Title: **Heterogeneous urban fabrics**. Typo-morphological diversity as enabler of urban resilience: the case of Brussels

Author: Barbara Le Fort

Affiliated university: Université catholique de Louvain (UCLouvain) - Faculté d'architecture, d'ingénierie architecturale, d'urbanisme (LOCI)

Start - expected end year of PhD: 2013 - 2020

Supervisors: Prof. Yves Hanin & Prof. Jean-Philippe De Visscher

Abstract (150 words):

Urban heterogeneity in the Brussels Canal Zone offers great potential for innovative and adaptive urban redevelopment in order to meet Brussels' current and future challenges. This thesis aims to determine to what extent urban heterogeneity, analysed through the concept of typo-morphological diversity (TMD), is an enabler of urban resilience by guaranteeing urban fabric continuous adaptive capacity. From this hypothesis, this research explores adaptive processes of Brussels heterogeneous urban fabrics. First, analysis of the typo-morphological mapping has demonstrated the uniqueness of heterogeneous urban fabrics, and highlighted their internal organised complexity correlated to street hierarchy. Secondly, morphogenesis of paradigmatic case studies has demonstrated the high adaptability of heterogeneous street fronts through recurrent redevelopment processes and has revealed the particular impact of public space status and design on TMD. These results allow us to draft and evaluate scenarios to guide transformations of heterogeneous urban fabrics by guaranteeing urban resilience in Brussels.

Keywords: Heterogeneous urban fabric, Typo-morphological diversity, urban resilience, Brussels

To cite this paper: Le Fort (2019) 'Heterogeneous urban fabrics. Typo-morphological diversity as enabler of urban resilience: the case of Brussels', paper presented at the 2nd International European Urbanisms Seminar, Leuven

Introduction

The environmental crisis and the awareness of the finite nature of resources (Meadows, Meadows and Randers, 1972) coupled with the increase in urban population (United Nations, 2018) has raised the urban question to the rank of major objective of sustainable development (Charte d'Aalborg, 1994, Caron and Châtaigner, 2017). The increased awareness of the existing building stock value has guided urban strategies over the past two decades towards renovation, revitalization and recycling of obsolete or declining urban elements (D'Arienzo and Younès, 2014).

Within this perspective, the concept of urban resilience (Chelleri, 2012, Marcus and Colding, 2014, Toubin, Lhomme, Diab, Serre and Laganier, 2012), has been proposed as conceptual framework to develop alternative modes of urban development and planning including volatility, uncertainty, complexity and ambiguity (Bergevoet and van Tuijl, 2016, Durand and Paquot, 2017, Salat, 2017, Verebes, 2013). The definition of urban resilience, which has been applied in this research, refers to the capacity of an urban system 'to adapt to change, and to quickly transform systems that limit current or future adaptive capacity' (Meerow, Newell and Stults, 2016, p. 45).

Key attribute of urban resilience (Feliciotti, Romice and Porta, 2017), urban diversity – comprised of a mix of formal, functional and social mixes (Wood and Dovey, 2015, p. 65) – is crucial for urban adaptation and innovation (Ahern, 2013, Dovey, Pafka and Ristic, 2018, Jacobs, 1961). In the field of urban morphology, research has demonstrated the positive role of 'morphological mix' (Wood and Dovey, 2015, p. 65) for maintaining a continuous balance between urban robustness and adaptability (Marcus and Colding, 2014, Salat, 2017), which is a property of urban resilience (Chelleri, 2012, Meerow, Newell and Stults, 2016). Moreover, urban form components, namely the streets, the plots and the buildings (Vernez Moudon, 1997), have specific robustness and adaptability to change (Conzen, 1960, Vernez Moudon, 1986). For instance, the adaptation of building and plot patterns is more likely to occur than the transformation of the street network (Caniggia and Maffei, 2000 [1979], Conzen, 1960, Conzen, 1975). This outcome has lead us to investigate urban fabric adaptive capacity through the lens of the transformation of urban form components. In this context, typo-morphological diversity (hereafter TMD) is defined by a simultaneous diversity in street, plot, building and public/private interface types within urban fabric and street front.

