



Regulating urban densification: what factors should be used?

SPECIAL COLLECTION:
URBAN DENSIFICATION

EDITORIAL

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HIGHLIGHTS

Urban densification is increasingly accepted as a necessity and is important for no-net land take. Densification occurs in many places, especially fast-growing cities with a combination of demographic change, economic pressure and large transport infrastructure projects. The costs and benefits of density require a nuanced understanding: potential direct, indirect and cumulative effects (environmental, economic and social), both on- and off-site. The optimisation of densities implies a need to identify the conditions that can create the most value for the city, specify the places most appropriate for future inhabitants and activities, and promote spatial justice. The papers published in this special issue converge in depicting urban densification as a complex, nonlinear process, which has to be addressed at various scales. Multifactorial metrics of density are superior to aggregated ones because they offer a better understanding of the urban forms and how they are experienced by inhabitants and users. Both hard and soft densification have to be duly monitored and regulated if cities are to avoid overcrowding of places and buildings, which can be detrimental to urban resilience. The relation between urban densification and housing affordability is a critical factor that policymakers must address.

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The expansion of built-up urban areas leads to a loss of agricultural land and green spaces (Foley *et al.* 2005). It tends to increase the distance travelled by car or public transport and contributes to habitat fragmentation. Accordingly, several cities and regions have adopted planning policies dedicated to fostering urban densification, through in-fill development and urban consolidation, in order to prevent a further expansion of urban areas and the concomitant artificialisation of open/green spaces.

Infill development is promoted by the European Commission through the no-net land take goal adopted in 2011 (Science for Environment Policy 2016). In practice, it means all developments on non-previously urbanised land should be offset by returning brownfield sites back to a natural state before 2050. It acknowledges the need to limit the urban encroachment on land to ensure sufficient land is provided for other purposes (e.g. agriculture, forestry, ecosystem services, biodiversity, etc.). This constitutes an important paradigm shift in the field of urban planning: land is now considered as a non-renewable resource, and therefore needs to be processed in a circular, closed-cycle approach, rather than in a linear, open-cycle one (Preuß & Ferber 2008). This no-net land take policy has been gradually adopted by several member states and/or European regions, with different thresholds, time horizons and trajectories. Its implementation will require the densification of existing urban areas to accommodate new households, new economic activities and new infrastructures.

This special issue investigates the specific challenges, impacts and fragilities that urban densification creates in many cities and the different scales where these can be found. Therefore, it questions the hegemonic discourse in favour of urban densification (Neuman 2005, Perez 2020) and proposes a more nuanced and holistic view of its costs and benefits. Although urban densification may provide several social, economic and environmental benefits, it is argued that densification requires assiduous monitoring and regulating by public authorities and urban planners to promote resilience and reduce fragilities.

This special issue's call for papers sought contributions that investigate, analyse and provide evidence on urban densification in a multidimensional perspective, considering economic, social and environmental factors that impact at different scales. Resistance to densification can be related to:

- *socioeconomic issues*: defending the rights of existing communities to maintain a low density in order to preserve affordable housing or local workplaces, etc.
- *environmental issues*: the protection of green areas included in already dense areas (Naess *et al.* 2020)
- *morphological issues*: cadastral inertia and difficulties in plot reallocation for larger developments (Gallagher *et al.* 2019)

Higher densities may also introduce new fragilities that reduce urban resilience. These different factors should be considered from a spatial justice perspective, balancing the individual and collective costs and benefits of densification. The significant questions for spatial justice related to governance are:

- What public institutions (at national, municipal and neighbourhood levels) have agency to incorporate these issues into their policies, assessments and practices?
- How do these institutions and their processes reflect the voices and needs of different groups, especially the most disadvantaged who may be more exposed to adverse consequences of densification?
- What links and connections operate between urban planning and individual building site level, and *vice versa*?
- What are the relevant data sources to steer existing urban densification processes, from the building to the metropolitan scale?

In this special issue, densification is framed as a boundary object, necessitating an interdisciplinary approach. It involves diverse disciplines such as human geography, urban and transport planning,

The call for papers led to a surprisingly few number of papers related to the environmental dimension of urban densification. The published papers are shown in **Table 1**. **Table 2** provides an overview of their scope, considered drivers and effects. The costs and benefits of urban densification on the local microclimate, air pollution and pressure on green spaces, both inside and outside the city, were not directly addressed in the submitted articles. Instead, several papers address the social and economic dimensions of urban densification, adopting a critical perspective as regards its motivations and outcomes. This reflects a growing interest for a critical understanding of the experience of densification by urban dwellers. This is especially the case of Asian cities that witnessed the most radical forms of urban densification over the last 20 years.

