areas is seen as a means of education and connection to nature, leading to a feedback loop that ensures the protection of natural sites (Câmara Municipal do Porto, 2005, p. 230). The plan lists a variety of social functions such as civic activity, recreation, and social interaction. Sport and green space overlap as both are planned under "collective space types." UGS also begins to be seen as a cultural asset in the city: "Safeguarding and enhancing the natural and built heritage and the image of the city" is part of the objective of "enhancing the urban identity of Porto" (Câmara Municipal do Porto, 2005, p. 9). This plan does not list specific economic functions expected from the city's UGS, or frame UGS as an investment opportunity, but includes a green space type of mixed green areas centered on productive uses, namely agriculture and forestry, indicating some expectation for economically productive UGS. In contrast to Buffalo, the plan presents problems with the loss of UGS: A strongly expanding real estate market led to development pressures that caused the loss of existing UGS, especially private green space. "Land that [had] only recently been cultivated and [belonged] to old farms or groups of rural houses" was occupied in this way (Câmara Municipal do Porto, 2005, p. 98).

While social, cultural, economic, and ecological functions are all included to some degree as expectations of green space in the plan, the focus seems to be on ecological functions. This is also clear from the MES definition and even the framing of MES. Economic functions are the least emphasized; as in Buffalo, a seeming tension emerges between real estate pressure and green space. However, compared to Buffalo where the pressure was felt on city-owned and managed parkland, in Porto, it concerns the destiny of some small and scattered spots of former agricultural and quasi-rural private land still left within a densely occupied urban territory.

3.2.4. Porto: 2020

The MES appears in the 2020 report but is operationalized differently: It consists of four "components" rather than the seven land types used in the 2006 report (Câmara Municipal do Porto, 2020, pp. 67–68). The European-level concept of GI is specifically referenced in this report, representing the first clear introduction of "GI" into Porto's plans. The report states that the MES objective "is to promote the continuity of natural and cultural systems, the sustainability of the territory from a physical and ecological point of view, the growth of biodiversity and the protection of architectural and landscape heritage" (Câmara Municipal do Porto, 2020, p. 67), a broader definition than previously used.

The 2020 Porto report considers specific ecological issues, including soil permeability, air quality, heat island minimization, and nutrient circulation (Câmara Municipal do Porto, 2020, pp. 36, 64, 68–69, 76). The issue of soil sealing is raised, which is related in the plan to lack of vegetation and aquifer recharge problems (Câmara Municipal do Porto, 2020, p. 74). Like the 2006 report, social functions include recreation and social interaction. However, unlike in the 2006 report where both green space and sport areas are "collective space types," in the 2020 report they were separated: sport into the public facilities system and UGS into the environmental system. This may reflect a diminished importance given to some social functions of UGS compared to environmental outcomes. The productive-use mixed green area land type from the 2006 report does not reappear in the 2020 report.

This is the first analyzed document in which UGS is closely linked to of attractiveness in Porto. An overall objective of the plan is to "promote the living conditions and well-being of the population, reinforcing the residential attractiveness of Porto," with one indicator being "improved public space" (Câmara Municipal do Porto, 2020, p. 225). This shows the general framing of public space, including green space, as a contributor to quality of life and attractiveness. This report also describes how improving public spaces, and in one case specifically, green spaces, could be a means of reducing social (and spatial) exclusion in two areas that are still "stigmatized" (Corujeira and the Campanhã Railway Station area). These areas are both in the eastern part of the city, which is described as "still having stigmas associated with [it]" but having various attributes including landscape qualities that could make it an area that benefits from the "expansion of urban dynamics" (Câmara Municipal do Porto, 2020, pp. 28–29). On the other side of the city, improving the beach- and river-fronts is seen

as a means to redistribute tourism and leisure activities away from their concentration in the historic center (Câmara Municipal do Porto, 2020, p. 43). Green (and blue-green) spaces are also considered to maintain Porto's attractiveness on a larger scale: "Reinforcing the [city's] current attractiveness presupposes strengthening the factors that have contributed to position Porto among the most attractive cities in Southern Europe" (Câmara Municipal do Porto, 2020, p. 20); the city's natural and landscape "attributes" are listed among these features. This section seems particularly concerned with "qualified professionals," positioning the city as aiming for a specific type of attractiveness.