This paper, which summarises a doctoral thesis, aims to determine to what extent TMD is an enabler of urban resilience by guaranteeing urban fabric continuous adaptive capacity. From this hypothesis, this research explores Brussels heterogeneous urban fabrics adaptive processes.

Urban heterogeneity in the Canal Zone of Brussels has great potential for innovative and adaptive urban redevelopment in order to meet Brussels current and future challenges. However, this heterogeneity is likely to disappear due to the current lack of in-depth knowledge of this spatial resource and its actual significant transformation. To bridge this knowledge gap, three methodological step-stones are considered: *typo-morphology* as a research tool to disaggregate, understand and describe complex urban forms (Vernez Moudon, 1997); *mapping* as a research method to produce spatial knowledge (Dovey, Pafka and Ristic, 2018); and *urban resilience* as a conceptual framework to evaluate the current and future adaptive capacity (Meerow, Newell and Stults, 2016) of Brussels heterogeneous urban fabrics.

From this triple methodological framework, this research investigates how to characterize TMD in the Brussels Canal Zone, and explores the TMD evolution during the complete adaptive cycle of paradigmatic heterogeneous urban fabrics facing contextual changes. Based on the TMD definition, a typo-morphological mapping has been built in order to identify and describe Brussels heterogeneous urban fabrics. From this original survey, a comparative morphogenetic analysis of case studies has been developed in order to examine TMD evolution during continuous complex adaptive processes.

Analysis of the typo-morphological mapping has demonstrated the uniqueness and the plurality of heterogeneous urban fabrics, and highlighted their internal organized complexity correlated to the street hierarchy. The morphogenesis of paradigmatic case studies has demonstrated the high adaptability of heterogeneous street fronts through recurrent redevelopment processes and has revealed the particular impact of public space status and design on TMD. Finally, these outcomes has allowed us to draft scenarios to make visible the current spatial mutations experienced in heterogeneous urban fabrics.

Theoretical framework and methodologies

Typo-morphological diversity (TMD)

Urban diversity (Jacobs, 1961) has recently been proven to be a key enabler of resilience of complex adaptive systems, allowing systems to implement multiple adaptation strategies (Feliciotti, Romice and Porta, 2017, Marcus and Colding, 2014). Applied to urban systems, urban diversity is generally measured in terms of the distribution of land uses (Dovey, Pafka and Ristic, 2018, van den Hoeck, 2008) or the geometry of morphological components (Dovey, Pafka and Ristic, 2018, Tarbatt, 2012, Wood and Dovey, 2015). However, urban diversity is a more complex concept. Recent works have therefore highlighted the need to consider 'morphological mix' inside urban fabrics (Wood and Dovey, 2015, p. 65) and 'spatial diversity' in the street system (Marcus and Colding, 2014, p. 54) within the urban resilience conceptual framework. We propose to combine these two concepts into a new one called 'typo-morphological diversity' (hereafter TMD), which is characterized by a simultaneous diversity in street, plot, building and public/private interface types inside the urban fabric and street front (Figure 1).

Figure 1. Compositional hierarchy of Brussels heterogeneous urban fabrics with a high level of typo-morphological diversity.

Figure 1 illustrates the concept of TMD with the 'compositional hierarchy' (kropf, 2017, pp. 5-6) of a Brussels paradigmatic heterogeneous urban fabric. This multi-level diagram disaggregates complex urban fabric into the main urban form components, namely streets, plots and buildings (Vernez Moudon, 1997), and urban fabric structures which articulate components, namely blocks and street fronts (Caniggia and Maffei, 2000 [1979], Conzen, 1960) and interfaces (Dovey and Wood, 2014). All these components and structures are nested and interrelated. In this case, every component and every structure present diversity. However, it should be noted that the Figure do not represent upper scale urban systems and territorial organisms (Caniggia and Maffei, 2000 [1979]), which affect the way urban fabric has been developed and transformed.