AUTHORS	TITLE	DOI
J. Teller	Regulating urban densification: what factors should be used? (Editorial)	10.5334/bc.123
B. Giddings & R. Rogerson	Compacting the city centre: densification in two Newcastle	10.5334/bc.74
G. Schiller, A. Blum, R. Hecht, H. Oertel, U. Ferber & G. Meinel	Urban infill development potential in Germany: comparing survey and GIS data	10.5334/bc.69
F. Kostourou	Housing growth: impacts on density, space consumption and urban morphology	10.5334/bc.75
N. Martino, C. Y. Girling & Y. Lu	Urban form and liveability: socioeconomic and built environment indicators	10.5334/bc.82
D. Godoy-Shimizu, P. Steadman & S. Evans	Density and morphology: from the building scale to the city scale	10.5334/bc.83
N. Livingstone, S. Fiorentino & M. Short	Planning for residential ‘value’? London’s densification policies and impacts	10.5334/bc.88
J. Rinkinen, E. Shove & M. Smits	Conceptualising urban density, energy demands and social practice	10.5334/bc.72
S. Angel, P. Lamson-Hall & Z. Gonzalez Blanco	Anatomy of density: measurable factors that constitute urban density	10.5334/bc.91
X. Li & M. Sunikka-Blank	Urban densification and social capital: neighbourhood restructuring in Jinan, China	10.5334/bc.70
J. Teller	Urban density and Covid-19: towards an adaptive approach	10.5334/bc.89
M. Berghauser Pont, P. Haupt, P. Berg, V. Alst�de & A. Heyman	Systematic review and comparison of densification effects and planning motivations	10.5334/bc.125

Table 1 Articles in this special issue ‘Urban Densification’, *Buildings and Cities* (2021), 2(1); guest editor Jacques Teller.

Table 2 Overview of the articles in this special issue ‘Urban Densification’: their focus, drivers and effects.

AUTHORS	SCOPE				MAIN DRIVERS	MAIN EFFECTS	
	NATURE	PURPOSE	SCALE	PROCESS		EXPECTED	OBSERVED
J. Teller (Editorial)	Functional/ structural	Descriptive/ normative	Multiscale	–	–	Multifactorial	Multifactorial
B. Giddings & R. Rogerson	Functional/ structural	Normative	Metro area	Hard versus soft densification	Policies	City attractiveness	Studentification, lack of affordability
G. Schiller, A. Blum, R. Hecht, H. Oertel, U. Ferber and G. Meinel	Structural	Normative	Country	Soft densification	Policies	No-net land take	–

AUTHORS	SCOPE				MAIN DRIVERS	MAIN EFFECTS	
	NATURE	PURPOSE	SCALE	PROCESS		EXPECTED	OBSERVED
F. Kostourou	Structural	Descriptive	Building	Soft densification	Micro-decisions	Affordability	Adaptability
N. Martino, C. Y. Girling & Y. Lu	Structural	Descriptive	Neighborhood	-	-	-	Urban liveability
D. Godoy-Shimizu, P. Steadman & S. Evans	Structural	Descriptive	From building to metro area	-	Evolution of building typologies	-	Energy use
N. Livingstone, S. Fiorentino & M. Short	Structural	Normative	Site level	Hard densification	Policies/real estate/finance	Value capture	Lack of affordability
J. Rinkinen, E. Shove & M. Smits	Functional/structural	Normative	Housing unit	Hard densification	Policies/real estate/finance	-	Social practices/urban metabolism
S. Angel, P. Lamson-Hall & Z. Gonzalez Blanco	Functional/structural	Descriptive/normative	Metro area	-	-	-	-
X. Li & M. Sunikka-Blank	Functional/structural	Intention	Site level	Hard densification	Policies/real estate/finance	Slum cleaning	Reduced social capital
J. Teller	Functional	Descriptive	From county to country level	-	-	-	Urban health
M. Berghauer Pont, P. Haupt, P. Berg, V. Alstäde & A. Heyman	Functional/structural	Descriptive/normative	Multiscale	-	-	Multifactorial	Multifactorial

Another series of papers is related to the measure of urban densification, considering both past densification and potential one. Interestingly most articles dedicated to the measure of urban density and densification propose a multifactorial set of indicators so as to disentangle the different dimensions of density, and their evolution over time.

2 SCOPE OF URBAN DENSIFICATION

Densification, intensification, consolidation and infill development are proximate concepts, which do not fully represent reality. Therefore, four alternative dimensions are proposed here. These are useful for addressing the scope of urban densification: its nature, purpose, scale and process.

2.1 NATURE: STRUCTURAL VERSUS FUNCTIONAL DENSIFICATION

The process of densification can typically be observed through two main variables, that is, through the increase of population and jobs (functional density) or of built floor area (structural density) within a defined area. Structural density can itself be addressed through a combination of two main indices, that is, the ground space index (GSI) and the floor space index (FSI). It is the combination of these two indices that provides a robust way to address the actual urban forms for a given value of density (Berghauer Pont & Haupt 2010).