In this plan, the overall multifunctionality expectations of the green space system of the city appear to have shifted somewhat. While social functions were already expected from the city's green space in the 2006 report, in 2020 the MES definition is explained in broader terms, not only on protecting ecosystems but also referencing cultural systems and heritage. The economic expectations from green spaces appear to have shifted; instead of select sites having a productive land-use type, other sites are expected to help in territorial balancing by improving the image of some areas of the city. The overall blue-green system of the city is considered to be relevant for city competitiveness and attracting residents; this was already somewhat visible in 2006 via reference to urban image but is even more explicit here. It can therefore be argued that while there is not a dramatic shift from 2006, green space is given an increased role in overall territorial development, and ecological and attractiveness functions are also reinforced. The multifunctionality expectations of the overall network can thus be viewed as increased. Beyond formally created areas such as parks, natural areas such as the riverfront and beaches are clearly incorporated into this system.

4. Discussion and Conclusions

This study was built on the hypotheses that urban shrinkage affects green space planning: (1) directly (as a driver of UGS planning decisions); and (2) indirectly (as a context in which decisions are made). The results from the qualitative content analysis of planning documents in two shrinking cities provide evidence to support the first hypothesis: Urban shrinkage appears to be a driver of cities' expectations for UGS. In Buffalo, recent emphasis on the unique, historic character of the parks and parkways system and waterfront shows a revaluation of these heritage features and suggests the city has conceptually reframed these in response to shrinkage. In Porto, an aspect of green space contributing to urban competitiveness is also seen in the 2020 report. In the concept section of urban shrinkage, this article presented two theories from the literature about the mechanism by which urban shrinkage affects response strategies: with, or without, perceptions of shrinking serving as a mediating factor. Our results support the hypothesis that shrinkage has directly affected green space planning by creating goals for green space functions that are a direct response to issues created by shrinkage; however, it is unclear whether perceptions or attitudes towards shrinkage were a relevant mediating factor. Notably, although urban shrinkage was acknowledged to a greater or lesser degree, there was essentially a uniform focus on regrowth and no acknowledgment of potential desire to stabilize at lower populations or continue shrinking. Further research on the planning process could investigate this.

The specific outcomes expected for UGS in response to shrinkage may depend on the framing of shrinkage in each city: the way that "the conceptualization of shrinkage is dependent on a variety of frames that interpret the associated effects as crises of a specific nature" (Ivanov, 2021, p. 15). For example, in Buffalo, a narrative that problematizes depopulation and economic disinvestment leads to green space being a means to attract residents and companies. The literature often approaches the question of green space in shrinking cities from a perspective of managing an excess of (vacant) space, which can be considered adapting to shrinking (in the sense presented by Copus et al., 2021). However, the results found here show that green space responses in shrinking cities can also be framed around mitigating the issue of shrinkage by retaining and attracting residents (Copus et al., 2021).

As some parts of these plans focus on green space as an attractiveness factor for potential future residents, the question arises as to whether green space is planned and managed in a way that can draw new investment and residents and serve the local population, or whether trade-offs are being made. If so, questions are raised of what the underpinning logics of proposed greening are and who they are serving (Safransky, 2014; Walker, 2016). Clarifying this would require further research into the planning process and/or the outcomes of green space planning in these contexts.