Building type diversity results from the mix of building typology (see Figure 2 caption) within the street front. Figure 1 illustrates a street front composed of at least five different building types. Plot shape diversity is the mix of plot shape and size within street front. Plot shape affects the way spaces are distributed inside and outside buildings. It thus affects building type diversity. Inversely, land use programming influences plot pattern. Narrow plots – around 6 meters wide – refer to the constructive system of Brussels typical raw houses (Ledent, 2017). Wide plots allow the development of urban industrial and logistics activities. Mixed configurations generate the design of medium width plots – between 7.5 and 9 meters wide – allowing either domestic or commercial activity on the frontage ground floor with 3 meters wide vehicular access to backyard workshop and warehouse. Irregular plots generally result from plot regrouping due to urban renewal projects.

Street network diversity is calculated with Space Syntax (Hillier and Hanson, 1984). Among the syntactic measurements present in Space Syntax theory, the choice value measures the flow of movement through the spaces and represents the potential for passage (Al_Sayed, Turner, Hillier, Iida and Penn, 2014). Spaces that offer a high value of choice have a greater potential for pedestrian and vehicle flows. The choice value calculation for Brussels (Mezoued and Letesson, 2018) was simplified into three hierarchical categories:

- The urban main axis links main urban and metropolitan centres and has a high choice value, which results in a high potential for passage induced by its position in the street network (Al_Sayed et al., 2014). This axis is a catalyst at the city level (Marshall, 2005).

- The local main axis is a lower level catalyst axis at the scale of the urban fabric (Marshall, 2005). It generally connects at least one main urban axis and has a medium choice value.

- The local axis with low choice value completes the local scale of street hierarchy.

The street network diversity illustrated at the bottom in Figure 1 presents a normal distribution of street categories (Salat, Labbé and Nowacki, 2011): few urban main streets surrounding the area, more local main streets crossing the area, and lots of local streets refining the urban mesh.

Building type, plot shape and width, and street hierarchy inform on public/private interface type. Researchers call depth or public/private interface the spatial configurations that provide access, through transition devices, from public to private space (Carmona, 2015, Clossick, 2017, Dovey and Wood, 2014, Habraken and Teicher, 1998). Spatial relationships between the location of economic activity on the plot and the street are essential to stimulate production, exchange, consumption and reproduction practices (Dovey and Wood, 2014). The interface diversity of street front is therefore a key factor in accommodating different activities within urban fabric. It is translated physically and spatially into three entry systems allowing plot internal distribution from the street:

- In homogeneous built typologies, the single entry system has an interface to a single type of space, a warehouse for example for productive types or dwellings for residential types.

- The separate entries system, also present in mixed configurations, dissociates, for productive types, logistical entrances (adequate access for motor vehicles or handling vehicles to productive or storage spaces) from administrative or private spaces (pedestrian access to administrative or residential spaces).

- Finally, the double entry system integrates both logistical access – or public access in the case of shops – and private access via a single entrance. In this configuration, access is shared between residents – users of residential spaces on the street side – and users of backyard semi-industrial spaces.

The street front is a portion of urban fabric composed of a row of built or unbuilt plots, placed contiguously along the same street-line (Conzen, 1960, kropf, 2017). The boundaries of street front are defined by the adjacent streets and by the bottom line of the plots composing it. The street front results from an urban process that combines the three urban from components. Three elements are therefore important to consider when defining and characterizing the street fronts of the canal territory:

- The status of the street, which defines the street front, as well as adjacent streets status;

- The position of the street front within the block, defined as a limited set of buildings or undeveloped plots surrounded by streets;

- The internal typo-morphological composition of the street front.

Street front diversity, which concerns the diversity of street fronts within urban blocks, results mainly from street network diversity (Le Fort and De Visscher, 2020 (in press)). The block diversity, which refers to the diversity of block shape, size and composition, results from socio-economic processes on spaces affected by topographical, cultural and urban heritage (Allain, 2004).

Considering urban diversity as a transcalar concept, the TMD concept allows for deep analysis of how urban diversity affects the adaptive capacity of urban fabric.