Structural and functional densities are obviously related but may present divergences over time and space. This is especially the case when buildings undergo subdivision and subletting, which may imply an increase of population densities that goes faster than the corresponding increase of built areas. By contrast, the commodification of housing may imply a subsequent growth of the building stock (and an increase in built form) without a corresponding uptake by inhabitants/occupiers or fewer people in larger dwellings. Similarly, a decrease of population and/or jobs can occur without a subsequent decrease in terms of buildings or built area. This is the case of shrinking cities and, at a smaller scale, of brownfield sites.

Angel *et al.* and Martino *et al.* both propose a multifactorial set of indicators that address the dual nature of densification. Structural density can be measured through a series of variables, including parcel (site) size, network density, housing numbers, while functional density can be measured through the average number of people occupying a single dwelling or the number of jobs available in one area. This last factor is considered as an important dimension of urban liveability by Martino *et al.* They highlight that the economic vitality of an area is directly related to structural factors, such as centrality, the year built, but also the parcel area. This conclusion is directly in line with the early works of Jane Jacobs who considered building frontage as an important determinant of economic vitality, especially in the retail sector.

2.2 PURPOSE: NORMATIVE VERSUS DESCRIPTIVE

Two main uses of the densification concept can be distinguished.

The first approach is related to densification as an intention and denotes a resolve to increase urban density over time through different means in order to achieve predefined goals. In this perspective, the definition of densification is deliberately normative and performance based. It conveys the notion of dense urban areas associated with public spaces, an efficient transport system, a high level of walkability and excellent accessibility (Neuman 2005). Often termed as ‘intensification’, it basically postulates that densification is not a value in itself. It has to be associated with other services so as to effectively create a lively environment (Dempsey & Jenks 2010). This teleological conceptualisation is directly associated with the ‘new urbanism’ movement (Duany & Plater-Zyberk 1993) and the transit-oriented development agenda (Renne & Wells 2004: 12).

The second approach is more centred on the densification as a phenomenon, which can be measured and related with other variables. Densification is here understood as the progressive increase of built and/or population density over time (Mustafa *et al.* 2018). In this view densification may be planned and/or be driven by individual urban agents. It is not necessarily goal driven. It is always relative to a specific place or context, and may develop in very different urban configurations, both central and peripheral, with different speeds, driven by several factors and connected to a varied set of outcomes. This second approach is the dominant one in environmental and ecological sciences. It does not postulate that density may be inherently associated with benefits or costs. It is somehow presented as a ‘neutral’ variable.

This is, for instance, the case in the analysis of the incidence of urban density on the diffusion of Covid-19. Teller highlights that the issue keeps being contested, not the least because the definition of density is not consistent throughout studies and may cover different dimensions according to the complete set of variables considered in the study. This is certainly true for the distinction between density and connectivity, which are related but distinct features of the urban environment, but can be easily confused with each other.

The neutrality of any variable may always be contested, especially when applied to human environments such as cities or urban areas. As stated by Rinkinen *et al.*, urban metrics tend to be performative and the divide between normative and descriptive variables is highly questionable. Once a given variable has been somehow related with a given outcome, it is rapidly appropriated by actors and policies in developing their argument in favour or against some developments. Urban density and densification do not constitute an exception in this regard. Even though they were initially descriptive in their attempt to relate urban density with energy use, the works of Newman & Kenworthy (1989) were rapidly recycled through norms and regulations, sometimes very distant from the initial intensions of the authors.

Berghauser Pont *et al.* analyse the densification effects addressed in scientific studies when compared with those addressed in planning practice in Sweden. They reveal important inconsistencies between both spheres. These inconsistencies may be attributable to several factors, which include a difficulty in knowledge transfer from science to practice and, conversely, a lack of evidence to support some arguments frequently used by practitioners.

Angel *et al.* explicitly recognise this overlap between descriptive and normative dimensions of urban density. They decompose densification into a set of seven factors. They explain that density is a multifaceted phenomenon that requires a multifactorial approach involving both structural and functional factors. This provides greater clarity and understanding, especially to policymakers and planners. Their visual representation of density is designed to allow cities to better identify and administer an appropriate route for further densification.

2.3 SCALE: FROM THE HOUSING TO THE METROPOLITAN LEVEL

The issue of densification can be observed spatially through the variations of density across scales and places. The scales addressed in this special issue vary from the dwelling level to the metropolitan and country level.

Arguably the scale of analysis will affect the mere understanding of density and densification. At the housing level, densification is primarily related to overcrowding, but it can also be related to the rise of privacy and individualisation of housing. At the building and block scales, density is related to typologies and urban forms, while at the neighbourhood and agglomeration level it is primarily associated with the settlement structure, the provision of green spaces and the relation with transportation systems.