Our results also suggest that while shrinkage is one factor driving expectations of UGS in city planning, it is not the only factor. Expectations of ecological functions developed significantly in both cities during the period studied. This mirrors broader trends in city planning: Nature in the city is no longer conceived of as a "refuge," but as a means of greening the city, with a more socio-ecological perspective and concerns for sustainability and wider environmental impact (Duvall et al., 2018). The idea that access to nature might increase environmental concern appears in the more recent plans, showing a changed perception of people's role in environmental protection. Around the time of Porto's 2006 report and Buffalo's later plans was also when concepts of ecosystem services and GI took off in the academic literature (Escobedo et al., 2019); this suggests that our findings align with broader shifts in green space planning trends. Other (non-shrinkage) factors also appear to be

at work in regards to social, cultural, and economic expectations. These include tourist demand in Porto; focus on using attractive landscapes to draw visitors away from the city center aligns with the strong impact of tourism described by Varady and Matos (2020).

The second hypothesis of this study was that shrinkage functions as a context in which UGS planning is conducted and thus indirectly affects UGS planning. Ecological concerns related to the cities' pasts appear to play a role in green space expectations and objectives: Where Buffalo is concerned with pollution from a long industrial history and many brownfield sites, Porto's documents show a higher concern with soil sealing, possibly due to green space loss over the 19th and 20th centuries (Madureira et al., 2011). Buffalo's more recent plans incorporate vacant land into the city's GI, suggesting that high vacancy as a result of shrinkage may affect the way in which GI is perceived and that vacant land is framed.

The introduction to this article shows that many of the concerns around green space in shrinking cities that are addressed in the literature are about vacant spaces and unmanaged land. However, the results show that most of the expectations of functions related to GI in shrinking cities are not related to these issues but rather to fulfilling objectives that would be relevant in any city, such as ecosystem services, or to resolving issues stemming from shrinkage such as attracting residents. This raises the question of whether vacant land is being fully integrated into the city's main green space planning, or if these issues still exist but are being dealt with in a different scope. As we see multifunctionality expectations for GI increasing over the years in shrinking cities, the integration of vacant land into the GI system could be a means of better meeting these expectations. However, as the introduction to the article notes, shrinking cities face challenges for planning and management that can sometimes lead to following traditional planning approaches. It seems this may be what is occurring regarding GI planning in these cities, even if the GI expectations are modified somewhat to meet specific challenges presented by shrinkage.

In this study, we investigated changing expectations for the multifunctionality of GI in shrinking cities. Future research could investigate other core GI principles, such as connectivity and equity, in a similar context. While we focused on overall UGS, research could also consider differentiated expectations by green space type, particularly vacant or abandoned space, which is a common research theme in shrinking cities. Likewise, while this study investigated planning approaches and intentions, a spatial analysis could inform us whether on-the-ground transitions towards GI occurred in these contexts.

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Conflict of Interests

The authors declare no conflict of interests.

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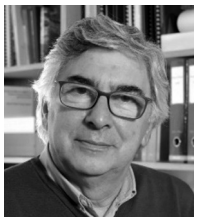
About the Author

Olivia Lewis holds an MSc in environmental science, policy, and management from the MESPOM program. At the time of publication, she was working towards a PhD in spatial planning at the University of Porto under the RE-CITY ITN program. Moving to an urban planning lens from previous research on urban gardens and gardening, she is interested in better understanding how and why people shape the natural environment around them and vice versa.

Sílvia Sousa is an urban planner and a senior researcher at CITTA—Research Centre for Territory, Transports and Environment, in the Department of Civil Engineering of the Faculty of Engineering of the University of Porto. She has been actively involved in national and international research projects with a special focus on historic centre management, shrinking cities, urban resilience, and public value capture. ORCID: https://orcid.org/0000-0002-3825-5389



Paulo Pinho is full professor and chair of spatial and environmental planning at the Faculty of Engineering of the University of Porto. He was the founder and has been the director of CITTA—Research Centre for Territory, Transports and Environment for the last 15 years. From 2015 to 2019, he was the secretary general of AESOP. His recent research focuses on urban metabolism and low carbon cities, urban morphology and metropolitan dynamics, shrinking cities, and new forms of urban space production.