Urban resilience and adaptive cycles

As a systemic approach, the concept of resilience recognizes continuous change within complex adaptive systems (Holling, 1973), such as urban systems (Chelleri, 2012, Hassler and Kohler, 2014). The notion of continuous change has lead Holling, in collaboration with botanist Lance H. Gunderson, to propose the 'adaptive renewal cycle' model (Gunderson & Holling, 2002) to explain the different phases of formation and transformation of complex adaptive systems. In parallel, a great deal of research in urban morphology has shown that the urban form experiences cyclical periodic changes (Caniggia, 1994 [1986], Conzen, 1960, Kropf, 2001, Panerai, Demorgon and Depaule, 2018). These cycles are understood as the product of complex inter-scalar synergies between morphological components themselves and upper scale change processes (Allain, 2004, Feliciotti, Romice and Porta, 2018). To characterize complex continuous adaptive cycle experienced by urban fabric, Feliciotti et al. (2018) have applied the conceptual framework of 'adaptive renewal cycles' to morphological cycles. In doing so, they defined the urban adaptive cycle as four phases: creation, growth, collapse and reinstitution (Feliciotti et al., 2018, pp. 3-4). This definition has been used as a methodological framework for the study of heterogeneous urban fabric adaptive cycles.

Main findings

TMD mapping

By classifying the elements of urban form by type, typology is both a method and an outcome. It allows us to get away from the collection of isolated objects and to understand, with a certain level of abstraction, the complexity of urban fabrics (Allain, 2004, p. 23). Considering building types as a spatial referent for mapping heterogeneity (Le Fort, 2019), we developed a typology based on two criteria (see Figure 2). First, we consider the ordinary building as a physical and spatial translation of the function it hosts. We thus defined the typology from the initial function of the building, namely housing, retail, production, amenity and tertiary activity. Secondly, we operated a distinction between homogeneous configurations, which present only one function on the plot, and mixed configurations, which allow for two or more functions on the same plot.

Figure 2. Detail of TMD map for Brussels Canal Territory. Labels 1-3 show case studies presented in Figure 4.

The Canal Territory, as defined in the Plan Régional de Développement Durable PRDD (2018), and the chaussée de Gand – one of the oldest economic axis of Brussels – have been chosen for the typological mapping in order to maximise the variety of heterogeneous street fronts. Figure 2 shows a detail of this unprecedented mapping from Beco Dock on the north to Heyvaert disctrict on the south. At first sight, Figure 2 highlights the uniqueness and the complexity of every heterogeneous street front. However, some recurrent structures appear, such as nodes, axes and areas (highlighted respectively with circles, rectangle and dashed rectangle in Figure 2) presenting the same typo-morphological logic of street front organisation. Next sections will analyse this typo-morphological logic in order to understand how heterogeneous urban fabrics are organised (Figure 3) and how they adapt to change during a complete adaptive cycle (Figure 4).

Coherent typo-morphological logic

This section is based on the hypothesis that there is a typo-morphological logic in the organisation of heterogeneous urban fabric (Castex, Céleste and Panerai, 1980). After having identified and classified the different street fronts mapped within the Brussels Canal Territory, we noticed the predominance of some simple and coherent typo-morphological combinations, as synthetized in Figure 3:

- Mixed home-shop units (blue) are installed on corners and, in the case of irregular street fronts, on the crossing parcels with a storefront on main urban axis and a logistics entrance on another side of the block, articulated to a secondary street;

- Homogeneous productive units (pink) and mixed house-workshop (orange) units are located in the middle of the street front where they benefit from the greatest depth;

- In the case of rectangular street fronts (first column in Figure 3), the location of homogeneous productive units is more random and results from a regrouping of several parcels. Mixed house-workshop (orange) units take the form of T or L after buying the back of neighbouring parcel, increasing the floor area dedicated to productive activity;

- Heterogeneous street fronts are generally located on local main axis directly connected to an urban main axis, along which commercial-dominant street fronts (first row in Figure 3) are generally located.

Figure 3. Synthesis of main typo-morphological logics observed within Brussels' heterogeneous street fronts.