Several papers in this special issue adopted a multiscale approach.

Rinkinen *et al.* develop the argument that a lower density at the dwelling level may be associated with a better resource efficiency in an urban metabolism perspective. Their study of dwellings in Hanoi revealed that dwellings with larger floor areas had less dependency on technical devices and made greater use of local resources. In contrast, densely packed and smaller dwellings were extremely dependent on air-conditioning, washing machines and pre-packaged food.

Godoy-Shimizu *et al.* highlight the time and place dependence of densification processes through an analysis of the entire residential building stock of London. They reveal that urban densification took different forms over time. The prevalence of high-rise buildings is quite a recent one when considering the entire building stock of the city. The density of the building stock is measured at six scales, from the parcel (site) to the local authority level. Their highly detailed study reveals the great disparity of built densities across places in London and across scales. The microlevel analysis confirms that London's building stock is structurally dominated by low-to-medium-density buildings. High-density buildings are very concentrated in iconic areas, such as the City of London, which appears as very marginal when considered along with the rest of the building stock.

2.4 PROCESS: SOFT VERSUS HARD URBAN DENSIFICATION

Addressing urban densification as a process raises the issue of the relevant time scales along which to observe it. Accordingly, one may further distinguish two main forms of densification: soft versus hard. This division mirrors the divide between tactical and strategic urban planning.

Soft densification typically proceeds incrementally through continuous, small-scale adjustments of the urban fabric (Moudon 1986). It is basically a form of urban expansion, still proceeding in the direct continuity of existing buildings. Such incremental forms of densifications can be observed in several contexts. They may occur with or without authorisation or administrative overview. Soft densification is inherently a people-centred and bottom-up process that allows people to adapt houses to their needs. Nevertheless, it can be activated through policies, as in the case of the UK where small transformations of the built environment no longer require planning permission (Knight & Williams 2012). It may be observed in formal and informal urban settlements:

Residents manage density by building in largely incremental ways, enhancing precarious housing and infrastructure over time and learning how to negotiate multiple urban sites, actors, and networks in often highly volatile urban assemblages both within and beyond the neighbourhood.

(MacFarlane 2016: 635)

Soft densification is not easy to measure through conventional techniques, especially since this process may develop without any change to the building's footprint (as, for instance, in the case of vertical densification). Administrative data related to densification are not always reliable. There are also deficiencies in the statistics about demolition/reconstruction projects, lack of information about changes of building uses, etc.

By contrast, hard densification proceeds through large-scale policy-driven developments, involving the redevelopment of existing urban structures. These pre-existing urban structures may be unused places, such as brownfields, or densely occupied areas, for example, resulting from slum resettlement policies. Hard densification is usually conceived as a state-driven policy. In practice, it appears that many of these operations require private funding. The role of the state is often one of facilitator rather than one of developer, even in centrally planned contexts (Robinson *et al.* 2020). This has a direct effect on value-capture mechanisms associated with these operations, their impact on housing affordability and the final design of urban areas (provision of green spaces, privatisation of public areas, etc.).

Kostourou highlights that the existing urban organisation, in terms of building typology, network configuration and location, may be more or less prone to soft densification. Interestingly she refers to the notion of affordance to explain such processes. The notion of affordance was initially coined by Gibson in the field of the ecology of vision. It typically denotes the interplay between some structural features and human expectations. It can further be related to the pattern language of Alexander *et al.* (1977), who associated some specific configurations with given social practices. In the context of densification, this notion of affordance helps to better understand the mutual adaptation of buildings with their occupants over time. It allows one to overcome a cause-effect approach too common in urban densification studies.

These two strategies are directly related to the development model adopted by cities. Giddings and Rogerson highlight that urban densification may operate through a mono- or polycentric model. Interestingly the authors argue that hard densification projects may not be up to date with contemporary urban development. They are very dependent on the provision of retail and office space, which may lose some of their relevance with the development of Industry 4.0 and the rising dominance of e-commerce.

It should further be stressed that soft densification may ultimately lead to poor-quality dwellings and increased housing risks, through inadequate subdivisions, subletting or vertical extensions. Far from being innocuous, soft densification should be considered as an important yet challenging urban regulation issue because it operates through minor adjustments that may fall outside the scope of public surveying and whose cumulative effects are not entirely predictable (Dunning *et al.* 2020). It has become an even more pressing issue since the development of short-term housing rental platforms (e.g. Airbnb), which, besides their effects on residential densification, may lead to a further constraint on housing affordability for urban households (García-López *et al.* 2020). There is a need for non-conventional tools to monitor soft densification processes at the city scale in order to better regulate it.