The great majority of heterogeneous street fronts follows these typo-morphological logics. However, it would be regrettable to reduce the richness of Brussels heterogeneity to these major typo-morphological principles. The uniqueness of Brussels heterogeneous street fronts depends mainly on local and historical factors, such as the location and development period of the street front. The next section illustrates this uniqueness by presenting a morphogenesis of three sets of street fronts, organized in blocks.

Recurrent redevelopment processes

Extract from a paper written with Jean-Philippe De Visscher (2020 (in press)), this section investigates the evolution of heterogeneous urban fabrics during a complete adaptive cycle of formation and transformation in order to study the physical and spatial adaptations of heterogeneous urban fabrics in response to socioeconomic-political cyclical events. Based on detailed morphogenesis, Figure 4 presents a synthetic comparison of three Brussels case studies experiencing complete adaptive cycle. It highlights four recurrent typo-morphological processes, particularly visible on plot patterns evolutions (Figure 4, labels 1-4).

Figure 4. Comparative synthesis of case studies adaptive cycles highlighting four recurrent typo-morphological processes (labels 1-4).

Label 1 shows the dominant principle of development during the urban fabric growth phase, namely the erection of industrial buildings on large plots in the middle of street fronts. These large median plots show slower adaptive cycle but a more radical mutation process than the smaller ones. The current socio-economic shift of the area – from a productive area into a more residential one – drives their conversion into public spaces, as indicated by label 2. Consequently, the dominant principle highlighted on label 1 is reversed during the reinstitution phase: current main plot pattern modifications and typological mutations occur on corners facing – refurbished – public spaces (label 3). Finally, label 4 highlights the loss of medium-size plots due to plot amalgamation in order to replace mixed productive buildings by denser residential typologies. More broadly, this 'residentialisation' process is visible on a wider scale by the current drastic conversion of productive and logistic buildings into residential ones (De Beule, Boswell, Doornaert and Hanssens, 2012, De Voghel, Strale, Boswell and Coekelberghs, 2018).

This outcome confirms the general hypothesis that TMD is an enabler of urban resilience by guaranteeing urban fabric continuous adaptive capacity. However, it is important to note that the majority of these morphological processes are conditioned by street network properties. During the creation and growth phases, the diversity of street status, lengths and profiles fostered a balanced diversity of plots and building types, organised within a variety of street fronts. During the reinstitution phase, the decrease in the street network diversity was followed by an equivalent decrease in plot diversity, with the disappearance of large plots and the merging of medium and small corner plots. This current 'residentialisation' of street profiles and

the current decrease of TMD indicates that TMD is not self-regenerating (Le Fort and De Visscher, 2020 (in press)).

Visions

Considering the continuous loss of TMD due to above-mentioned redevelopment processes, this section aims to question the future adaptive capacity of these urban fabrics with scenario-based approach. The objective is to make visible the current spatial mutations experienced in heterogeneous urban fabrics. Figure 5 shows four different visions of Heyvaert district based on the extrapolation of the four recurrent redevelopment processes. More broadly, these four visions, some of which are contradictory, tackle main Brussels urban challenges (PRDD, 2018) and refer to main urban revitalisation trends currently observed in Brussels Canal Zone.

Figure 5. Scenarios of heterogeneous urban fabric mutations based on observed recurrent typo-morphological redevelopment processes.

Vision 1 reinterprets the dominant principle of productive plots in the middle of street front. Answering the need for integrated small productive spaces in the city, it proposes an optimization of open spaces - productive courtyards - around which a cluster of complementary activities is set up. In doing so, the use value of these spaces is increased. In addition, the pooling of spaces and services due to clustering makes it possible to cope with the rising land price.

Vision 2 extrapolates the transformation of the hearts of industrial blocks into a new network of public spaces of sociability, which meets the need for more open green spaces in dense urban area. These new public spaces allow the opening of new facades offering the possibility of installing neighbourhood amenities. However, the loss of large productive plots, especially along canal infrastructure is irreversible and the risk of district gentrification is high.

Vision 3 enhances the process of intensifying angles, especially at the right of canal infrastructure where the width of the open space allows for the erection of higher iconic buildings. This densification by grouping corner plots is preceded by a redevelopment of the public space into squares where neighbourhood activities, terraces and playgrounds take place. This scenario reinforces the public space 'residentialisation', which leads to a decrease in TMD.

Finally, vision 4 reproduces the process of grouping medium-size plots for the construction of apartment buildings on a commercial or productive base, which is the architectural translation for urban diversity. The spaces for sociability are privatized and landscaped on the base, which presents a homogeneous frontage to the public space. While these macro-lots optimize the urban spatial resource by superimposing one or more activities, they have a very rigid architectural form which questions future adaptations (Lucan and Hidalgo, 2012).

This exercise confirms that urban heterogeneity in the Canal Zone of Brussels has great potential for innovative and adaptive urban redevelopment in order to meet Brussels current challenges. However, as Meerow et al. have warned, urban changes 'should not become highly adapted to current conditions at the expense of general adaptive capacity' (2016, p.45). Without a global vision of TMD management, the future adaptive capacity of urban fabrics in the Canal Zone is not guaranteed.

Discussion and conclusion

The research results are twofold: fundamental and applied. On the one hand, the identification of heterogeneous urban fabrics contributes to the research field in urban morphology by addressing a subject that is still insufficiently studied: complex heterogeneous urban fabrics. Our research therefore questions the

principle of 'homogeneity' (Conzen, 1960, p. 5, Merlin and Choay, 2015, p. 766) conferred on urban fabrics and prefers the idea of coherent typo-morphological logic. In doing so, we complete the definition of urban fabric up to complex urban spaces whose study has so far been lacking. The analysis on the relation between typo-morphological properties and heterogeneous urban fabrics adaptability to contextual changes brings new knowledge on the relationships between urban form and urban resilience.

On the other hand, the unprecedented mapping of Brussels heterogeneous urban fabrics shed light on their complexity and uniqueness. The typo-morphological analysis of heterogeneous street fronts revealed their internal organized complexity and demonstrated that they result from a spontaneous process of urban development correlated to the street hierarchy. In the context of Brussels, TMD allows for urban fabric adaptability during collapse and reinstitution phases, during which resilience is a value.

Heterogeneous urban fabrics with high TMD are thus more likely to adapt to change than homogeneous ones. In a context of current urban and environmental crisis, TMD appears to be a resilient common capital to be maintained, protected and regenerated. However, due to the current lack of urban planning tools adapted to this challenge, we observe the depletion of this spatial resource caused by the multiplication and accumulation of redevelopment processes, such as urban blocks fragmentation, loss of medium size plots, corner intensifications, and public space redefinition. It is crucial to consider urban diversity and resilience with a systemic approach at urban fabric level and not only at the scale of mixed and flexible buildings. To reach this objective, it is important to implement cross-disciplinary and transcalar approaches bringing together urban actors from different sectors and territorial levels in order to plan and accompany simultaneously the evolution of streets, plots and buildings. Urban fabric and street front should be considered as strategic urban scales, with regard to upper and lower scales influences and systemic interrelations. These recommendations require the implementation of a continuously updated TMD monitoring system. Finally and more fundamentally, this research highlights the need to acknowledge the role of TMD in urban resilience strategies.

References

Charte d'Aalborg (Danemark: Conférence européenne sur les villes durables, 1994)

Plan Régional de Développement Durable PRDD (Bruxelles: Région de Bruxelles-Capitale, 2018)

Ahern, Jack 'Urban landscape sustainability and resilience: the promise and challenges of integrating ecology with urban planning and design', *Landscape Ecology 28/6* (2013), 1203-1212

Al_Sayed, Kinda, Turner, Alasdair, Hillier, Bill, Iida, Shinichi and Penn, Alan *Space Syntax Methodology* (London: Bartlett School of Architecture, UCL, 2014)

Allain, Rémy *Morphologie urbaine : géographie, aménagement et architecture de la ville* (Paris: Armand Colin, 2004)