3 MACRO- AND MICRO-DRIVERS OF URBAN DENSIFICATION

Much of the literature has been centred so far on macro-drivers of urban densification. Three main macrolevel forces contribute to densification of cities: demography, economy, and transport infrastructures. Policies somehow constitute a transversal factor that is affected by and influencing these three drivers.

3.1 DEMOGRAPHY

The population growth and urbanisation of the world's population is the first key driver of densification. Several cities, especially in the Global South, are facing extreme population growth and land shortages, which leads to a densification of existing areas, through either soft- or hard-densification processes. Rininen *et al.* and Li & Sunikka-Blank, respectively, address urban

densification in Hanoi (Vietnam) and Jinan (China). In both cases, densification is directly related to the spectacular growth of urban dwellers at the metro-scale. In Global North cities, one instead observes a structural densification of cities, partly driven by shrinking household sizes. The evolution of household size is itself related to the ageing of the population and evolution of the way of life. Single-person households are more dependent on urban services (Delmelle *et al.* 2014; Hernández-Palacio 2017). As discussed by Giddings & Rogerson, if cities are to maintain their population basis, they hence have to increase the number of dwellings, which is not always possible to achieve through a restructuring of the housing stock.

3.2 ECONOMY

The real-estate market desires the creation of places with high profitability, strategically located in large metropolises (Dave 2010). This mechanism is further fuelled by the financialisation of the real-estate sector and the commodification of housing, which act as a driver for more concentrated operations and attracting international investors (Aalbers 2016). Densification here appears as a means to increase value extraction by investors and developers. It is also increasingly seen as a means to finance social and/or public services such as affordable housing, sport facilities and green areas through negotiated planning gains. As suggested by Livingstone *et al.*, it is thereby associated with a form of ‘private Keynesianism’, which does not always deliver its promises.

3.3 TRANSPORT AND MOBILITY

Transport infrastructures act as a catalyst of urban densification by increasing the accessibility of specific places (Todes *et al.* 2018), reducing public transportation costs and increasing the cost by personal vehicle travel (Amer *et al.* 2017; Aquino & Gainza 2014; Hernández-Palacio 2017). Transit-oriented development around rail fosters the development of high-density development, which diminishes with the distance from stations (Delmelle *et al.* 2014). Other infrastructures such as bus rapid transit (BRT) also act as a driver of densification (Rode *et al.* 2017). It would be naïve to consider that transport infrastructure would mechanically lead to structuring effects such as densification. In many cases, it is the long-term combination of transport investments, urban policies and alignment of stakeholder agendas that contribute to densification, more than the sole transport infrastructure itself. Such urban concentration policies may also be associated with significant rebound effect. In the case of Newcastle in Australia (Giddings and Rogerson), the polycentric development of high-density urban areas along transport infrastructures is associated with a further degradation of the status of the historic centre.

Besides these macrolevel drivers, several the papers of this special issue considered microlevel drivers that may lead to densification.

3.4 AT THE HOUSING LEVEL

Kostourou highlights that the size and typology of houses, the configuration of parcel (site) and organisation of the street layout and the ownership cycles (number of owners in a given period of time) are associated with periodic reinvestments and extensions of the houses. These micro-adjustments may appear derisory at first, but they can contribute to a significant growth of building volumes in the medium to long term. She reports that soft densification led to an 82% increase of ground coverage and a 62% increase of the built volume over 120 years in the area under study. Besides the opportunities related to housing improvements and better use of existing infrastructures, this constitutes a significant pressure in terms of soil sealing and loss of open space.

3.5 AT THE PARCEL (SITE) LEVEL

Schiller *et al.* propose several useful criteria for cities and urban planners to identify the potential for infill development. The size of parcels and connection to existing streets appear as primary factors that may drive densification. Importantly, they acknowledge that this potential is theoretical. The reality is these parcels may not be available for development because their owners are not

interested in selling, in some cases for speculative reasons. Besides this, the parcel structure and its characteristics are an important driver or brake to urban densification. It is always easier to split than to aggregate parcels, especially when some or all of these are already built (Gallagher *et al.* 2019).

Such microlevel drivers are usually overlooked in the literature related to densification. One reason may be that it is much easier to collect data about macrolevel drivers and hard densification than it is for microlevel drivers and soft densification. More research is needed to closely monitor the actual occupancy of buildings. Activity-based usage is an important (but often neglected) source of densification for buildings in terms of dweller, worker or user numbers. It is also related to a potential source for infill development for those buildings whose occupancy level is low or non-existent. The development of high-resolution remote sensing, Lidar surveys and high-frequency data combined with urban micro-simulation techniques may contribute better ways to capture such phenomenon and, most importantly, to assess their cumulative large-scale effects on the long run.