Bergevoet, Tom and van Tuijl, Maarten *The Flexible City, Sustainable Solutions for a Europe in Transition* (Rotterdam: Nai010 Publishers, 2016)

Caniggia, Gianfranco 'Lecture de Florence', in: Sylvain Malfroy (eds.), *L'approche morphologique de la ville et du territoire* (Bruxelles: Institut Supérieur d'Architecture Saint-Luc Bruxelles, 1994 [1986]),

Caniggia, Gianfranco and Maffei, Gian Luigi *Composition architecturale et typologie du bâti : 1. lecture du bâti de base* (Versailles: Ville Recherche Diffusion, 2000 [1979])

Carmona, Matthew 'London's local high streets: The problems, potential and complexities of mixed street corridors', *Progress in Planning 100/*(2015), 1-84

Caron, Patrick and Châtaigner, Jean-Marc *Un défi pour la planète: les Objectifs de développement durable en débat* (France: IRD Éditions, 2017)

Castex, Jean, Céleste, Patrick and Panerai, Philippe *Lecture d'une ville : Versailles* (Paris: Moniteur, 1980)

Chelleri, Lorenzo 'From the «Resilient City» to Urban Resilience. A review essay on understanding and integrating the resilience perspective for urban systems', *Documents d'Anàlisi Geogràfica 58/*(2012), 287-306

Clossick, Jane 'The Depth Structure of a London High Street: A Study in Urban Order', PhD dissertation (London Metropolitan University, 2017)

Conzen, Michael Robert Günter *Alnwick, Northumberland: A Study in Town-Plan Analysis* (London: Institute of British Geographers, 1960)

Conzen, Michael Robert Günter 'Geography and townscape conservation', in: H. Uhlig and C. Lienau (eds.), *Anglo-German Symposium in Applied Geography* (Giessen-Würzburg-Munchen: 1975), 95-102

D'Arienzo, Roberto and Younès, Chris *Recycler l'urbain : pour une écologie des milieux habités* (Genève: MētisPresses, 2014)

De Beule, Michel, Boswell, Ralph, Doornaert, Alain and Hanssens, Bart *Observatoire des activités productives. Evolution 1997 - 2011* (Bruxelles: Ministère de la Région de bruxelles-Capitale et SDRB, 2012)

De Voghel, Christophe, Strale, Mathieu, Boswell, Ralph and Coekelberghs, Sophie *Observatoire des activités productives. Immobilier logistique et état des lieux 2017* (Bruxelles: perspective.brussels, Bruxelles Mobilité & citydev.brussels, 2018)

Dovey, Kim, Pafka, Elek and Ristic, Mirjana *Mapping Urbanities. Morphologies, Flows, Possibilities* (New York: Routledge, 2018)

Dovey, Kim and Wood, Stephen 'Public/private urban interfaces: type, adaptation, assemblage', *Journal of Urbanism: International Research on Placemaking and Urban Sustainability 8/1* (2014), 1-16

Durand, Anne and Paquot, Thierry *Mutabilité urbaine : la nouvelle fabrique des villes* (Gollion: Infolio, 2017)

Feliciotti, Alessandra, Romice, Ombretta and Porta, Sergio 'Urban regeneration, masterplans and resilience: The case of Gorbals, Glasgow', *Urban Morphology 21(1)/*(2017), 61-79

Feliciotti, Alessandra, Romice, Ombretta and Porta, Sergio *From system ecology to urban morphology: towards a theory of urban form resilience* (Barcelona: 2018)

Habraken, N. John and Teicher, Jonathan *The structure of the ordinary : form and control in the Built Environment* (Cambridge, Massachusetts: MIT Press, 1998)

Hassler, Uta and Kohler, Niklaus 'Resilience in the built environment', *Building Research & Information 42/2* (2014), 119-129

Hillier, Bill and Hanson, Julienne *The social logic of space* (Cambridge: Cambridge University Press, 1984)

Holling, Crawford S. 'Resilience and Stability of Ecological Systems', *Annual Review of Ecology and Systematics 4/*(1973), 1-23

Jacobs, Jane *The death and life of great American cities* (New York: Random House, 1961)

Kropf, Karl S. 'Conceptions of change in the built environment', *Urban Morphology 5/1* (2001), 29-42

kropf, Karl S. *Bridging configurational and urban tissue analysis* (Lisbon: Instituto Superior Técnico, Departamento de Engenharia Civil, Arquitetura e Georrecursos, Portugal, 2017)

Le Fort, Barbara *Brussels Urban Recycling: Industrial Buildings as Resource* (Lisbon: 2019)

Le Fort, Barbara and De Visscher, Jean-Philippe 'Typo-morphological diversity and urban resilience: a comparative study of three heterogeneous blocks in Brussels', *Urban Morphology* (2020 (in press)),

Ledent, Gérald 'Genèse de la maison bruxelloise', in: Priscilla Ananian and Bernard Declève (eds.), *Montréal et Bruxelles en projet(s)* (Louvain-la-Neuve: Presses universitaires de Louvain, 2017), 127-154

Lucan, Jacques and Hidalgo, Anne *Où va la ville aujourd'hui ? : Formes urbaines et mixités* (Paris: Ed. de la Villette, 2012)

Marcus, Lars and Colding, Johan 'Toward an integrated theory of spatial morphology and resilient urban systems', *Ecology and Society 19/4* (2014)

Marshall, Stephen *Streets and patterns* (New York: Spon Press, 2005)

Meadows, Donella H., Meadows, Dennis L. and Randers, Jørgen *The limits to growth : a report for the Club of Rome's project on the predicament of mankind* (New York (N.Y.): Universe books, 1972)

Meerow, Sara, Newell, Joshua P. and Stults, Melissa 'Defining urban resilience: A review', *Landscape and Urban Planning 147/*(2016), 38-49

Merlin, Pierre and Choay, Françoise *Dictionnaire de l'urbanisme et de l'aménagement* (Paris: PUF, 2015)

Mezoued, Aniss and Letesson, Quentin 'Repenser le partage de l'espace public pour un hypercentre marchable', in: Brussels Studies Institute - Brussels Centre Observatory (eds.), *Portfolio #2 Zoom In | Zoom out on the Brussels city centre* 2018), 61-77

Panerai, Philippe, Demorgon, Marcelle and Depaule, Jean-Charles *Analyse urbaine* (Marseille: Parenthèses, 2018)

Salat, Serge 'A systemic approach of urban resilience: power laws and urban growth patterns', *International Journal of Urban Sustainable Development 9/2* (2017), 107-135

Salat, Serge, Labbé, Françoise and Nowacki, Caroline *Les villes et les formes : sur l'urbanisme durable* (Paris: Hermann, 2011)

Tarbatt, Jonathan *The plot : designing diversity in the built environment : a manual for architects and urban designers* (London: RIBA Publishing, 2012)

Toubin, Marie, Lhomme, Serge, Diab, Youssef, Serre, Damien and Laganier, Richard 'La Résilience urbaine : un nouveau concept opérationnel vecteur de durabilité urbaine ?', *Développement durable et territoires 3/1* (2012), 1-18

United Nations *The World's Cities in 2018 : Data Booklet* (New-York: 2018)

van den Hoeck, Joost W. *The MXI (Mixed-use Index) as Tool for Urban Planning and Analysis* (Brussels: Faculty of Architecture at the Delft University of Technology, 2008)

Verebes, Tom *Masteplanning the Adaptive City* (London: Routledge, 2013)

Vernez Moudon, Anne *Built for Change: Neighborhood Architecture in San Francisco* (Cambridge, Massachusetts: MIT Press, 1986)

Vernez Moudon, Anne 'Urban morphology as an emerging interdisciplinary field', *Urban Morphology 1*/(1997), 3-10

Wood, Stephen and Dovey, Kim 'Creative Multiplicities: Urban Morphologies of Creative Clustering', *Journal of Urban Design 20/1* (2015), 52-74