4 EFFECTS OF URBAN DENSIFICATION

This special issue invited authors to address both the costs and benefits of urban densification, and to shift from an axiomatic perspective on the issue. The effects of densification can broadly be organised along environmental, economic and social dimensions. Berghauer Pont *et al.* propose a comprehensive review on the effects of urban densification, considering six categories. They highlight that effects related to transport have largely dominated the scientific agenda up to now. This is especially true for both the direct and indirect effects of transport, for example, air pollution and infrastructure costs. Understanding and anticipating these potential effects (whether positive or negative, promoted or endured) are essential for improving the regulation of urban densification.

4.1 ENVIRONMENTAL EFFECTS

4.1.1 Energy consumption

When estimating energy consumption, many authors acknowledge the positive effects of densification, even though most of them acknowledge that such an effect is not linear and place dependent (Conticelli *et al.* 2017; Asfour & Alshawaf 2015; Lima *et al.* 2019). The observed reductions of energy consumption are mainly related to compact building forms, but this may have detrimental effects on cooling loads in summer conditions (due to lack of capabilities for natural ventilation), especially in hot climates. Urban densification is also associated with reduced access to daylight, which might increase electrical consumption for lighting.

Godoy-Shimizu *et al.* address the relation between urban density and energy consumption at different scales, from the building to the metropolitan scale. Their study is based on actual energy consumption reported by households. It largely confirms the positive effect of density on energy consumption. This is especially the case for gas consumption (used primarily for space heating). Much less so for electricity. In both cases they stress that the relation between density and energy consumption is not smooth and will depend on building morphology: buildings with a higher density but less compact shape may consume more than lower density buildings with a more compact shape.

4.1.2 Air quality and urban microclimate

Transport is the largest cause of air pollution in many urban areas. An increased density is usually associated with congestion (Rode *et al.* 2017), and densification tends to increase the number of individuals exposed to pollution in cities (Yuan *et al.* 2017; Haaland & van den Bosch 2015). Reducing traffic emissions can partly improve air quality in urban areas. Therefore, urban densification should be implemented along with transport policies to combat pollution, which can give better results at both city and local levels. High urban densities are often associated with fewer green areas and higher amounts of anthropogenic waste heat, which tends to increase the urban

heat island (UHI) effect (Li *et al.* 2020; Conticelli *et al.* 2017). The impact of urban densification on the UHI effect has to be considered against those arising from an increased urban sprawl.

4.1.3 Mobility

Urban densification is associated with more use of public transport, less distances to cover and a reduction in the carbon footprint. Densification brings buildings (residence, offices, shopping) closer to each other, which encourage people to use softer modes of transport such as walking, cycling, *etc.* and to avoid using cars. People tend to use public transportation because they are more efficient in dense environment. Moving towards sustainable mode (trains, buses, walking) of transport reduces transport energy consumption and proves to be cost-effective. Despite the positive impact of densification, the problem of traffic congestion and its side effects, such as increased noise and emission, exist. The problem is more evident in the Global South because of very high densities in many cities and the unavailability of sufficient public transport infrastructure (Arifwidodo & Perera 2011; Rensburg & Campbell 2012).

4.1.4 Land use and biodiversity

Urban densification is associated with a reduced land take, which has a positive effect on the availability of land for agriculture, nature and biodiversity. At the urban level, various studies highlight that densification is usually associated with mixed land use, which allows a blending of residential, commercial and institutional activities in a given area. Mixed land use usually reduces transport costs and encourages walking and cycling due to short distances.

Schiller *et al.* address the mechanisms designed for no-net land take in Germany. Interestingly they reveal that densification is not restricted to large urban areas. A significant share of infill potential is located in small and medium-sized cities (fewer than 20,000 inhabitants). One-quarter of the potential is located in municipalities with fewer than 5000 residents. There are large disparities between different sizes of cities' human and technical resources for monitoring and steering infill development.

4.2 ECONOMIC EFFECTS

4.2.1 Housing affordability

The effects of densification on housing affordability are not straightforward. Some studies highlight that housing prices may become affordable when density increases due to the reduced size of housing units in compact development (short roads, fewer infrastructures). It may also have an effect on the supply chain (Lobaccaro & Frontini 2014). Densification through 'roof stacking' (additions at roof level) also proves to be cost-effective (Amer *et al.* 2017). Housing prices can also rise due to the high price and limited availability of land, and value capture by developers and investors. Many Asian and African cities suffer from limited availability of land with respect to population, hence the increase in housing cost (Boyko & Cooper 2011; Dave 2010; Todes *et al.* 2018).

Martino *et al.* highlight that housing affordability is one of the few dimensions of liveability negatively affected by density in the metro Toronto area. Livingstone *et al.* address the impact of densification policies in London on housing affordability. They find that it may not be density itself that drives higher housing prices. Instead, it is the interactions between private and public actors, with conflicting requirements as regard financial risks, potential economic benefits and demands for the production of affordable houses.

4.2.2 Economic attractiveness

Urban density is associated with a greater attractiveness for companies through agglomeration effects in the service sector, better location with regard to existing centralities and a greater adherence to public life in the streets of residential areas (Montgomery 1998).

Martino *et al.* highlight that the number of jobs is positively correlated with parcel size and centrality indices. They suggest that the effects of density and densification are best measured at

intermediate urban scales, that is, with a radius of 4800 m, which tends to imply that the economic benefits of density are diffusing well beyond the microlevel. This is a central finding of their research as the costs and benefits of urban densification are too often related to local inhabitants and activities, without considering possible spillover effects. Such an approach fits with MacFarlane's (2016) conceptualisation of urban density as a topological artefact, connecting places and people through material and immaterial flows. These spillover effects should be accounted for in urban regulation. Urban densification should be promoted in specific places, considering it will have a lever effect on surrounding spaces.

4.2.3 Infrastructure costs

Densification through infill development also reduces the cost of construction as existing infrastructure can be utilised by more households. This effect is well documented in the existing literature, especially in the economic costs of networks related to urban sprawl, and also when the number of potential users and the maintenance costs are taken into consideration (Halleux *et al.* 2008; Pflieger & Ecoffey 2011).

Quite strikingly two papers of this special issue, by Martino *et al.* and Kostourou, take opposite views on causal chains. They address how densification may be facilitated by the presence of a dense, highly connected road network, which is framed as an affordance for densification. Kostourou found that road density constituted a major hindrance in terms of economic costs at the construction stage. Later on, it appeared to offer more room for diversification of building adaptation over time. It helps to shift the focus from the motivations to the conditions for urban densification. The assessment of these conditions at the planning stage may improve the resilience of urban developments.

4.3 SOCIAL EFFECTS

4.3.1 Quality of life

This is one of the most important factors to consider when regarding densification. However, quality of life is very difficult to define and measure. Several studies show that high density results in smaller and sometimes overcrowded houses, which in turn leads to the social stress of living (Boyko & Cooper 2011; Poruschi & Ambrey 2018; Todes *et al.* 2018). In high-density situations, people are not satisfied with the size of their dwellings (Dave 2010). Many cities in China with high density are facing a negative outcome, leading to a worsening in the perceived quality of life (Wang & Shaw 2018).

Martino *et al.* consider the relation between density and liveability. Liveability is different from quality of life as it tends to focus on places, whereas quality of life tends to focus on people. The authors find that liveability is positively correlated with density, except for housing affordability. Rinkinen *et al.* address the relation between density and social practices at the housing and neighbourhood level. They highlight how social practices are deeply affected by densification, at both an individual and a household level. They recall that density and densification are directly associated with household structures, patterns of living and working, consumption and travel behaviour, and, more generally, attitudes towards the proximity of others.

4.3.2 Privacy

The proximity of adjoining residential buildings creates problems of overlooking and noise. Smaller dwellings lack internal space and between other houses, which results in lack of privacy. People may accept the lack of privacy as a trade-off against other considerations (Dave 2010), but not everyone has a choice in the matter. The social and cultural embrace of group living and bonding can help to adapt to the absence of privacy. This factor is linked to both perceived and physical densities.

High density is associated with gated communities in China. Li and Sunikka-Blank discuss the relation between density and privacy. In this circumstance of Jinan, privacy and density increased, but this reduced the social contact amongst local people. The previous urban typologies provided

more communal spaces for cooking, toilets and bathing, which afforded neighbours many opportunities to meet and form social bonds.

4.3.3 Access to services and facilities

The proximity and access to all services and facilities is an important dimension of the human development index (HDI). Densification allows better access and proximity of housing to various services and facilities such as schools, medical care, shops for daily needs, postal services, banking services, *etc.* Dave (2011) claims that cities in developing countries have better accessibility to services because of their mixed land-use planning, providing basic facilities at walkable distances. Sometimes a high floor area ratio (FAR) in small sites can lead to negative results due to an overcrowding of urban facilities (Wang & Shaw 2018). Unequal access to green spaces and urban services is observed in high-density areas. Both the availability and the pattern of distribution of green spaces are crucial in understanding these effects.

The provision of green infrastructures in a dense city is crucial for the benefit of residents. Green spaces (e.g. parks, open spaces, water features) should be maintained to provide several ecosystem services, including air quality, wildlife, biodiversity and water management. In addition, green infrastructures provide a place for social interaction exercise and recreational activities—increasingly important if dwelling sizes are small.

Schiller *et al.* argue that in-fill development and no-net land take policies should be balanced with the need to develop green areas, maybe of smaller size, within the urban fabric. Teller highlights that the demand for green infrastructure is especially pressing in exceptional urban conditions such as those the populations of world cities witnessed during the Covid-19 pandemic. This suggests that cities should increase the provision of green spaces so as to face such exceptional circumstances, especially in dense urban environments.

4.3.4 SOCIAL DIVERSITY AND CAPITAL

Densification is expected to promote social interactions and cultural diversity. It is also associated with a lower level of urban fragmentation. Some studies suggest that high-density areas have higher social safety and tolerance. People tend to share responsibilities and have an active neighbourhood. Todes *et al.* (2018) reveal that dense cities in South Africa are more demographically and economically diversified. Some studies have shown that high density negatively affects social interaction and community spirits and worsens social equity (Wang & Shaw 2018; Dave 2010; Zhu 2012; Romero-Lankao 2012). Some other studies were related to perceived form of densities (Dave 2010). There may be a ‘fear of the unknown’ amongst some residents.

Martino *et al.* highlight that urban density is positively correlated with social diversity in metro Montreal. However, Giddings and Rogerson show that a negative consequence of density can create homogeneity—a high proportion of students may inhabit one area due to the smaller size of housing units. Although there is an expectation of a mix of different residents, the densification strategies in London are mainly targeted at more affluent groups, and may further negatively affect housing affordability in neighbouring areas, as explained by Livingstone *et al.* And the evolution of social practices of inhabitants related to new urban configurations can negatively impact social capital. This is especially the case when there are latent divisions between ‘stayers’ and ‘newcomers’, as in the Jinan case analysed by Li and Sunikka-Blank.

5 CONCLUSIONS

Urban densification is increasingly accepted as a necessity. This is especially the case in fast-growing cities where a combination of demographic change, economic pressure and large transport infrastructure projects combine to foster densification. The costs and benefits of density need to be understood in a nuanced way, considering potential direct, indirect and cumulative effects, both on- and off-site. Regulating urban densification implies identifying the conditions

along with it can bring most value for the city and the places where it really makes sense for future inhabitants and activities.

The papers published in this special issue converge in depicting urban densification as a complex, non-linear process, which has to be addressed at various scales and across time. Multifactorial metrics of density were presented and shown to have significant advantages over aggregated ones, because they offer a better understanding of the urban forms at play and the experience of inhabitants. A critical issue for urban planners and decision-makers is addressing both structural and functional density, as well as making clear distinctions. Observed discrepancies between both dimensions over time and place are highly instructive of existing urban challenges, may these consist of overcrowding, speculative behaviours or building dereliction.

There is still a need to develop the time dimension of densification, especially on shorter time frames. Urban densities may be submitted to rapid fluctuations, on an hourly or a daily basis. These are related to the pulse of the city. As highlighted during the Covid-19 crisis, such 'instant densities' have a direct impact on urban health. They may also have lasting influences on the real-estate market and require adaptations at both the levels of building and urban infrastructures. Information technologies and social media play both a supporting and a revealing role in these instant densities.

Much research has been directed towards hard densification, which develops in specific places and can be planned strategically, even though public authorities may be prone to accept denser developments than what they initially planned. Less research has been directed towards soft densification that can be observed in several urban areas and proceeds through incremental adaptations of the building stock, a subdivision of existing buildings and an increase of inhabitants in existing buildings. Both processes have to be duly monitored and regulated if cities want to avoid the overcrowding of places and buildings, which can negatively impact urban resilience. As more data become available at the microlevel of buildings and households, this affords a greater in-depth understanding of the potential and effects of soft densification.

The relation between densification and housing affordability is a central issue for research and planning. If high density is related to more expensive and exclusive housing, the poor and working-class people may be pushed to the periphery or places with fewer services. It may force young households to inhabit increasingly smaller dwellings, with a lasting negative impact on our cities and societies. However, high density is not synonymous with exclusivity. This will typically vary with place, urban forms and time. In the Global South, density is associated with informal settlements and the urban poor. When considered from a historical perspective, the relation between high density and exclusive housing is a recent phenomenon. Not so long ago dense, urban environments and tower blocks were associated with post-war social housing projects in several European countries.

Accordingly, the relation between urban density and housing affordability is inherently political. It is largely determined by the way public authorities regulate access to urban land and the division of labour between private and public actors in the supply of housing. The present constellation of actors (e.g. large densification projects outsourced to private actors) is driving specific value-capture mechanisms that hinder housing affordability. The consideration of both the positive and negative impacts of densification can open a more nuanced understanding of the value of densification and who this value is for. Housing affordability and urban liveability should certainly be regarded as central values of densification (for either hard or soft densification). An important further requirement is a capability to understand the dynamic interactions and outcomes between densification and social practices, and how densification and density are actually experienced by inhabitants.

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COMPETING INTERESTS

The author has no competing interests to declare.

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